Standardisation and Variety Reduction for Higher Productivity

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Introduction

Importance of standardisation and variety reduction was realised in the United States of America during the First World War when, owing to acute shortage of materials and technical manpower, conservation in every respect became a matter of strategic necessity. The War Industries Board achieved conspicuous results through enforced restrictions on variety to increase production capacity of the industry. After the termination of the First World War, Mr. Herbert Hoover appointed a Committee on Elimination of Wastage in Industry. The Committee enquired into the conditions of a large number of typical industries and came to the conclusion that the overall productivity in American Industries was not more than 50 percent of the possible maximum due to existence of unnecessary variety. A nation-wide movement for simplification in Industry was started through the agency of the Simplified Practice Division of the United States Department of Commerce. In many cases, reduction in variety ranging from 24 to 98 percent was brought about. To cite a few examples, 33 different lengths and 44 different heights of hospital beds were replaced by 3 types of beds of standard length and height and 40 different varieties of milk bottles were reduced to 4.

The Second World War led to a further impetus to standardisation and variety reduction in the United States, which continued unabated after the war. A typical example is the achievement of US Defence Department for cost reduction through standardisation, simplification and variety reduction. At the initial stage, the cost reduction was of the order of 500 million dollars per year and by 1967 it is excepted to be nearly double the amount per year. In recognition of the efforts, the Standards Engineers Society of America awarded its first Leo B. Moore prize to Mr. Robert S. McNamara, US Defence Secretary, under whose leadership the programme was carried out.

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in the United Kingdom, a committee similar to the Hoover Committee was constituted in 1948 under the Chairmanship of Sir Ernest Lemon with the following terms of reference :

> "To investigate, in consultation with the British Standards Institution and appropriate organisations, the methods by which manufacturers and users of engineering products determine whether any reduction in the variety of products manufactured is desirable in the light of technical, commercial and other considerations; to report whether these methods are adequate and what, if any, further measures should be taken by Industry or by the Government to ensure that such simplifications as are determined are put into effect."

The Committee came to the conclusion that in many branches of engineering industry, variety could be reduced with great benefit to the industry, trade and general consumers. Its observation on economics that could be secured through standardisation is worth quoting :

> "There can be no question that unnecessary variety of product at any stage of manufacture lowers efficiency. The loss is not confined to any one stage of manufacture, but extends to the supply of raw materials and components. It also applies to all phases of distribution and to the ultimate user. The latter is not only faced with the resulting higher prices but often with related problems of non-interchangeability, delay in obtaining non-standard spare parts, increased stocks and unnecessary design and administrative work. Because the technical and economic problems of standardisation and reduction of variety are complex, it is often not realised how large are the overall savings which can be made by increasing the length of production runs as a result of eliminating or reducing the manufacture of specials or small batches."

A survey conducted by the Indian Standards Institution (ISI) to collect available data with regard to the present and future requirements of various types of steels in terms of tonnage, specifications and, where possible, forms, shapes and sizes, indicated that the demand exists for well over 1500 varieties of alloy and special steels, including tool steels in the country. In most of the cases, the demand was for small quantities of material which precluded the possibility of developing indigenous production. The survey indicated that the demand had been generated because of overseas collaboration with industrial units from a number of countries. As a result of intensive efforts, it was possible to reduce the variety from 1500 to 156 types of special and alloy steels, considered adequate to cater to various requirements. An attempt has also been made to minimise the use of imported alloy ingelements, such as nickel and molybdenum, and to encourage the use of indigenously available alloying elements, such as manganese and chromium. The ISI study resulting in the preparation of Indian Standard schedules for wrought steels for general engineering purposes (IS:1570-1961), has made it possible to plan the establishment of new alloy steel plants in the country. With the outbreak of hostilities with Pakistan, need for further reduction of variety of alloy steels received consideration and ISI committee recommended, as an emergency measure, that production in the country should be restricted to 76 varieties only for maximum economy during emergency.

Mathematical Formulae

For mathematical proof of the benefits from standardisation and variety reduction, the following theories, advocated by the leaders in the field, may be referred to :

Monsieur Caquot, past President of French Standards Body (AFNOR), propounded an approximate theory, which has subsequently been verified. According to this theory, in a manufacturing organisation the unit price of an article mass produced, varies inversely as the fourth root of the number of articles produced :

$$P_v = \frac{K}{\sqrt[4]{N_0}}$$

where P_0 = Cost of an article

N_0 = number of articles produced

K = a constant

If N_1 articles are produced, cost of unit article will be :

$$P_1 = \frac{K}{\sqrt[4]{N_1}}$$

$$\text{or} \; \frac{P_1}{P_0} = \sqrt[4]{\frac{N_0}{N_1}}$$

$$\text{If } N_1 = 16 \text{ No} \quad \frac{P_1}{P_0} = \sqrt{1/6} = 0.50$$

$$\text{If } N_1 = 2 \text{ No}, \frac{P_1}{P_0} = \sqrt[4]{\frac{1}{2}} = 0.84 \text{ (approx.)}$$

That is, by doubling the volume of production during continuous operation, the cost of unit is reduced to 84 percent; or in other words, by restricting variety and concentrating on volume production, manufacturing cost could be reduced considerably.

A similar theory, called *LEARNING CURVE*, has been advocated by the Stanford Research Institute after a statistical study of direct labour input of all aircrafts produced in USA during the Second World War. The theory is based on the hypothesis that a worker learns as he works; and the more often he repeats an operation, the more efficient he becomes, with the result that a direct labour input per unit declines. Data on direct labour hours on successive manufacture of different kinds of aircrafts—bombers, fighters, etc.,—indicated that the rate of improvement followed a uniform pattern. Once production started, the fourth unit was found to require about 80 percent as much direct labour as the second unit; the tenth 80 percent as much as the fifth; the 200th 80 percent as much as the 100th, and so forth—in each case, a reduction of 20 percent between doubled quantities. Because of this uniform pattern, the aircraft industry's rates of learning was approximated at 80 percent between doubled quantities.

The experience based on aircraft industry was found to be applicable to other industries and learning curve concepts are now used to forecast labour time and cost per unit product to selling prices, plan delivery schedules, calculate capital and labour needs and so on. The curve also indicates the desirability of standardisation of methods and processes for higher labour output.

The third theory is a deduction from inventory control principles, according to which Economic Order Quantity for procurement is given by the formula :

EOQ : $Q = K\sqrt{A}$

where Q = economic order quantity in rupees
A = annual consumption in rupees
K = constant

Let us assume that through conscious attempt towards variety reduction it was possible to standardise a part for use in two different products, whose consumptions were rupees 10,000 and 22,500 per annum respectively. Since economic order quantities for procurement of the item are :

$$Q1 = K\sqrt{10000} = 100K$$

and $$Q2 = K\sqrt{22500} = 150K$$

Average inventory for the parts would be

$$\frac{Q1 + Q2}{2} = \frac{100 + 150}{2}K = 125K$$

For the standardised part, annual consumption would be Rs. 32,500.

Hence $$Q3 = K\sqrt{32500} = 180K.$$

Average inventory = 90 K.

Therefore, a reduction of inventory by $\left(1 - \frac{90}{125}\right) 100 = 28$ percent.

National Efforts for Variety Reduction

National standards provide a very potent instrument for reducing unnecessary variety to augment resources of the nation. The example of special and alloy steels referred to earlier can be examined in this connection. The 156 varieties in IS : 1570-1961 or 76 varieties recommended for use during emergency, represent the minimum number required to meet the need for all economic sectors concerned. Thus, a basis is available to regulate the demand of the users, and this would automaticallv lead to rationalised production in the country. Some other examples of variety reduction attempted through Indian Standards selected at random are :

	Original Variety	*Reduced Variety*
Cast iron pipes and fittings	Over 2000	638
Electric Cables	43	18
Electric Winding Wires	150	75
Automobile lamps	400	43
Automobile batteries	220	8
Jute Bobbins	63	3
Rectangular tins	Over 100	7
Round Paint tins	70	7
Steel drums	20	13

Adoption of national standards alone does not result in desired benefits from standardisation to an organisation. For example, Indian Standard recommends 638 types and sizes of cast iron pipes and fittings; if a unit adopts all these for use in the products manufactured in the company, it would not be difficult to visualise the effect on manufacturing, scheduling, storing and so on. Similarly, adoption of 75 different types and sizes of electric winding wires by a manufacturing unit would not be desirable when examined for rationalisation within company use.

Company Standardisation

Company standardisation provides an organisational means for simplification and rationalisation within company operations. Company standards developed for internal use provide the basis for future development on rational lines and aim at achieving the same function within a company which the national standards aim at the national level. These standards are not necessarily restricted to technical issues, but frequently extend to administrative policies and procedures.

Role of Company standards for simplification, rationalisation and variety reduction of company operations will be evident from the examples subsequently discussed.

Drafting Practice : Indian Standard code of practice for General Engineering Drawings, IS : 696 would serve as a useful guide to the companies to develop their own drafting code and this would solve a number of problems, when the drawings are to be used outside company premises.

Basic Standards : Company standard on sizes and tolerances for round holes in metals developed by Eastman Kodak Company can be referred to as an example of the use of such a standard for variety reduction. Readily available information about lists of preferred sizes which meet the needs of majority of uses in the Company itself serves as a basis. The standard was developed in 1956; since then most of the holes in new drawings were of sizes and tolerances referred to in the standard. As a result, the number of new gauges procured for inspection of holes in parts dropped from 3,553 in 1957 to 935 in 1963. The Company estimated a saving of 10,000 dollars per year on procurement cost of guages due to less number of sizes, large quantity per size and smaller total number of guages. This also led to a considerable saving in the cost of drills, reamers, drill bushings, perforating punches, etc.

Reference may be made to similar work done in an Indian Company, namely, Jyoti Limited, Baroda, which has now an organised company standardisation activity. Before the development of the company standard, 150 different sizes of drills were maintained in stock according to the requirement of product design laid down by different collaborators. With suitable modification in design, it has been possible to rationalise drill sizes to 99. Similarly, requirements of pitch-diameter combinations of screw threads have now been reduced to 52 from 63 to meet the needs of all types of products of the company.

Standard Parts : Indian Standard on studs (IS : 1862-1961) incorporates the minimum number of sizes and materials required to meet the needs of the various sectors of the Industry. Tata Engineering & Locomotive Co. Ltd. (TELCO) made a selection in their company standard on studs. In the absence of such a document, other sizes are sure to creep into in course of use. For another example of enforcing restrictions on variety, reference may be made to the company standard of the Heavy Machine Building Plant, Ranchi on 'Turned Hexagonal Bolts', where 11 diameters with 36 lengths have been selected out of 16 diameters with 44 lengths recommended in IS : 1364 : 1960.

A number of other companies after a survey of the possibilities reported a great deal of reduction in the variety of standard parts and tools. Some examples are given below. However, systematic efforts in this direction through development of documented standards are yet to be initiated in many of the companies.

		Original No.	*Reduced to*
Fertilizer Corporation of India Ltd., Sindri	Bolts and nuts	1700	700
	Electrodes	90	23
	Oil Seals	495	307
	Bearings	1239	850
	(Now ordered to size and not manufactured part number)		
PSG Industrial Institute, Coimbatore	Hexagonal bolts	77	44
	Hexagonal Screws	37	18
	Single point cutting tools	216	60
Estrela Batteries Ltd, Bombay	Cutting tools	161	94
	Hand tools	138	85
	Instrument	8	6
	Machine tools	157	94
Tata Iron & Steel Co Ltd, Jamshedpur	Gear Couplings	119	10
	V-Belts	191	90
Tata Engineering & Locomotive Co. Ltd, Jamshedpur	V-Belts	26	9
	Twist Drills	704	600
	Black bolts	306	120
	Half Machined bolts	22	10

Standards for Design Parts : Design parts, by increasing their use, can be raised to the status of standard parts for company operations. Manufacture of such parts can then be standardised and mass produced for economic operations. To achieve this, company standards on parts, that could be repeatedly used, are to be developed and made available to the designer for guidance.

Benefits derived through such an effort can be amplified from the experience of Jay Engineering Works Ltd, Calcutta, in their sewing machine manufacture :

Domestic model	350 parts - all standard
Tailor model	5 special parts
Link model	30 special parts
Streamline domestic	70 special parts
Industrial	340 special parts

The policy to encourage use of standard parts at the design stage made it possible to bring out *LINK MODEL* within five months of conceiving the idea.

A small engineering works in South India (Goverdhana Engineering Industries Ltd, Coimbatore) with 110 employees, manufacturing power driven centrifugal pumps and electric motors, recorded substantial savings through similar efforts. Manufacturing range of the Company in the case of electric motors for pumps is 3/4 HP to 15 HP and total types are 9, and in the case of pumps is from 1½ in. delivery to 6 in. delivery and total types are 27 for different total head delivery combinations. In order to connect these 27 types of pumps with 9 types of motors, the company was using 19 types of pump couplings and 5 types of motor couplings, making a total of 24 types of couplings. After study, the company has been able to bring down the total types of couplings in pumps to 3 and in motors to 4, thus bringing down the total to 7 types only. It has been estimated that by this the company has been able to save 28.2 percent on the cost of couplings.

Maintenance Standards : In maintenance field, there is ample scope of variety reduction through standardisation. An example can be referred to from the experience of a firm in Germany in the field of lubricants. The company was using 179 varieties of lubricating oils and greases for their equipment and products. This led to higher procurement cost as well as frequent breakdowns in company's manufacturing equipment owing to wrong use of lubricants. The company standard developed was implemented in 1956. After one year of practice, the following results were achieved :

(a) The variety of lubricants in store was reduced from 179 to 25.

(b) Average machine breakdowns caused by wrong use of lubricants was reduced from 29 to 2.

(c) The total cost per annum for lubricants was reduced from 169,000 DM to 87,000 DM, while the total weight of lubricants in store continued to be 120 tonnes. The net saving of about 82,000 DM was due to rebate on bulk purchase.

Taking inspiration from the success due to variety reduction in the field of maintenance by foreign companies, many Indian firms also started variety reduction in this field. The following is an illustration of such attempts.

The work done at Tata Iron and Steel Co. Ltd, Jamshedpur to standardise the sizes of moulding boxes for effective maintenance also serves as a useful example. In non-ferrous foundry, electric steel foundry and general foundry of TISCO, survey indicated that there were about 1665 moulding boxes in 134 sizes. Eighty-nine different sizes were reduced to 10 standard sizes from IS : 1280-1958, the remaining 45 sizes were found to be for special purposes, justifying further study. The depth of the boxes specified in IS : 1280-1958 varies from 100 to 250 mm, while that of the boxes in actual use in TISCO was found to vary from 100 to 750 mm. In order to ensure rationalisation, the company decided that 2 or 3 boxes would be combined if higher depths were required and special lugs have been designed for the purpose.

Store Codification

Store codification is another effective means for variety reduction. The story of a plain single diameter pin being found under 111 different names in the drawings of a few selected manufacturers is well-known and need not be repeated. In actual practice it is often found that an item is being stored under two/three different nomenclatures. Standard terminology is not a solution to the problem, since no clear distinction can be given between a bracket and a support, a lever and a link or a collar and a sleeve. Sometimes, an item is designated as a component of some special assembly and given a number as VF2/EM3/25 meaning Ventilator Fan No. 2, Electric Motor Model 3, Part 25. This is regardless of the fact that it is identical with AC4/FM2/13 meaning Airconditioner Mark 4, Fan Motor Model 2, Part 13.

The only solution to the problem is codification of items by numerals. There are two systems in use, serial numbering system and classified system. Classified system seems to be more appropriate for adoption in India in the present juncture. Serial numbering system to function effectively, that is to ensure that an item is never allotted two different numbers, requires adequate supporting documentation. Classified system to work without breakdown in course of use requires a well-thought-out plan to start but once it is put into operation, it is free from the defect referred to earlier. The system also highlights similar items in store and thereby assists in variety reduction.

There are numerous examples from Indian experience that could be referred to show discovery of obsolete items, release of capital blocked in store, etc, in an attempt to codification by classified system. In any organisation where store is not codified, it could be strongly recommended that work should be initiated on a priority basis.

Conclusion

Unnecessary variety of products and processes at any stage of development lowers efficiency. Variety, however, cannot be reduced just for wishing it. Systematic effort in this direction is only possible through standardisation; ISI standards serve the national cause and company standards that of the organisation. While some progress has been made in organising national standardisation in India, company standardisation practice as a formalised activity is yet to develop in this country. A beginning has been made in some of the companies but in a majority of them, the activity is conspicuous by its absence. Company standardisation strengthens, stimulates and complements national standardisation. □

Material Conservation : Need for Concerted Efforts

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Many of the material resources at our command are exhaustible. We can hardly justify putting them to extravagant or less-productive uses. It is, imperative that ways are devised to conserve these resources for the best possible uses and thus extend the period over which they will be available.

It is, in fact, the scarcity of foreign exchange in the past that has spurred interest in respect of material conservation. Many of the imported metal items were sought to be conserved through the adoption of various material saving measures, mainly with a view to effecting reduction in their imports. Recently, oil has been added to this list, particularly in view of its soaring prices. The National Productivity Council and the Material Conservation Committee in the Directorate General of Technical Development are doing creditable work in this area by recommending suitable industrial processes and practices. Petroleum has been sought to be substituted by coal wherever possible. Greater interest has also been evinced in the use of petroleum more as a raw material for the petro-chemical industry than burning it as a mere fuel The comfortable foreign exchange position should not be a cause of complacency. These efforts need to be pursued on a continuous basis, and extended to such other areas as may bring in substantial gains.

MC Techniques

Material conservation is a complex proposition. There are numerous contributory factors and many of them would seem even insignificant, if taken in isolation. Indeed, any general increase in productivity is accompanied by conservation of inputs in some measure or the other. More important among such contributory factors may be :

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— Avoidance of wastes and waste recycling;

— Putting inputs into the most productive uses;

— Technological innovations which enhance productivity in general and particularly that of the material inputs; and

— Maintenance engineering.

The amount of foodgrains wasted for want of proper storage facilities and eaten away by rats, the quantity of iron and other metallic scraps left to rust out, the extent to which sugar recovery from sugarcane is affected by the adoption of inferior methods in the making of *khandsari* and *gur* are all some instances indicative of the abundant scope available for conservation.

It has been identified that the adoption of better industrial practices could save as much as 9 percent of the furnace oil consumed at present. About 10 percent of the raw cotton is estimated to be wasted in the process of spinning. The National Productivity Council has also drawn up a long list of items where there could be substantial conservation of raw materials. It is also pointed out that shortage of raw materials could be reduced by as much as 10 to 15 percent by the mere adoption of material conservation techniques.

There are wastes in all the spheres of economic activity, such as production, distribution, consumption, etc. Outmoded practices and obsolete plant and equipment account for a major portion of the material resources wasted by the industry. Inadequate storage facilities have also been responsible to some extent. In general, material conservation by industry would depend, to a large extent, upon adoption of better techniques by industry on a continuous basis. Unfortunately, in India, this has turned out to be very difficult. The biggest bottleneck is the ban on the secular growth of industrial units. Adoption of better techniques or modernisation and rehabilitation would not be possible unless the individual unit is allowed to grow in its own product line. Secular growth is essential not only from the technological angle but also from the point of view of improving financial viability of such units. Enterprises which do not grow ultimately become sick. It is like riding a cycle indeed: either you move forward or fall down.

Recycling of Wastes

Recycling of wastes is an important way of achieving material conservation. Some progress in this direction has already been made in industries like steel by the setting up of secondary steel plants. In fact, the mini steel plants have now come up against scarcity of scraps. Mini steel plants need to be encouraged primarily on the ground that they help conserving iron ore substantially. However, the policies adopted in respect of mini steel plants give an impression as though this aspect has been completely overlooked.

This might as well turn out to be a bad precedent for the growth of such material-saving industries in other areas also. There is ample scope for waste recycling in industries like paper and chemicals. Manufacture of cement from slag also has immense potentialities, particularly, in view of our massive plan for the steel industry. It should be ensured that industrial units doing waste reclamation will have a permanent place in the economy.

There is much scope for turning wastes into wealth in the rural areas. If only all the green manure available in our villages is properly collected and conserved with appropriate practices the pressure of demand on fertilisers could have been greatly eased. The farmer in this way would have got a cheaper input mix and the nation benefited from a reduced dependence on naphtha. The same is true of 'gobar gas' plants. Much of the rural demand for power can be met by the setting up of 'gobar gas' plants and the electric power released to that extent to industry. This would also mean saving of coal used in thermal power plants and conserving timber which is rather indiscriminately burnt away by the farmer at present. However, the achievements so far in these areas leave much to be desired.

R & D Activities for MC

Availability of appropriate technology is thus crucial to material conservation. Putting the right quality of inputs into the right production process and getting the maximum output is another way of effecting material conservation. Material conservation of this kind may be expected to have favourable effects in many other areas as well by facilitating the accumulating of material surpluses. Intensive research and import of technology, particularly in all technologically-deficient areas, should be encouraged. There is a need to create a congenial atmosphere in which the industrial units undertake research with enthusiasm and the industrial research itself becomes meaningful. Research is an industry by itself. Any individual industrial unit may not like to spend on it unless there are adequate gains in the near future. The results of all industrial research should be allowed to be fruitfully exploited for any unit doing it or sponsoring it. In fact, many of the large units in the country today are confronted with this bottleneck. One is to have an open mind as far as import of technology is concerned.

Maintenance engineering is another aspect of material conservation that has not got so far the attention it deserves. We have put up huge industrial complexes and also are producing a wide variety of consumer durables. It is important to ensure that the machines last their full life. The life of a plant depends to a large extent on the quality of inputs used. The quality of coal today has become quite undependable and obviously, the life of a cement plant using it is reduced. The same holds good for the quality of power also. Sharp fluctuations in the frequencies affect the lives of a wide ranging continuous process industries and also affect the production. Research and adoption of appropriate measures in these areas could directly result in the conservation of capital itself. The story of public utilities, say, roads, railways, bridges, etc., is not much too different. Maintenance is an integral part of conservation. Better maintenance of such infra-structural facilities might largely contribute to the life span of a truck and the tyre used or a locomotive.

Conclusion

The time has come when our efforts at material conservation are not confined only to areas involving conservation of foreign exchange. It concerns all those areas where there could be substantial conservation of material and thus capital. Formulation of a National Policy in this regard would be quite appropriate at this juncture. An incidental question relates to the export of raw materials. As of now, our export list contains a number of raw materials and semi-finished products. It will be worthwhile to give some thought to the extent to which the country could afford to export raw materials without adding any value to them, particularly in the interest of the growth of indigenous industries.

In a wider context, material conservation may have to be conceived as to include the conservation of both natural resources and the capital created hitherto in the form of plant and machinery and infra-structure. It may even include the preservation of environment also. The emphasis of material conservation should, in due course, be shifted to such areas wherein the country could reap substantial results. □

Material Conservation for Increased Productivity

Shantanu N. Desai*

It is a happy augury that there is an increasing awareness about materials conservation. Science and technology hold great potentials for humanity but they are not effective in the absence of appropriate institutional arrangements. There is very little data available on material conservation, both material-wise and industry-wise. The need for a Central Data Bank, under the circumstances, cannot be over-emphasised and it would be proper if the Material Conservation Division of the DGTD opens a Cell to provide information and statistics. This will hasten the spread of knowledge on the subject and serve as a useful base for research and development in various industries.

The National Productivity Council and other similar organisations can play a vital role by serving as forums for training, as also undertaking survey work. We have passed through an agonising period of inflation, spiralling prices and all that they imply—distortions in the economy and the problems and difficulties faced by industry and labour. In the wake of positive Governmental measures, conditions are now propitious for the economy to look up and for industry to march ahead. Its progress will very much hinge on the degree of consumer satisfaction it is able to generate in terms of price and quality. The former, primarily, is a matter of costs and in that light, the new realities affecting energy and materials acquire special significance. That the supplies of basic essential materials will remain adequate to meet growing demands in future, can no longer be taken for granted. In fact, the prospects for economic prosperity in coming years will, to a large extent, depend on how the world adjusts itself to new constraints and new expectations regarding some of the key ingredients of human endeavour, viz., energy and materials. What is new in regard to energy and materials can probably now be better recognised and appreciated. Growth, evidently, cannot go on forever—a fact that has emerged all over the world, with particular regard to energy.

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Material Conservation, the Only Way

The efficient and economical use of materials is, therefore, very essential and it is desirable that this awareness spreads through industry generally. There is another factor which should command a much better appreciation of the concept of material conservation. In manufacturing and construction activities, cost of materials adds up to more than 60% of the total cost. Accordingly, small changes in material costs can result in large sums of money being saved or lost. In our country, we have an abundance of resources, both human and natural, but the capital required to exploit them is very large. Unfortunately, capital is woefully scarce. Since the flow of capital is far below needs, we have to make the most economical use of it.

Any avoidable expenditure not only adds to cost but also deprives the nation of some essential project or programme. In other words, the impact of social and economic cost of waste or avoidable expenditure is much higher in this country than in a developed country. We have to conserve materials not only from the point of view of capital conservation but also to improve our competitiveness in foreign markets, since without that, we shall not be able to step up our exports.

Industrial managers have been slow in appreciating the importance of material conservation as they have hitherto been obliged to be preoccupied with other more immediately and directly pressing matters such as finding new markets, continuing production in the face of constraints of labour, raw materials, power and transport but now they must increasingly turn their attention to this important aspect. Material conservation can lead to increased profits without any trouble, either by labour or by any other source. It results in increased productivity of capital by preventing large amounts of capital being locked up for long periods in inventories.

The common cause of wastage is that materials are quite often purchased unnecessarily or much larger quantities than actually required are purchased or sometimes wrong materials, are purchased. Better planning and programming of materials, an efficient system of feed-back and review and adjustment of stock levels can reduce wastage to a considerable extent. Wastage in consumption due to negligence or over-consumption is another frequent cause of wastage of materials. It should be possible to conserve materials by effecting changes and by adopting new methodologies throughout the chain right from the stage of Materials Planning and Programming to Inspection and Quality Control with the aid of modren technology and the latest technical know-how.

How to Bring About MC

Material specialists, by working in close liaison with suppliers, can benefit from the suppliers' know-how which could be at times very useful in solving technical problems. Suppliers make enormous contributions to every company's design efforts, to a much greater extent than most people realise. Contact with supply sources can help in innovation of designs resulting in weight reductions which will naturally reflect on cost and profits.

Material specialists should be in a position to suggest ways in which costs could be reduced through minor changes in shape of the item by reviewing stylist sketches. Such reviews not only make it possible to eliminate costly features that contribute relatively little to sales appeal or utility, but also help guide engineering to the type of process that is most economical for a particular component. By working closely with the engineers, material specialists can assist by proposing standard components, bringing in suppliers to aid in development work, guiding design decisions and acquainting engineers with new materials and techniques.

Until recently, we have been quite unmindful of the extent of inputs like energy and materials so long as the desired level of production is achieved. It is only now that it is being recognised that many functions could be performed using half or less of the previous standard amounts of these items. Wastes represent unrecovered resources. Had they been subjected to recycling, that could have helped to a certain extent in reducing the use of commodities in short supply and helped in finding a solution to the ever-growing problem of solid waste.

Recycling is possible in many industries, the more popular among them being glass, metal and paper. Some observations made by the panelists at a Recycling Conference held in Washington some time back with regard to metals are worth mentioning. As for metals, the Panel reminded the Conference that one ton of scrap conserves 1.5 tons of ore and one ton of coal requires 74% less energy and 97% less raw material and causes at least 90% less air pollution. The panel also drew attention to the apalling fact that out of about 1.1 million oz. of gold and 1.5 million oz. of palladium, platinum, rhodium and similar precious metals used in the US in 1974, a major part went to landfills.

The sea and land have been the traditional receptors of waste produced by the society since they have been the most natural and economical means of disposal so far. According to recent statistics, industry produces as much waste as generated by residential and commercial sources per year. In a decade, the industrial waste produced by some industries is expected to double. With shortages of energy, resources and finance, the concept that solid waste is good for landfilling is fast changing. Notwithstanding the fact that no matter what you do with solid waste, it costs money—money to transport and money to bury it. It may be far more convenient to attempt to reuse the waste after necessary processing.

The World Health Organisation and the NATO Committee on the Challenge of Modern Society have active industrial waste management guideline programmes. The Scandinavian countries, Switzerland and Japan have industrial residue control programmes. In the Netherlands, a key element in the waste management programmes is the regulation of the waste haulers. England, Scandinavia and West Germany have industrial and hazardous clearing houses where waste from one industry can be directed to another for use as that industry's feedstock.

All units with Research and Development Cells should be equiped to promote recovery of materials from their source of waste. With this end in view, Government should consider offering incentive and credit to give impetus to a concept which, if gains, can result in substantial reduction in the consumption of basic raw materials and energy, ultimately serving to conserve scarce capital. Government should also consider giving concessional fares for the transport of recycled materials. □

Waste Disposal and Recycling of Wastes

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Waste disposal or recycling of wastes can also be stated, in other words, as wealth from waste. It is one of the important facets of material conservation. Material Conservation is, in short, optimisation of use of raw materials, reduction in process wastes and recycling. It is not only a priority national objective in our economy but it is also a matter of extreme importance for industrial managements. Material conservation helps in saving of foreign exchange where such materials are imported and reduction in costs of production.

Apart from the various steps which could be taken for conservation of materials like material plans, value engineering, variety reduction and standardisation, reduction in in-process wastage/scrap arisings, recycling is one of the areas where there is still ample scope for tackling the problem in a systematic manner.

The scrap arisings broadly fall under the categories of 'in-process scrap' and 'obsolescent scrap'. The problem of dealing with the obsolescent scrap is wide and diverse in nature. The distribution of such scrap in a number of cases result in productive usages by the village and small scale industries. Also there are good examples where managements can reuse the scrap to the extent possible.

However, the problem of reduction of in-process scrap requires to be taken up in a more organised and systematic manner. It is bearing this in mind as well as importance of recycling that DGTD has formed a Material Conservation Division which, apart from its other functions, also provides a Secretariat to the Standing Committee on Material Conservation which is headed by the Secretary, Technical Development, and comprises representatives of the Industry, Government departments, R & D organisations, etc.

Initially, concentrating its attention to ferrous and non-ferrous materials,

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the Material Conservation Division has commissioned a number of studies with the National Productivity Council. The Council has, in close dialogue with industry, professional institutions and R & D organisations presented areas of in-process scrap reduction and recycling possibilities in copper and zinc. It has been revealed through such studies that considerable scope exists in avoidance of waste and in recycling. For instance, the waste products arising from the galvanising industry can be profitably recycled to get primary zinc by atmospheric distillation or it can be used for other high-value items starting from these waste materials.

A number of actions have been taken which concern with policy and operational actions. These actions include policy guidelines on recycling, introduction of appropriate technologies, watch over materials norms, industry and unit-wise, modernisation, fiscal measures, etc. A number of Development Councils/Panels have done useful exercises and are further pursuing the objectives in mind which have already yielded useful benefits.

In the chemical industry, a number of wastes could be effectively recycled and which would not only result in material conservation, but also check pollution. The DGTD, in association, with other Government departments and organisations has initiated several schemes intended to utilise industrial wastes and a number of units have been set up based on recycling of waste products. The more important of the areas are :

- — Recovery of caprolactum from nylon waste (Six units manufacturing nylon have already set up recovery units.)
- — Production of electrolytic manganese dioxide and manganese sulphate (monohydrate) using waste liquor of Travancore Titanium Products;
- — Recovery of argon and ammonia from purge gases of ammonia plant in fertiliser industry;
- — Manufacture of portland cement by utilising clinkered blast furnace slag and also fly-ash emanating from thermal power plants.
- — Manufacture of zinc dust from zinc hydroxide sludge emanating from sodium hydrosulphite industry. (By this method, this industry can become self-sufficient upto 90% of its entire

requirements of zinc dust.)

— Manufacture of oxalic acid using 'AIN BARK' (a forest waste product) instead of utilising cane sugar.

  There is already one unit successfully producing this item.

— Recovery of caffeine from tea waste or dust. There are a few units already in the country which have started this work effectively using indigenous technology.

— Manufacture of ossein from crushed bones. There are a few units already producing ossein profitably and exporting the same, earning sizeable foreign exchange, as against what they used to lose when they were exporting crushed bones.

— Recovery of fluorine in the form of cryolite or aluminium fluoride from the gases of fertiliser complexes. Some progress is already made in this direction.

There are quite a few new items of production starting from waste products like tobacco waste, mica waste, etc., which are stated to have been developed successfully by the various national laboratories, who are seized with this problem of utilisation of industrial wastes. Similarly, on the non-ferrous front, two notable examples are recycling of lead acid batteries and other lead scraps from which lead alloys required for the industrial purposes are being recovered successfully. Tin dross is also being successfully recycled to produce metallic tin, thus saving considerable amounts of foreign exchange.

Notwithstanding above actions, there are yet immense possibilities of considerable savings both to the economy and the manufacturer through continued attention to industrial productivity improvements and in that materials conservation aspects. Through in-process scrap savings and recycling, it is estimated that over 20% of the total material requirement for the industry could be met although this percentage will vary from industry to industry and unit to unit in the same industry. We have made a small but a promising beginning; there is a lot more to be done. A multipronged attack for the optimum use of materials, reduction in process scraps, recycling of wastes and recovery of by-products, wherever it is technically feasible, would, in the long run, prove highly beneficial to our national economy. □

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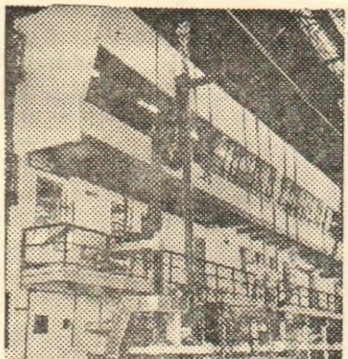

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Conservation of Zinc in Dry Battery Industry

N. Sreenivasan,* R. K. Mehrotra & S. K. Mehrotra*****

Dry battery industry in India accounts for approximately 10% of the total consumption of 70,000-90,000 tonnes of zinc, galvanising industry having the largest share at 55%, die casting brass, paints and chemicals, etc., accounting for the remaining 35%. Zinc losses in dry cell industry vary between 3% to 6%, depending on the technology adopted and the care taken in adhering to proper practices. 300 to 600 tonnes of zinc is thus wasted in dry battery manufacture alone, the losses being still higher in galvanising and other industries. Even at an average figure of 6% zinc loss, this works out to a colossal sum of Rs. 60 million. This, undoubtedly, is not a small loss which a country with scarce non-ferrous resources can afford to ignore. All-out efforts must, therefore, be made to conserve zinc and reduce these losses.

This paper attempts to present some of the major available technologies and practices, which, if implemented judiciously, can lead to substantial conservation of zinc. This paper also lists some of the areas where research and development work should be undertaken for further improvements.

Need For Conserving Zinc

Upto as late as 1967-68, the country's entire zinc requirements were being met through imports. Indigenous production commenced in 1967-68, and is now catering to 25-30% of the requirement; the balance 70-75% continues to be met through imports. With the commissioning of Hindustan Zinc Ltd's second plant at Vizag and expansion of Debari Smelter, the installed capacity of HZL has reached 75,000 tonnes and along with Cominco Binani Zinc's expansion, it is expected that by 1980-81, India will become self-sufficient in zinc. During the two decades, 1951-1970, the price of zinc remained more or less steady at around Rs. 2,500 per tonne. From 1970 the zinc prices started fluc-

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tuating widely due to :

(i) worldwide market speculation,

(ii) supply and demand position,

(iii) worldwide energy crisis, and

(iv) environmental pollution control legislations in different countries. From Rs. 3,170 per tonne in the beginning of 1971, zinc price shot up to Rs. 16,660 per tonne by end 1974; it has since then come down to Rs. 11,000 per tonne by the end of 1977.

Thus, considering the sharp increases in zinc prices in India and the world over, and because of valuable foreign exchange involved in importing this metal, it is essential that all wastages are minimised. Zinc is a major raw material, accounting for almost 60% of the direct material cost of a dry cell. Zinc conservation, therefore, should form an essential part of any cost reduction programme in dry battery manufacturing.

Function of Zinc in Dry Cell

Zinc serves a dual function in a dry cell: it acts as Anode of the cell and also serves as a container for holding the Cathode, cathode mix, electrolyte and other ingredients. Figure 1 gives the general constructional details of a round cell. Figure 2 gives the process outline of zinc can manufacture.

Sources of Zinc Losses

In the dry battery operation, wastage of zinc during melting and casting operations, is primarily due to :

(i) volatilisation of zinc,

(ii) formation of zinc oxide or dross,

(iii) carryover of free zinc entrapped in dross, and

(iv) spillages.

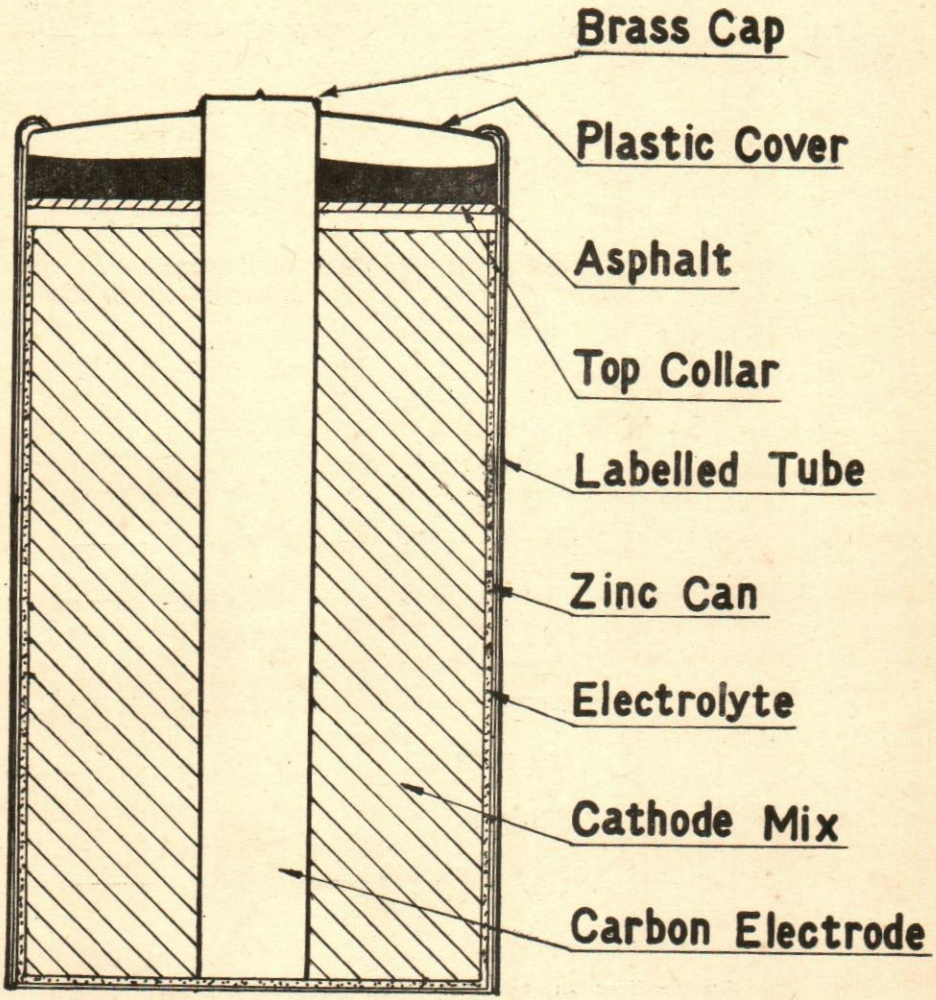

Fig. 1 : General Constructional Details of a Round Cell

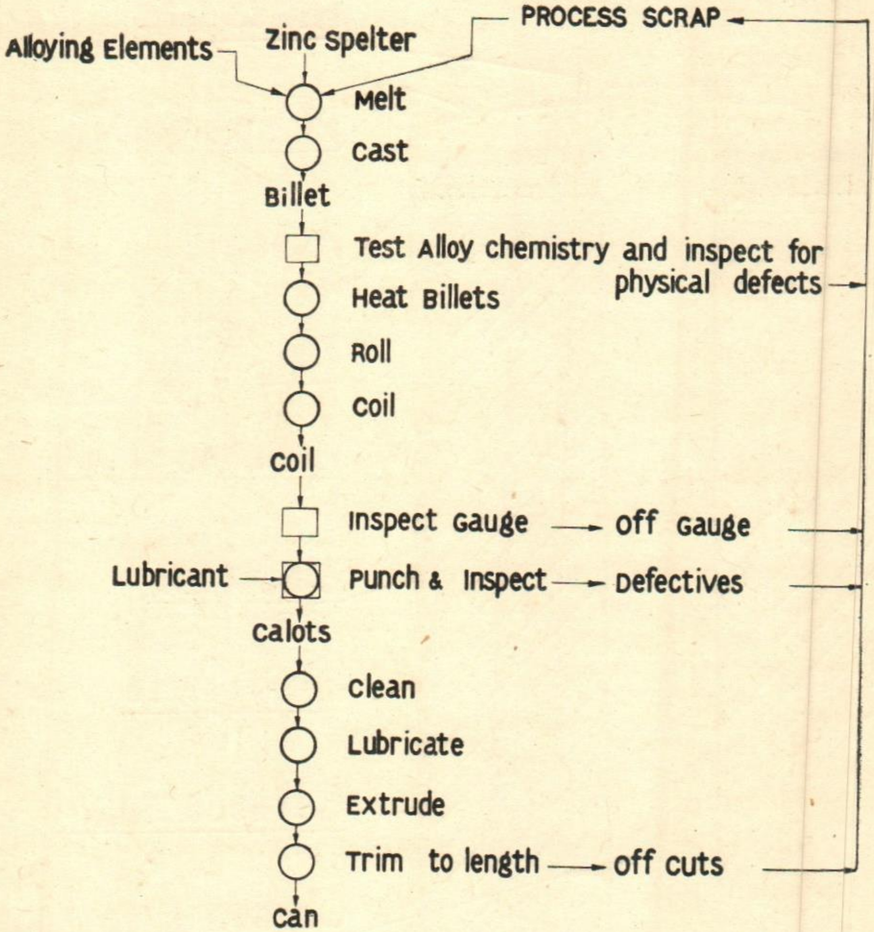

Fig. 2: Flow Chart for Zinc Can Manufacture

The above losses being inherent in the melting and casting process, higher in-process scrap with consequent more frequent recycling enhances the total wastage. To adequately conserve zinc, it is, therefore, essential to (i) reduce vaporisation and oxidation losses and (ii) to make optimum use of casting by avoiding rejections, increasing yield and minimising rework as much as possible.

Some of the suggestions for conserving zinc in dry battery industry are discussed below. Most of the practices and procedures can as well be applied to any zinc processing unit in a suitably modified form.

Raw Material Control

Zinc spelter and process scrap form the basic raw materials for battery alloy making. Process scrap could be in the form of rejected cans, trimmings, coils, calots, sheets, etc. Prolonged exposure of zinc spelter/scrap to rain and sun during storage results in severe oxidation and, thereby, increased losses during melting. User and supplier should jointly endeavour to conserve these raw materials as much as possible by :

(i) transporting zinc spelter and process scrap in closed wagons or containers,

(ii) minimising transit time,

(iii) storing zinc spelter and can trimmings, etc., in covered sheds, and

(iv) maintaining lowest practicable inventories.

Process Control

Zinc has a boiling point of 906°C with a low vapour pressure. Though normal operating temperature in a furnace does not exceed 500°C, even localised overheating can cause rapid volatilisation of zinc. As much as 0.5 to 2.0% of zinc could be lost through vaporisation, depending on the technology adopted and practices followed.

Zinc, due to its high activity towards oxygen, readily forms oxide as soon as a layer of liquid metal is exposed to atmosphere. These oxides have to be skimmed off as dross before tapping the molten metal for casting; in the process, however, a considerable amount of free zinc gets entrapped in the skimmings.

These losses being inherent in the melting operation, all process controls should be directed so as to :

(i) minimise vaporisation losses,

(ii) minimise dross generation,

(iii) recover free zinc from dross,

(iv) improve yield, reduce scrap/rejection/rework at all stages of manufacture.

(*i*) *Vaporisation Losses :* In oil-fired furnaces the losses are higher than even 2% because of poor temperature control inherent with such furnaces. For zinc melting, main frequency induction furnaces are preferable as these provide better controls on melt temperature and rate of heating, thereby reducing the volatilisation losses.

(*ii*) *Dross Generation :* Generation of dross can be reduced by the following steps :

(a) Storage of spelter/process scrap in covered sheds without direct exposure to atmospheric conditions.

(b) Quick and uniform rate of melting to a temperature just sufficient to produce a sound casting.

(c) Compact clean charge having low volume to weight ratio.

(d) Minimum possible frequency of skimming as it has an important bearing on dross generation. More frequent skimmings expose fresh layers of zinc to atmosphere, resulting in increased losses. Crucible furnaces are emptied at the end of a day's operation; whereas electric induction furnaces contain molten zinc at all times. During idle periods, dross continues to form even though the furnace cover is closed. It is recommended to retain the dross layer during idle periods in addition to keeping the furnace lid covered. 'MARINITE' floating covers have also been used in countries like U.S.A. with definite advantages.

(*iii*) *Recovering Free Zinc from Dross :* First step in separating free zinc from dross is fluxing. Unfluxed zinc dross can contain up to 90% of its weight as free metal. Primary purpose of zinc fluxing is to separate dross constituents from the metal in a skimming operation. When fluxing is accomplished properly, zinc melting losses should be under 5%.

The separation of metal from drosses, commonly called "fluxing" or "drossing off" operation, consists of a reaction of the flux with a caked semi-solid dross that forms on the melt surface. This action generally is exothermic. It makes the dross light, fluffy and powdery so that entrapped metallic zinc can settle out of the dross into the molten bath below and the powdery dross can be removed readily by skimming.

The common fluxes for zinc alloys are zinc and ammonium chlorides; these can be employed separately or in combination. The latter can be either a mechanical or a chemical combination. However, zinc chloride is highly hygroscopic and care must be exercised to avoid getting moisture into the molten metal. If moisture does get into the bath, it will flash to steam and splatter molten zinc on to the operator. A strainer type of skimming tool should be used for dross removal so that molten metal can drain back into the furnace. Care should also be taken not to scoop too deep.

In spite of good fluxing and careful skimming there will be metallic solids in the dross. To recover free zinc it is preferable to sieve the dross through 4, 8, 20 or 100 mesh screens, and remelt coarser fractions. Recovery with finer fractions being poor along with difficulties encountered in sieving and higher energy inputs required for remelting, the overall economics of remelting fines tends to become unfavourable. The minus fractions of sieved dross (zinc ash) should be suitably disposed off. Some industries prefer to pulverise the dross before screening through appropriate sieves; this is said to improve recovery of metallic zinc from dross.

(*iv*) *Yield Improvement :* Bearing in mind that melting inherently results in certain oxidation and vaporisation losses, to conserve zinc, maximum yield should be achieved from the casting once made by minimising rejections during subsequent operations and reducing rework. This can be achieved by instituting stringent and concerted process controls and improving process design to an optimum level.

Suggested areas for process controls are listed below :

1. raw material control
2. alloy charging
3. melting practices
4. wrong composition rejection control
5. gauge control at rolling
6. punching die maintenance
7. punching practices
8. product inspection
9. re-use of process scrap
10. slug (calot) cleaning and lubrication
11. die and product dimensional control at can extrusion
12. segregation of can trimmings, etc.

In short, a well-designed *TOTAL QUALITY CONTROL SYSTEM* right through raw material to outgoing product is essential for conserving zinc.

Technology

(*i*) *Induction Vs. Oil Fired Furnace :* Low frequency induction furnaces generate less dross than oil or gas fired crucible furnaces per tonne of zinc melted or poured. The reasons for this are :

(a) there is no overheating of zinc in electric furances, and

(b) there is always a "heel" metal in the induction furnace to promote scrap remelting.

It has been found that oxidation and vaporisation losses in induction furnaces can be reduced to less than 1% by following proper melting practices; this compares very favourably with 5% to 10% losses with oil-fired furnaces.

(*ii*) *Hexagonal Vs. Round Calots Punching :* Punching of round slugs from sheets or coils will invariably result in webbing scrap which has to be re-processed and the net yield is generally not more than 45% (fig. 3a). More than 55% of the zinc alloy cast has to be remelted.

"Scrapless" hexagonal calot punching may be used to increase the yield to as high as 85% (Fig. 3b).

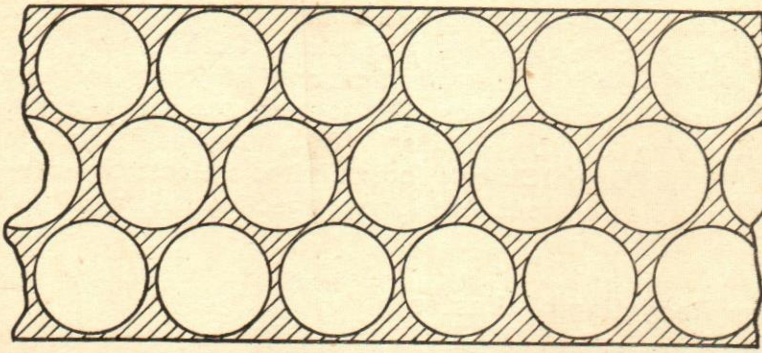

Fig. 3(a) : Round Calot Punching

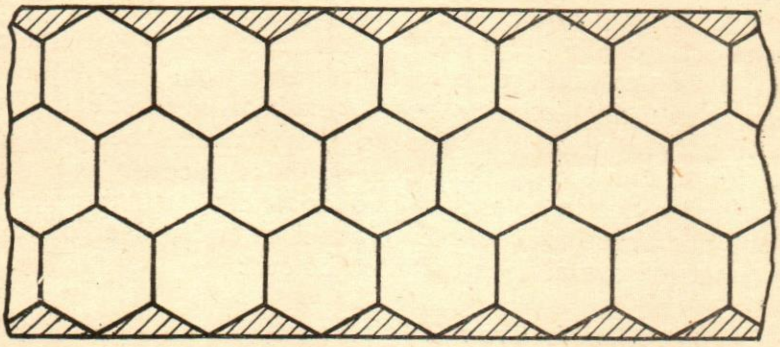

Fig. 3(b) : Hexagonal Calot Punching

This is a major step towards zinc conservation.

(*iii*) *Gauge Control :* Sheet gauge should be controlled with a very narrow range through a system of continuous monitoring. This saves in zinc cost both by keeping slug thickness to optimum levels, and also by avoiding off-gauge rejections.

(*iv*) *Sheet Punching Vs. Coil Punching :* Plant layout should be so arranged as to have integrated rolling and punching facilities. This will avoid the necessity of coiling the rolled sheets for intermediate storage. Punching of sheet has been found to give better yield and lower product scrap. This, however, necessitates larger space requlrements.

(v) Can Extrusion : By introducing stringent process controls at calot cleaning and lubrication, uniform preheating of calots, proper matching of punch and die dimensions, modifications of punch profile and calot feeding arrangement it is possible to save on zinc usage to a large extent. A saving of approximately 10% has been achieved in calot thickness at all Union Carbide India Limited's plants by incorporating the above measures without functionally affecting the can dimensions.

Utilisation/Recycling of Wastes

As discussed earlier, the zinc dross collected from the induction furnances is screened through suitable sieves. Finer fractions called zinc ash or blue powder, which cannot be economically remelted, though they still contain upto 90% total zinc and 60% free zinc, are sold off. It is possible to recover free zinc from zinc ash by various techniques, like distillation process, electrolytic process, aluminium process, modified aluminium process or partial recovery process. However, for Indian conditions, economics of recovery by the above stated methods have to be ascertained depending on the volume and type of zinc ash/dross available. Zinc ash that is disposed off to outside vendors is put to several uses as listed below :

(i) Zinc Chloride Manufacture : Zinc chloride is used in the manufacture of dry cell itself. Zinc ash can be converted to zinc chloride by dissolving it in hydrochloric acid and removing the heavy metals.

(ii) Zinc Dust : Zinc dust made by pulverizing the zinc ash can be used for manufacturing zinc hydrosulphite which is used for bleaching wood pulp in paper manufacture. It is also used for dyes and chemicals in the textile industry.

(iii) Zinc Paints : Paints formulated using zinc dust and zinc oxide with suitable vehicles, provide excellent rust-inhibiting properties, adhesion and abrasion resistance as top coats. The dried paints film contains about 80% zinc dust and 20% zinc oxide. Zinc dust-oxide paints are often used on galvanised steel outdoor structures, such as bridges,

water tanks and dams, etc.

(*iv*) *Plant and Animal Nutrition :* Zinc is an essential ingredient for life of plant, animal as well as human, though the requirements are in traces only.

Zinc ash can be used for the manurfacure of zinc sulphate which is water soluble fertiliser for plant life.

Suggestions for Further Improvements

In this section we outline some of the ideas which can act as embryo for further work.

1. VACUUM MELTING

Vacuum melting is very much practised for melting alloys that are highly reactive. This technique if adopted for zinc melting may result in lower vaporisation and oxidation losses.

2. CASTING OF ZINC CALOTS

Instead of punching calots from rolled sheets or coils, calots could be cast directly; this may improve the overall yield and reduce the process scrap, in turn, reducing the losses.

3. CONTINUOUS CASTING

Continuous casting and zinc billet and rolling to desired thickness may increase the overall yield, apart from improving the quality and reducing cost.

4. ALLOY CHEMISTRY

Only about 60% of the zinc in the can participates in dry cell electrochemical reaction; the balance is required for strength of the can to facilitate further processing it into a battery. Efforts should be made to get a stronger alloy for can manufacture, by suitably modifying the alloy chemistry, so that can gauge can be reduced further and more efficient utilisation of zinc for electrochemical reaction can be achieved.

5. CONDUCTING PLASTICS

Use of conducting plastics of composite materials as a substitute for brass caps used in dry cell can also be examined.

6. RECOVERY FROM VAPORISATION LOSSES

Attempts can be made to recover metallic zinc currently being lost through vaporisation by directing the vapours through cyclonic separators and control of effluent gases. □

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Conservation in Zinc Smelting Industry

S. V. Venaktesh*

Material conservation has assumed paramount importance particularly in the context of the mineral industry whose natural resources are depleting fast. India is particularly short of non-ferrous metal ore deposits. Hindustan Zinc Limited is engaged in activities of mining and smelting for lead and zinc.

India's ore reserves of zinc minerals are very limited and most of these are located in southern Rajasthan and neighbouring Gujarat with small occurences in Sikkim, West Bengal, Andhra Pradesh and Tamilnadu. Out of a total known reserves of 150 million tonnes for lead-zinc minerals, the average *in situ* grade of zinc is only 3.5% and lead only 1.5%. Thus the recoverable zinc mineralsation in the country works out to only about 4 million tonnes based on the cut-off grade for mining. While further efforts to discover new deposits are being continued, steps to maximise recoveries from the mine to the mill and the mill to the smelter have got to be taken up urgently to augment the zinc availability in the country from the limited ore resources of a very low grade.

The present mining practices yield only about 85% of the deposit to the mill as ore and the concentrators are able to enrich to zinc by a recovery of about 85% from the ore to the concentrates. The zinc concentrates produced in the country are based on sulphide deposits and contain about 52% zinc and 30% sulphur with other impurities.

The present installed capacities for zinc smelting from primary sources in India are given below :

Hindustan Zinc Limited, Debari, Udaipur	—	45,000 tpa
Hindustan Zinc Limited, Visakhapatnam	—	30,000 tpa
Cominco Binani Zinc Ltd, Alwaye, Cochin	—	20,000 tpa

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The author wishes to thank Mr. A.C. Wadhawan, Director (Smelting Operations) and the management of HZL for permission to publish this article.

All these three smelters have adopted an electrolytic process for extraction of zinc. Only the Debari Smelter is based on concentrates from indigenous sources as the mine development has not reached the stage of meeting the needs of all three smelters from the limited mineral resources in the country. Both the Vizag and Cochin smelters are port-based for treatment of imported concentrates, wherein 85% of the zinc content is paid for at international prices for zinc, less the treatment charges. Thus, it becomes imperative to attain at least 85% recovery efficiency while maintaining the close control on conversion costs to sustain as a viable industry.

In brief, the process of hydro-electrometallurgical winning of zinc metal is in three stages. First, the sulphide concentrates are roasted to convert into zinc sulphide. Zinc oxide and sulphuric acid is recovered from the roaster gases. The calcine from the roaster contains zinc, primarily as oxide and also has a small amount of zinc tied up as a ferrite. The oxide fraction leaches itself in sulphuric acid readily while the ferrite fraction is not soluble in dilute acid under normal conditions and this zinc (10 to 12% depending on the amount of iron in concentrate) is irrecoverable in this standard leaching process adopted in these three plants. The zinc sulphate solution from leaching is purified by addition of zinc dust and other chemicals and subjected to electrolysis to deposit zinc metal as cathode sheets which are periodically stripped and melted in induction furnaces to cast ingots. By-product cadmium is recovered from the purification residues and the zinc bearing solutions returned to the main circuit.

In addition to the zinc loss of 10 to 12% with the leach residues, there are small unavoidable losses with the vapour at different stages of roasting, leaching and melting between 1 to 2%. Some loss with solution and cadmium plant residues occur, which are incumbent to bleed out the impurities build up in system for carrying out efficient electrolysis, which is between 1 to 2% and unaccountable physical losses make up the balance.

The main area of conservation in the zinc smelting process thus stems from the possibility to recover zinc from the leach residues. There are both pyro-metallurgical and hydro-metallurgical methods for treatment of these residues being practised by different smelters in the world as indicated below :

a) Slag fuming

b) Waelz fuming

c) Cupola treatment

d) Sulphation roast/pressure leaching

e) Hot acid leaching/jarosite precipitation

The first three are basically pyro-metallurgical operations needing costly burning of fuels for breaking up zinc ferrite bond and produce a soluble zinc oxide and are generally installed in conjunction with a lead smelter. The last two are hydro-metallurgical routes integrated into the leaching system for careful precipitation and elimination of the iron impurities. The pyro-metallurgical methods claim an overall recovery of 88% to 94%, while the hydro-metallurgical routes promise an overall recovery of between 92 to 96%.

Hindustan Zinc Ltd. is putting up Waelz Kiln facilities for recovery of zinc oxide from the leach residues and lead, and the blast furance slags at Visakhapatnam, as the plant also has an integrated lead smelter. The leach residues are being stockpiled without any treatment at Debari plant presently. Serious considerations are being given for selection of a suitable process route for the electrolytic plant at Debari so that internationally-achievable recoveries for zinc can be attained within the next 3 to 4 years. The drive for meeting the material conservation needs of a particular scarce national resource of Zinc metal is also continuing vigorously. □

Material Conservation in Indian Non-Ferrous Foundries

S. Ramamurthy*

Current technological and commercial practices in this country for the manufacture and sale of non-ferrous castings have certain inherent characteristics that make material productivity (Kgms. of alloy used per saleable casting) the critical path in determining the profitability of the operation. The basic defects are : (i) selling of castings by weight (instead of piece-rate) even for diversified shapes, weights, quality levels and volume of order, (ii) scanty consideration for pattern engineering and economics. These are contrary to modern ideas of Product Analysis/Pricing and lead to unsatisfactory situations from the points of view of technology, economics and schedule-keeping. Significant relief can be obtained by steady educative efforts on a long-term basis. However, material conservation/productivity can be implemented as a starting point towards over-all increase in productivity of non-ferrous foundries. In this paper, the stages at which material conservation can be examined, are outlined, dealing only with the metallic materials. The non-metallics used, though important, are relatively of lower value.

Material Conservation Areas

Stock in Stores : Non-ferrous metals are high-value items and the inventory should be related to pattern of withdrawals of *each* alloy specifications, the cycle time for replenishment of stocks, the sales conditions for time of payment towards supplies made and of time required for return of rejections from customers. The last point is particularly important from the point of view of material conservation.

Melting Loss : Easily-oxidisable metals like zinc in copper base alloys and magnesium in aluminium base alloys lower material conservation when alloys are made in small batches in the foundry, instead of in

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establishments specialising in respective fields and using larger-batch sizes. In western countries, alloy ingots of correct chemical specification are bought ready-made by foundries who confine themselves to remelting the ingots alongwith their internal foundry returns. In India also, this practice is gaining ground, but it could be faster.

Spillage at Tapping Stage : Most non-ferrous foundries in India use coke or oil-fired crucible furnaces of the pit type. Quite often, the spillage while lifting the curcible is more than the oxidation loss. The lifting is manual and with illfitting and heavy tongs. Better tongs, which after the grip is attained, can be lifted out by a crane or chain hoist can be easily arranged. Furnaces of the tilting type are also more convenient in preventing spillage loss at this stage.

Spillage While Pouring : Pouring basins ought to be used. When they are not provided, the pouring gang adjusts the size, position and rate of molten stream around a 1″ to 2″ dia. hole, often in most inconvenient locations and surroundings. Metal is often lost by the time the hands, the legs and the eyes of the gang get co-ordinated. The pouring basin, better-arranged moulds and mono-rails will earn their cost within a year.

Yield : The ratio of the fettled casting to that of the casting at the knock-out stage is the yield. This is governed by the weight of gates and risers used. Most non-ferrous foundries in India are aware of this and satisfactory conditions prevail in many foundries. This cannot be said of those foundries which produce radiographic quality, but since these are few at present, this aspect is not amplified.

Rejections : This forms the *major* area, eroding the material productivity of foundries. This involves the whole of foundry technology and technical liaison with the customer. As such, it cannot be dealt with here, even though the material productivity factor is affected most by this problem. What *ought* to be done can, however, be stated as follows :

Pre-engineering : With the component drawing supplied by the customer as the basis, a casting drawing has to be *evolved* by discussions between the foundry engineers, the machining specialists and the inspection staff of the foundry and the customer. Here, deviations from casting design rules have to be corrected, the best parting line has to be chosen, machining allowances and tolerances decided, reference points, lines, and surfaces have to be chosen, and agreed upon, etc.

Pattern is designed, made and approved within the foundry. After required corrections, samples which obey the casting drawing are supplied to the customer. In the case of castings with the complex geometry, the foundry should do the reference-machining to the standards in the casting drawing.

The samples are laid out, fully or partly machined by the customer who should issue a Dimensional Acceptability Report (DAR). This binds the machine shop and customer inspection. Minor corrections to the pattern may still be needed.

With the DAR, the foundry corrects the pattern, if necessary, and effects bulk supplies. Rejections at foundry inspection stage is on the basis of the casting drawing only.

With the above steps carried out in the proper spirit, rejections, which affect material conservation/productivity in a vital way, can be pinpointed, especially for dimensional non-conformity with the casting drawing. When the problem is identified, rectification is easier than otherwise. Significant improvement in profitability *via* material conservation can certainly be achieved. □

Material Conservation : Efforts and Experiences at a Steel Tubes Plant

K. V. Ramaseshan* & N. P. Jyothi**

In most of the engineering industries, the material cost is of the order of 70-80% of the total unit cost of the product. The material consists of raw material, stores and spares and packing material. Thus, material conservation becomes a key result area to reduce unit costs. To remain competitive, any company would do well to ensure never-ending efforts towards material conservation. In this article, an attempt is made to share the experiences gained in this vital area of material conservation at Bharat Steel Tubes Limited.

Bharat Steel Tubes Limited was established in 1965 at Ganaur (Haryana), with technical collaboration of Abbey Etna Corporation, USA to manufacture ERW steel tubes in 1/2″-6″ diameter range to the tune of 1,44,000 tonnes per annum. There are two plants for galvanising the steel tubes. The plant caters to domestic as well as export markets.

Raw Material

Hot rolled coils are received from M/s. Hindustan Steel Limited and they are slit into various widths, on a slitting machine, depending upon the pipe size requirement. Here optimisation on end-wastages is achieved, thus keeping the scrap at the minimum. A close coordination between planning and production is maintained. Further reduction in scrap would be possible if suppliers can reduce the tolerance on the coils and improve their quality control, as defective coils received lead to material wastage and consequent production losses.

In-Process Rejection

The slits made at the slitting machine are fed to the rolling mills. The objective is to produce quality pipes of standard lengths with least

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rejection. The in-process rejection is controlled by reducing the stoppages of the mills, through daily monitoring of the number of stoppages, taking corrective action where necessary. The in-process rejection has been reduced to 1.5% from 3% over a period of five years. Further reduction is planned by gearing all units to receive coils of larger lengths so as to reduce rejection due to ends (butt)-welding of coils.

Power Supply

The equipment, especially the rolling mills, being of sophisticated controls, electrical as well electronic, calls for the supply of a constant voltage, as wide fluctuations can cause damage to the equipment, impair quality and result in production of non-standard lengths of pipes. There are instances where voltage is only 8 KV against 11 KV. Further, non-scheduled breakdowns, characterised by frequent power trippings also cause process rejection and zinc wastage in Galvanising Plant.

Zinc Consumption

The pipes are galvanised at 460°C to give a zinc coating on the pipes as a protection against corrosion. Zinc being a very costly item (Rs. 14,000 per tonne), efforts are being made to conserve zinc as far as possible, by analysing, experimenting the various process variables, consistant with quality and rate of production. Certain technological improvements are on the anvil in this direction.

Packing

In line with the ISI and BSS specifications and with customer requirements, material conservation is maintained by varying the gauge of wire, the size of labels and the strapping.

Stores and Spares

a) Consumption : Consumption is controlled by having a reissue of item valuing more than Rs. 500 by specific authorisation of departmental head, who is also accountable for the budgeted consumption cost of his department.

In addition, after an ABC analysis, 20 high-consumption items are taken for a monthly review on the consumption pattern *vis-a-vis* pre-set targets and corrective action where necessary is taken.

b) Standardisation and Variety Reduction : Considerable work has been done in these areas and the data given below speak for themselves.

Category	*No. of Varieties Prior to Study*	*No. of Items Eliminated*	*Percentage Reduction*
Bearings	350	50	14
V. Belts	57	20	35
Electrodes	62	34	55
Oil seals	98	20	20
Wire & cables	110	48	44
Insulating materials	125	45	36
Fuses	91	28	31
Others	278	36	31
	1225	306	25

c) Value Analysis : Recently, a committee consisting of Industrial Engineer, Design Engineer, Purchase Manager, together with Shop Floor Engineers, has been formed to further concentrate on value analysis, with regard to (a) specifications of various materials, including the tolerances (b) import substitution and (c) make or buy problems.

d) Repair and Reclamation : In the Tool Room where fabrications and machining facilities are available reclamation work is also undertaken, so as to make costly parts completely reserviceable. For example, worn-out crane wheels wherein the metallic deposition is done by special purpose electrodes followed by machining. The same has to be approved by Quailty Control before re-use. Worn out hacksaw blades are examined and where feasible, the same are resharpened on the Teeth Sharpening Machine. Certain items used for rolling of particular pipe sizes when worn out are ground to suit the next lower size.

Incentive Schemes

The incentive schemes in vogue for last six years have a built-in factor for rejection as well as important materials consumption in Rolling Mill, Galvanising (wherein zinc consumption has a higher weightage compared to production) and Threading Sections.

Over a period of years, the rejection has come down by 15-40% and consumption of important materials has reduced by 10-50% in various plants.

Import Substitution

There can be no better example than installation of indigenously built (except for a few imported parts) Tube Mill, Galvanising and Finishing plants for our sister concern M/s. Apollo Tubes at Ranipet (Tamilnadu), as a proof of development of indigeneous expertise.

Monitoring and Appraisal

There is a monthly monitoring and appraisal meeting of all departmental heads, wherein objectives laid down for each year of the various departments are reviewed. In this meeting, almost all the areas mentioned above are covered. A portion of the format pertaining to materials is as follows :

Item	*Previous Performance (Two years)*	*Target This Year*	*This Month*	*Upto Date This year*
Slitting scrap				
Rejection				
Zinc consumption				
Packing				
Stores & Spares				

Conclusion

As is evident from the preceding paragraphs, the management at BST places a very strong emphasis on material conservation, and encouraged by results achieved so far, consistent efforts are being maintained to explore new areas of improvement in materials consumption and conservation. □

Material Conservation Studies : Some Significant Indicators

B. S. Shankara*

Material conservation studies on two important metals, namely, copper and zinc, have been completed during the span of one year (1976-77). This paper gives some of the experiences of the author and the conclusions that can be derived therefrom.

Comprehension

It is the general impression of the author that material conservation is not well understood by many people in the industry; some understand this as only concerning mining and metal extraction. Some people have expressed doubts on the very need for efforts on conservation, be it materials or energy. This is explained by the philosophical thought that nature knows its own balancing equations and hence some or the other forms of alternative materials, resources and ways of living would be automatically found in course of time.

Counter Arguments

Material conservation efforts also face severe criticism, especially in the industrial atmosphere of our country. The per capita consumption of any commodity in India is very low as compared to other developed countries. This situation calls for promotion of consumption rather than conservation. Some feel that the efforts towards conservation being carried out in developed countries are more due to ecological reasons like pollution etc., than due to reasons of depletion of resources.

Another school of thought subscribing to the non-necessity of conservation efforts is that the industrialists and users are already compelled to make optimum utilisation of scarce and high cost material by the very nature of these materials, for example, copper and zinc.

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The views expressed are of the author and not those of the Council.

Conservative Nature

The area of non-ferrous scrap, the reduction of which is one of the main objectives of these studies, seems to be very complicated. Especially, the scrap arising in the imported metals, involve heavy foreign exchange, and hence the technology of processing them is treated as a secret area of operation.

Response and Co-operation

Generally speaking, the industrial units assure their cooperation for studies like material conservation and the like in seminars and other forums. But when such a study is undertaken, there is very little response. This has indeed made assessment of realistic and factual picture of the present status of production, fabrication and the use of these materials a difficult task, and has sometimes led to wrong conclusions. In such a situation, there is a possibility of even the statistics provided being manipulated, making it extremely difficult to draw correct inferences. One of the major reasons for such a behaviour is the fear of the industries about possible curtailment of allocations by the authorities. Another reason may be to safeguard their performance level from being known to their competitors. A general aversion to filling in questionnaires could be markedly observed during such studies. Many reasons could be advanced to this aversion by some people. Firstly, there are many such information-seeking activities undertaken by a number of agencies in our country. Secondly, each questionnaire differs from the other and the information sought is very elaborate, making replies tedious and time-consuming. Above all, the net result of these activities do not reward the industry suitably and decisions taken by the concerned authorities are either considerably delayed or are not relavent or sometimes, disadvantageous.

Small Quantities of Scrap

Industrial units with low consumption levels and small volume production, by and large, find recycling and recovery from scrap an uneconomic activity. Hence, on account of this and compelled by the natural tendency of disposing off the scrap with minimum effort and maximum return at their very doorstep, has resulted in all varieties of scrap being sold to vendors or to scrap traders. Unfortunately, these traders are not well organised in handling the scrap, thereby adding to the problems of already mixed-up scrap. The problems of scrap-user units are multiplied because of several handlings and mix-up. Every foundry unit, be it small scale or medium, finds it difficult to use the scrap effectively.

Vastness of the country, with units scattered all over, come in the way of pooling the scrap arisings. Thus, spillage losses and high transportation costs prohibit such centralisation.

Sharing Technology

Sharing of technology amongst units has been confined only upto writing papers and delivering lectures. There is a high degree of reluctance on the part of the units to part with the knowledge and experience gained by them over a period of time. Even the suggestions to share their developed technology with others on a consultancy basis or on a payment basis has not brought any acceptance for the fear of losing markets. On the other hand, there is a good enthusiasm and willingness to become consultants to industries in other countries. Thus, there arises a paradoxical situation in which the units in our country suffer on account of lack of upto-date technology which, however, is available indigenously.

Small Industries

The problems of small industries are all too well known. Raw materials and finished products do not undergo the essential quality inspection. This is because, these units cannot afford to have such inspection owing to lack of facilities. Consequently, the scrap generation, rejection and the bad performance of other vital equipments in which these components are used, are on the increase. Scarcity, high cost and longer lead periods of more-reliable and quality-tested products, have created an apparent sellers' market for poor quality products.

Electrical Energy and Its Effect on Scrap Generation

Electrical power supply to industries has two parameters related to production and scrap generation. Firstly, inadequate supply curtails attainment of full capacity. In certain industries, even well-informed power cuts results in variation in the quality of product due to stopping and starting of units. This further leads to wastage of materials. Secondly, interrupted supply increases the scrap generation. This situation is very common in some of the industrial centres. Operations of process equipments are stopped abruptly many a time during a day, which leads to rejection of semi-finished products. For example, in the case of enamelling of copper wires (in one of the industrial areas) power interruptions have been as many as 20-30 times in a month, resulting in 1-2% scrap generation. On an average, 200-300 MT of copper scrap result in the form of almost-finished wires, estimated to cost about one million rupees.

Whereas the problem of power shortage needs a long-term planning to solve it, power interruption which is a localised problem needs proper maintenance by power plants, distribution agencies and the user units. Although some devices are available to deal with power interruptions such as, no-break sets, diesel-generating equipments etc., their high cost and a low-volume production level of the affected products has posed difficulties for the units to use them. A possible solution lies in separating those units whose product characteristic demands a continuous power supply, from the general distribution network end feeding them directly.

Too Many Stages of Operation

A very ideal proposition to achieve maximum savings through reduction of scrap arisings is to plan production by a one-shot process, with a view to avoiding transportation, fabrication and second, third and subsequent melting of primary metals. This would envisage providing of production facilities at the primary metal manufacturers' end itself, wherever and to the extent possible.

Since it is humanly impossible to produce everything at one place, the next alternative is to identify such operations and processes which are repetitive in nature, such as meltings, machinings, etc. and minimising them. Particular cases of such operations are ingot melting for making alloys and further melting/reheating of alloyed ingots to make castings, rolled or pressed or forged products. Similarly, there is the area of manufacturing products through machining. Wherever and in whatever product categories possible, non-machining processes should be developed and encouraged. The main idea of these exercises is to reduce the number of stages of production.

And yet, a very important question remains to be answered. This arises out of the situation (presently obtaining in our country), when several scrap-generating stages of operation are removed and a number of people are out of their business. A particular case of this situation is in the context of many small units duing the alloying operations by remelting the ingots. Here a compromise has to be made between the maximum reductions in scrap/loss generation and their implications.

Too Many Varieties

The problems of different standards, specifications, systems of measurement, sizes, etc., have been many and varied. These have been in existence because of various foreign technical collaborations in the first instance, and secondly, due to changeover to metric system by our country, two decades ago. Since there is no time limit envisaged by the Government to completely abandon the systems of measurement other than metric, even today, many industries continue to use old systems and add to the problems of varieties. Even if the technical specifications by the manufacturers are changed to metric system, this will not solve the problem because the final user, namely the experienced technician, is only well-conversant with the older system. An illusteration would make this aspect clear. A house wiring cable was being spooled to a length of 91.44 metres and specified in the product label as such. The reason was that the electrician would invariably ask for 100 yards cable spool (91.44 metres). Now, if the manufacturer made a spool of 100 metres, he would have to price it higher as he would be giving more cable length as compared with other cable spools of 100 yards length. Considering the psychology of the consumer to compare prices, he had preferred to keep the length to 91.44 metres and the price at a competitive level. This is a glaring case of non-conformance to metric standards (of course, legally he has adhered to). In such a case, there would be wastage due to unusable length of cable, if one were to use it for house wiring and follow the metric measurements.

Scrap arisings due to other specifications of varied standards, problems of production, increased inventory, production hold-up etc., are non-quantifiable and contribute largely to the generation of wastes. It suffices to mention that in a single company alone, as much as 250 varieties of a single product were produced in a span of six months, due to variations in specifications.

It may now be worthwhile to consider making it a punishable offence if any other standards are followed or promoted for such of these products and components than those that have been covered under the Indian Standards Specification (not merely to conform to metric laws). There would be substantial savings if the varieties are reduced by adhering to standards alone.

Two Important Considerations of R & D

Research and development activities greatly contribute towards achieving substantial savings in materials. Two important aspects of research work to be carried out are:

i) Developing latest and economical processes for utilisation of scrap and wastes from industrial units. This is purely a metallurgical or material science area and calls for applied research work.

ii) Developing the latest and alternative technological processes for fabrication and processing of raw materials to produce finished products. This area calls for a review of product design, application design, considerations of value engineering and the economics of alternative processes.

Our country is very often dumped with obsolete technologies by the developed countries in the name of technical collaborations or transfer of technology; the second aspect, i.e., developing latest and alternative technological processes is more important. The practices adopted by both small and medium scale units are very old and they somehow 'make do' the operations with sporadic improvements applicable in their own sphere of activity. Hence, on an urgent basis, all such areas, where there is scope for improvement in the existing processes, should be identified and the leading national R & D institutions should be called upon to develop better production processes, besides processes for recycling, etc. □

Material Conservation and Recycling of Wastes in an Iron & Steel Plant

D. P. Kharia* & S. S. Iyer**

Introduction

All the world over, it is being increasingly realised now that the rational management and conservation of natural resources is the main hope for the future. What is true for the world. is much more significant for developing countries like India.

Our greatest assets are the natural resources we have been endowed with. Fortunately, it is in abundance, as also in the richer grades. But, for more than half a century in the past, we have been mining them selectively. This has been a wasteful method and has to change drastically (as it now does), not merely to prolong the availability of the depleting resources, but more importantly, to find ways and means of spreading the benefits of their use to a larger section of our society. In contrast, in scarce resources, our concern necessarily has to be one of survival.

On the other hand, the efforts at recycling, were hitherto predicated more upon economic factors and priorities, as we were able to dispose off the wastes and discards as such, rather than by introducing expensive technology, to convert them to usable and more easily disposable products. But, when one considers that approximately a third of the pollution load comes from the industries (the balance being from domestic and municipal wastes), and national planning is accelerating the pace of industrial development, feasible or not, profitable or otherwise, the responsibility enjoining on industries to more effectively dispose off effluents, even through some means of recycling, assumes gravity and urgency. Industry has to accept as inevitable what it earlier considered as uneconomic on account of mounting costs of waste removal and waste disposal.

In an integrated steel plant like Tata Iron & Steel Company Ltd. (TISCO), for every tonne of steel produced, approximately 4.5 tonnes of other

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materials are also handled. On the input side, raw materials and coal total 2.9 tonnes. Slag, dust, scale and other discards, total 1.5 tonnes. Besides, there is the unmeasured quantity of water and gases discharged out. The quantum of material is huge, as also the variety of items that the steel plant deals with everyday. It is against this background that this paper proposes to review TISCO's efforts at material conservation and recycling of wastes.

Earliest Application of Conservation Principle

It was Sir Henry Bessemer, who, in 1856, made the historic discovery of pneumatic process of steel making, which truly laid the foundation of large-scale iron and steel industries, and of extensive use of steel for general engineering purposes. But, had it not been for Karl Wilhelm Siemens, this would perhaps not have gained momentum. Siemens invented the regenerative furnace, and the pig and ore process of steel making, which gave timely solution to the serious limitations with respect to the use and/or disposal of huge quantities of scrap generated during rolling and shaping steel at the steel mills. In this itself can be seen the earliest application of the principles of material conservation and recycling of wastes. The return mill scrap was a "waste". Bessemer convertors could assimilate only a small proportion of it as charge. But, the regenerative furnace was capable of taking more than 60% of steel scrap in its charge. Consequently, what was so far a waste product of the steel mill, became a major raw material for steel making. The development of the electric arc furnance, which is ideally suited for an all-scrap charge, established firmly the role of scrap in the economy of the steel industry. Recently when continuous casting came into its own to replace the ingot route of steel making, arisings of scrap was reduced by over 70%. It was, but logical, that in consonance with all these developments, in-process scrap reduction, effective recovery and efficient recycling received and would continue to receive priority attention in the operations.

Scrap Use and Scrap Reduction

The primary source of ferrous scrap is what is generated in Blast Furnaces, Steel Melting Shops and Rolling Mills known as "Circulating

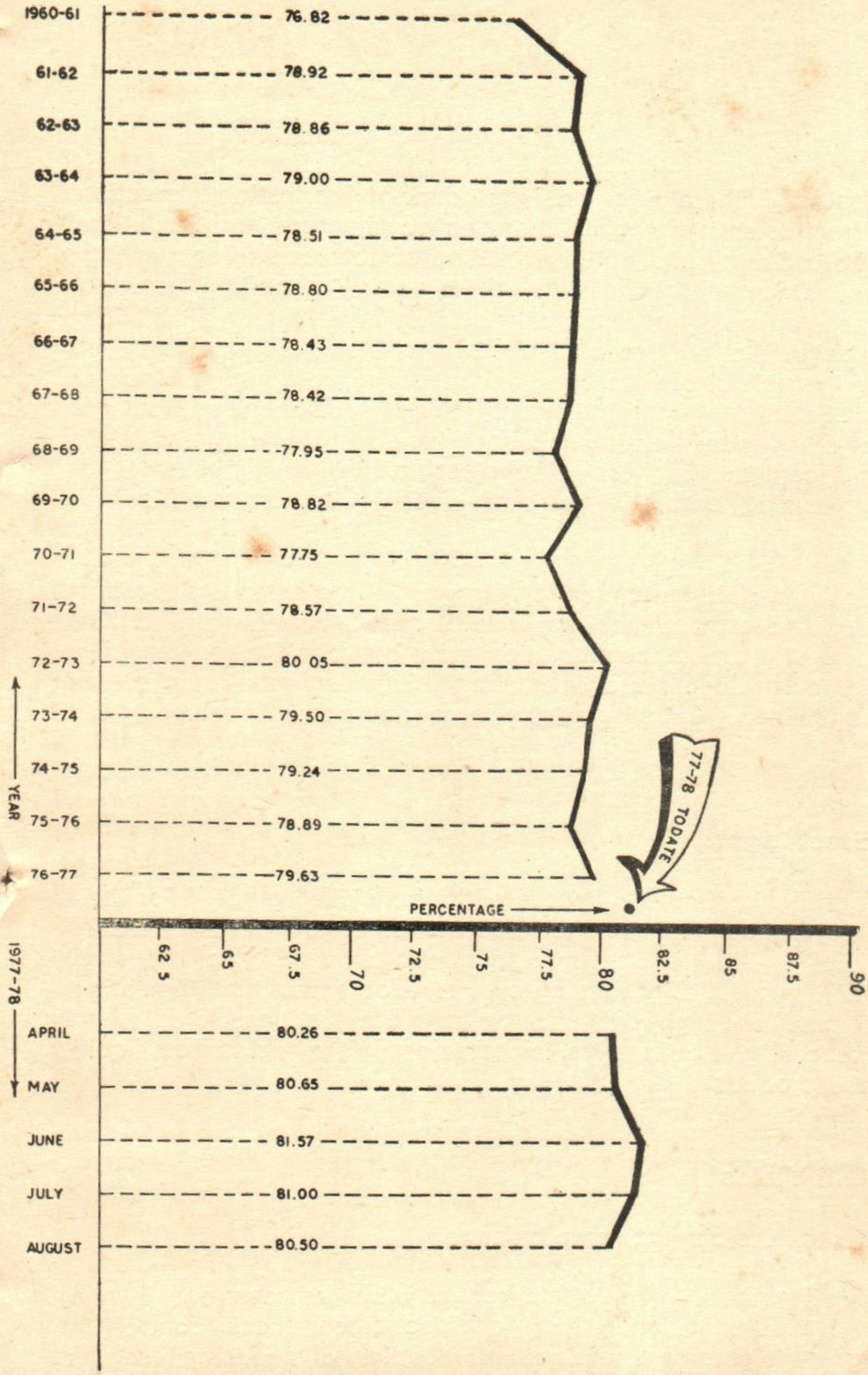

Fig. 1 : Gross Mill Yield

Scrap". Besides, there are arisings during fabrication, erection, machining, from defectives produced during manufacture, and such like, called "Process Scrap" and from dismantled structures and equipments, called "Capital Scrap". In TISCO, there is an elaborate system of collecting these arisings, automatically grading and seggregating them in accordance with a pre-determined mode of broad classification, and transporting the bulk directly to specific consuming points (Steel Melting Furnaces). Since the arisings are heterogenous in composition, sizes and bulk densities, however, a sizeable proportion of the arisings, which is a mixed and contaminated lot, is subject to further processing for grading and sizing before it becomes ready for consumption or disposal.

While it was the right approach to consume all the scrap produced in the plant itself (more particularly because its quality is known), TISCO's special efforts at material conservation were concentrated on reducing the arisings itself through improvements in yields, raising the value returns on the arisings, finding substitutes like recoveries from the dumps, and the like.

Yields of Steel Ingots

About 11% of the total steel output is of the fully killed grade. For their production, super-imposed hot-tops lined with refractory materials were used in the past. This resulted in discardings of over 23% of the steel poured in each mould. By changing over to exothermic and insulating type of hot-tops, the ingot top discards have been reduced to only 9 to 10%, thus securing a substantial improvement in the yields from liquid steel to rolled product.

Improved Mill Yields

Table 1 indicates the current scrap balance.

The arisings of process scrap, would reduce with improvement in the mill yields. Through rationalisation of ingot/bloom sizes, control on pouring heights/weights of ingots, standardisation of finishing lengths and process refinements to contain sectional variations within very

Table 1 : Scrap Balance

IRON SCRAP :

		Disposal							
Department	*Arisings*	*Genl. Fdy.*	*Steel Fdy.*	*SMS 1*	*SMS 2*	*SMS 3*	*Bl. Fcs.*	*Adit-yapur*	*For Sale*
Foundry	300					300			
Bl. Fces.	9500					6500	3000		
Mould Yard	4200	1800		1000	1400				
R T Shop	160							100	60
TOTAL :	14160	1800		1000	1400	6800	3000	100	60

STEEL SCRAP :

		Disposal							
Department	*Arisings*	*Genl. Fdy.*	*Steel Fdy.*	*SMS 1*	*SMS 2*	*SMS 3*	*Bl. Fcs.*	*Adit-yapur*	*For Sale*
Foundry	50		50						
SMS 1, 2&3	12500					12500			
Mould Yard	3100					3100			
R M No. 1	8000			6200	800			1000	
R M No. 2	9100		400			8300		400	
MLS Mill	1300			420		450		430	
Sheet Mill	3500			400	500			300	2300
Skelp Mill	450					100		350	
Plate Mill	2000			100					1900
W.T.A.P.	850			350				350	150
Merct. Mill	900							450	450
Adityapur	250			150		100			
Scrap & Salvage	2200			250	200	1500			250
Agrico	200			200					
Others	900			200		150			550
TOTAL :	45300		450	8270	1500	26200		3280	5600
GRAND TOTAL	59460	1800	450	9270	2900	33,000	3000	3380	5660

close limits, TISCO has been able to steadily improve the mill yields, over a period. Fig. 1 shows the trend over the period 1960-61 to date. It shows a marked reduction in the arisings of process scrap at TISCO.

More Profitable Disposal

Best results in material conservation will accrue from a dynamic approach, as conditions are never static, especially in the steel industry. For instance, some of the mill scrap is sold to re-rollers and other small-scale consumer goods manufacturers. At one time, the scrap dealers were having a bonanza in scrap trade for export as well as home consumption in mini-steel plants. Taking advantage of this increased demand, some of the circulating scrap was devoted for sale as higher profit earners. But, this would have had an adverse effect on the scrap availability for melting purposes, had it not been for a drive by TISCO to recover all capital scrap (piled up over years, in various sections of the plant), and to enhance the rate of winning iron-bearing material from the pitside scrap, skull and existing slag dumps through Heckett operations. It may be seen from Table 2, how the value return on scrap was improved and the once-discarded material recycled for consumption.

Table 2 : Heckett Remelting Scrap and Sale

Month	1970-71 *(all figures in tonnes)*	1971-72
April	17,741	19,140
May	17,496	19,689
June	15,471	17,866
July	17,527	19,540
August	17,601	18,809
September	16,641	17,187
October	16,577	18 400
November	17,374	18,971
December	17,419	18,823
January	17,743	18,861
February	16,788	19,572
March	15,060	18,646
TOTAL	203,438	225,504
SALE	139,527	140,934

Changes in Processes

TISCO facilities are designed to make steel by "scrap-hot metal" process at Steel Melting Shop No. 1, by "Duplex" process (100% blown metal) at Steel Melting Shop No. 2, by "scrap-hot metal-blown metal" process at Steel Melting Shop No. 3, and by "direct arc melting of scrap" in electric furnaces at Electrical Steel Foundry, Steel Melting Shop No. 1 and Electric Furnaces Shop at Adityapur. In an attempt to recycle more of scrap into the charges, the processes have been modified successfully at Shop Nos. 2 and 3. In the former, heavy cold scrap charges into the tilting open-hearth furnaces before taking blown metal are made in the latter, whence 50% of crude steel output is derived, the use of blown metal has been done away with, with the added advantage of a yield improvement (say 3%) through avoiding losses at blowing. Blowing losses amounted to nearly 10% of the hot metal, which formed a third of the raw material feed to make steel by the scrap-hot metal-blown metal process.

Raw Material Circuit

As in any industry, so in the Iron and Steel Works also, when basic raw materials are processed into finished products, a number of other materials arise—some, as by-products and others, as waste materials. Economics of operation dictate maximising the value returns of all these items, by either selling, or using them as such, or converting them into further usable products.

Iron ore is the basic raw material used in an Iron and steel plant. Fig. 2 indicates the processing of the material, right from mining, through preparation, to feed into the blast furnaces. At every stage, the discards are recovered and the quantities that are usable, recycled (as can be read from the fig.) A brief description of the process is given below :

Iron Ore Fines and Blue Dust : For more than half a century, the practice of selective mining was in vogue, to the exclusion of iron ore fines and blue dust. When modern, mechanised mining methods were introduced as part of TISCO's last major expansion programme, the position was further aggravated, due to higher arisings of fines, and larger areas being bypassed without mining. This was again compounded with the shift in emphasis to preparation of sized burden. The present trend is for sizing at +10mm/—30mm Mechanical mining itself produces considerable quantities of fines. Still more fines are generated in the course of

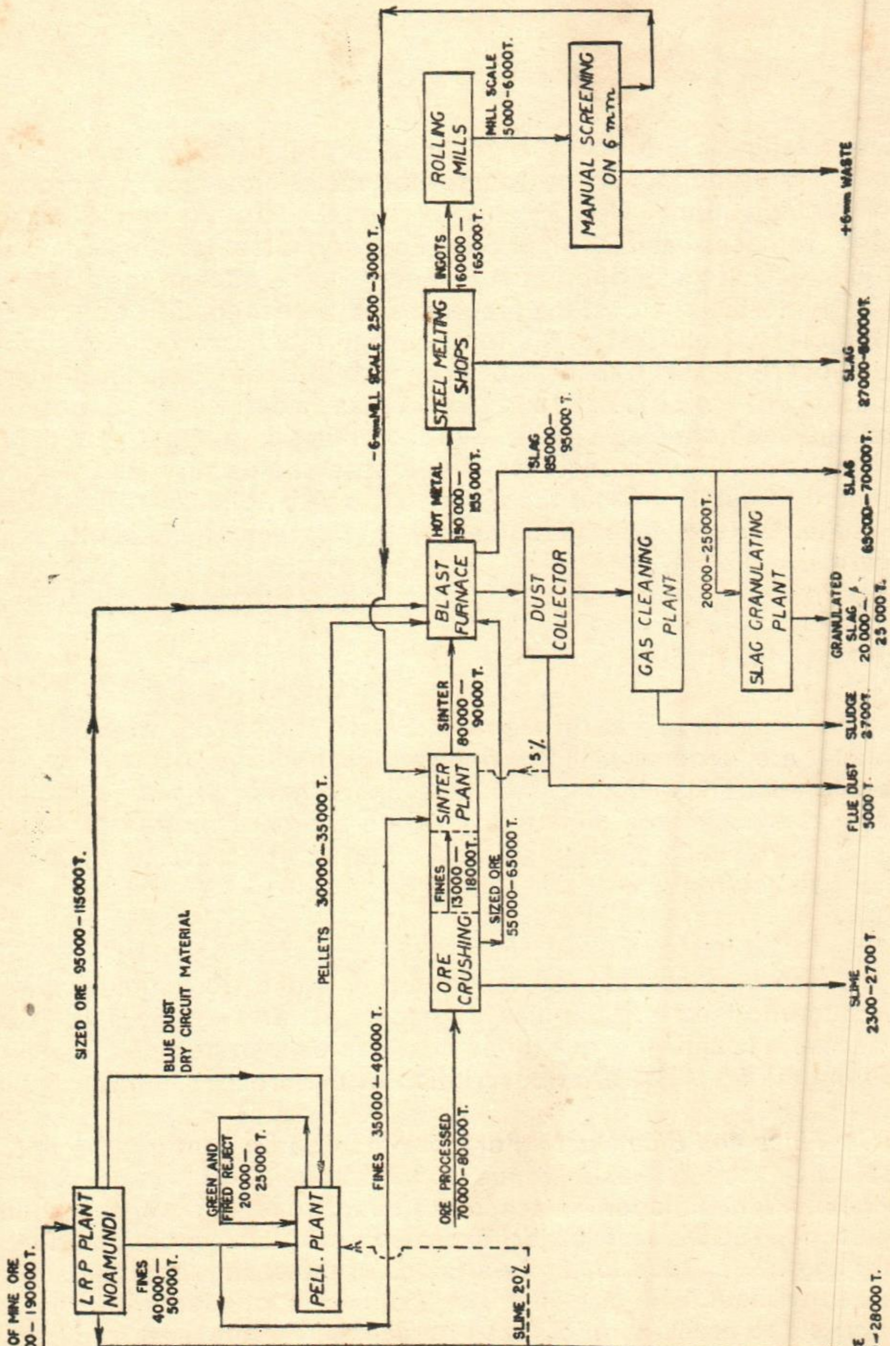

Fig. 2 : Raw Material Circuit

crushing the lumps to the smaller size. Sintering and pelletising have shown us the way out to gainfully utilise these fines (—10mm/+100 mesh) and blue dust as blast furnace charge, besides solving their problem of disposal, particularly during the monsoon season. Sinter and pellets have also helped to raise furnace productivity and reduce coke rate per tonne of hot metal produced.

Slimes : At LRP plant at Noamundi, 10—15% of ore processed comes out as slime (24,000-28,000 t.p.m.). At the Ore Crushing and Sinter Plant at Jamshedpur, 3.4% slimes is generated. (2,300-2,700 t.p.m.). The slimes are extremely fine material (60% below 200 mesh) and they contain a high percentage of gangue (20%). Therefore, the slimes are currently dumped out as waste. It is possible to find use for small quantities of slime as pelletising feed (20%), without impairing the properties of the pellets produced.

Gas Cleaning Plant Sludge : Approximately 2,500-3,000 tonnes of sludge is generated per month at the Blast Furnace Gas Cleaning Plant, 83% below 325 mesh in size, causing problems of handling in dry state. In chemistry, it is almost identical to flue dust. This is also totally wasted at present, although, it can find use as pelletising feed in small quantities.

Coal-Coke Circuit

Fig. 3 on Coal-Coke circuit shows input of Prime, Medium and blendable coal output of various categories of B.F. Coke and screened products, as well as recoveries of byproducts. Nut coke and coke breeze find use in the Steel Company itself, leaving little for sale. Pearl Coke was a preferred fuel for domestic consumption, and, therefore, it was a facility offered to the employees of TISCO. Remaining was sold out.

The value return through recovery of by-products in a Coke Ovens complex is only too well-known to need any reiteration. Primary derivatives like Coke Oven Gas, Coaltar, Crude Benzol, and Ammonium Sulphate are recovered as routine. While carbon monoxide gas and part of coaltar find uses in the plant itself, the balance left over like benzol products and ammonium sulphate are sold. Secondary derivatives like pitch, creostote, naphthalene, Coke Ovens discards like

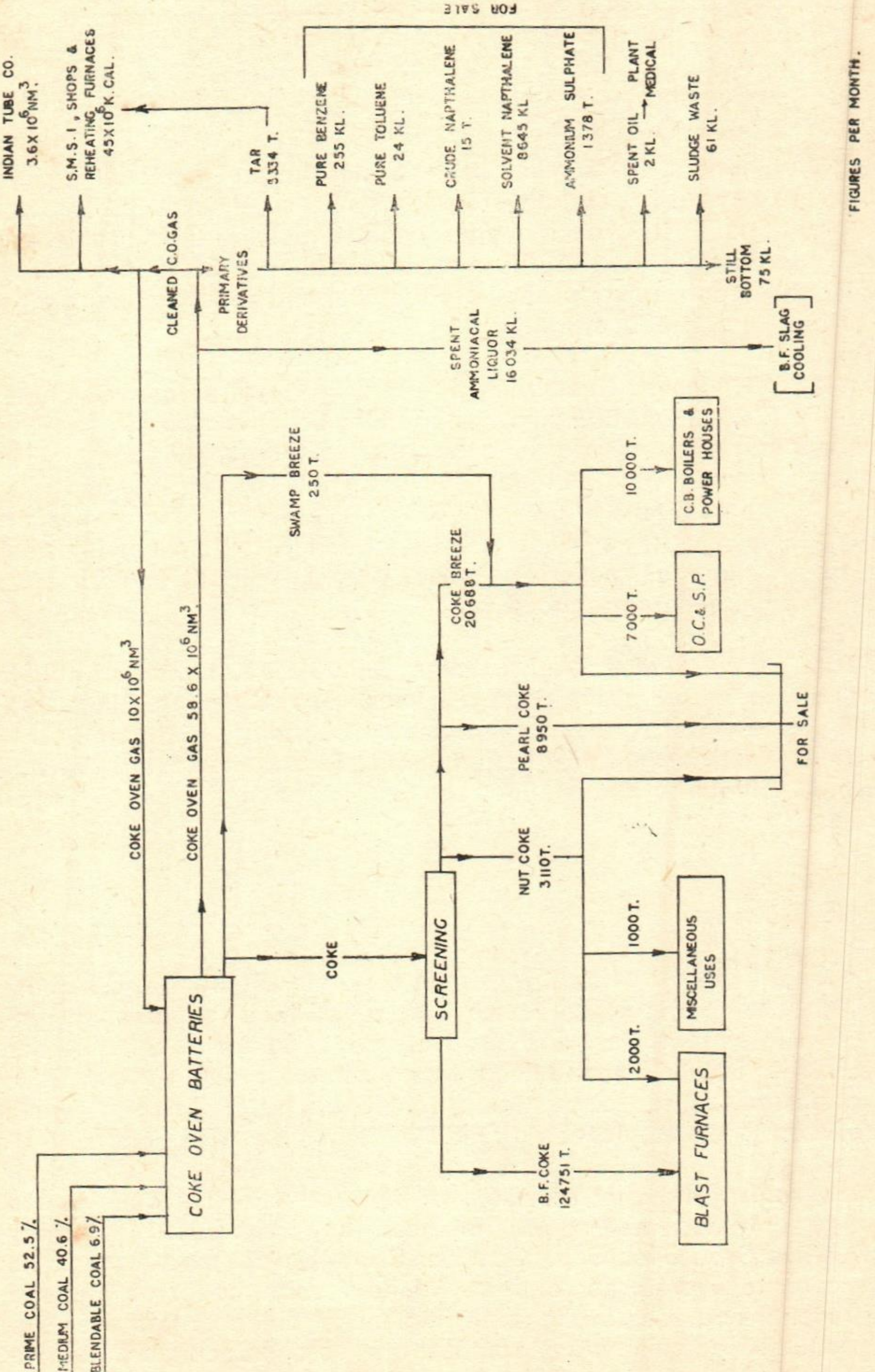

Fig. 3 : Coal - Coke Circuit Flow Chart

ammoniacal liquor, mother liquor from ammonium sulphate plant, acid sludge from benzol plant, tar acid derivatives where distillation plants are used and other potential resources of chemicals, also provide enormous scope for recoveries and economic uses. As referred to elsewhere, the spent ammoniacal liquor, after treatment, is proposed to be used for cooling B.F. slag, conserving use of service water, currently used for this purpose.

Slags

Yet another major by product of the iron and steel making processes is slag—the means by which impurities are separated from the metal and removed from the furnaces. Incidentally, slag performs other important functions as well, but that is not of relevance to this review. Besides performing their useful role in a particular process, these slags can still provide value in other uses, which is of significance for material conservation. Approximately 85,000-95,000 tonnes of B.F. slag and 27,000-30,000 tonnes of steel slag are produced in TISCO plant every month.

For years past, Blast Furance slag used to be dumped, making man-made hillocks. Even with modern blast furnace technology, the production of slag is about 350-400 Kg/tonne of hot metal. However, our average slag make is approx. 600 Kg/tonne. Its basicity is around 1.05, almost what cement manufacturers desire. Yet only about 1,000 tonnes of slag is being presently granulated daily by the jet process and supplied for cement making. The limitation is more due to want of capacity for granulation, as well as solidification of part of the slag produced, during transfer from blast furnace to the granulation plant. It is hoped to enhance the quantity throughout when the renovation work now in hand on the D Blast Furance granulation equipment is completed. Some slag is used for making ballasts for roads and tracks and as building material. There also exists a demand (though small) for B.F. slag for use in production of slag wool for insulating purposes.

As soil conditioners, B.F. slag and basic open-hearth slag have found favour in the recent past, specially because the soil around Jamshedpur is acidic in nature. Although the chief food elements that vegetation obtains from the soil are potassium, phosphorus, and nitrogen, they also need other chemical elements such as iron, sulphur, manganese and favourable conditions of humus content and basicity, which are provided by the use of small amounts of these slags.

So long, ferro-manganese slag was a waste product at TISCO's Joda plant. Through extensive experimentation, TISCO has succeeded in using ferro-manganese slag to replace part of the manganese ore that makes up the blast furnace feed. Present consumption rate is 2,000 tonnes of slag per month, replacing 1,400 tonnes of manganese ore and 300 tonnes of quartzite.

Process Improvement and Product Improvement

The very nature of the industry and the technology involved, underscores research and development as a prime requisite for process improvement. That was way, from its very inception, the Company established a process control unit, as part of the General Superintendent's organisation. Today, this has grown into a separate division by itself, discharging onerous responsibilities for process improvement, development of new products, quality evaluation of raw materials, corrosion prevention, tribology, pilot plant studies of new technologies, as well as engineering and development of new equipments.

Material conservation can result as much from product improvement as from process improvement. Steels such as Tiscon 42, Tiscon 50, cold twisted, high-yield strength, high bond, ribbed bars that save from 40% to 50% steel for concrete reinforcements; weathering steels that in open uses withstand corrosion due to weather without painting, low alloy high strength steels (LA55 and LA60), easily formable, with guaranteed weldability attributes, ideal material for pressings, containers, bridge structures and buildings, are but a few examples of our product improvement work.

Another important area in which the R & D Division of TISCO has made far-reaching contribution in material conservation and foreign exchange savings is in the development of a rotary kiln-based Sponge Iron plant. In this, besides solving the problems of high capital cost of a conventional integrated steel plant, anticipated shortage of coking coal, and the high escalation of price of coking coal all over the world, TISCO has pioneered an answer to the crying need for using non-coking coals which are plentiful in our country. In addition, TISCO has succeeded in establishing the parameters of this process and suitability of various types of indigenous ore supplies. The pilot plant, of 12 tonnes/day capacity, wholely designed, constructed and erected by TISCO technical personnel, without incurring any foreign exchange expenditure, is eloquent testimony to the Steel Company's concern and involvement in material conservation at the national level.

Work on preheating of coal, coke breeze addition to the coal mix, and manufacture of formed coke are efforts well under way for conserving the nation's depleting coking coal reserves.

Process and quality control efforts are also far-reaching. For instance, in routine recycling, scrap containing recoverable alloying elements like nickel, molybdenum, and non-ferrous scrap are segragated under metallurgical control, classified and the alloying elements and costly non-ferrous metals gainfully won and reused.

Energy

Fuels and energy account for a third of the cost of steel making. Therefore, conservation of energy and, consequently, the material involved in generation of energy and power enjoy primacy in all operations. The basic sources of fuel and energy in TISCO are coal, coke, coke oven byproducts, oil, blast furnace gas, coke oven gas and producer gas. Whilst, as routine, TISCO is engaged in avoiding waste, improving fuel rates and power rates of operations, more intensively, it has campaigned periodically to substiture fuels, to modify designs, to find alternatives, etc. To motivative the departments to greater efforts at savings, saving competitions have been organised, which paid off in reducing the overall fuel rate to a record low of 12.56×10^6 K. Cal per tonne of finished steel in 1976-77, whilst producing an additional 64,450 tonnes of steel as compared to the previous year. Another significant achievement of the year was the switch back to 100% coke oven gas consumption in all possible applications. This needed revival of equipment and controls since in disuse for the past 10 years. Besides, coke oven gas was introduced as regular fuel (upto 30% heat input) in shop Nos. 1 and 3 furnaces where, earlier, other fuels were preferred. Acceptability for use of carbon monoxide gas as heat input was of the order of 10% only. At the

Coke Ovens itself, for the first time, coke oven gas was used for injection into the blast furnace gas underfiring system. Use of this by-product fuel enabled corresponding savings in use of expensive purchased oil and tar.

Other Materials Recycled

Some other materials which are being successfully recycled or reused include screened products from coke ovens; flue dust from blast furnaces; dolo dust from calcining plant, waste pickle liquor from sheet mills, dismanted refractories; and cyclone dust from superbasic plant and mill scale. Details about their uses are given in the following:

Coke Breeze : The fines (−10mm) screened out of coke produced amount to approx. 20,000 tonnes per month. Due to its very abrasive nature, this material is the most difficult to dispose off or consume. However, in 1944, when process steam facilities were being extended, TISCO secured a boiler unit capable of successfully burning 100% coke breeze in the grate, for steam raising. The off-take at full rating is 5,000 tonnes of breeze per month. Besides, Boiler House No. 3 uses 5,000 tpm for sandwitch firing. At the Sinter Plant, coke breeze is used as fuel, to the extent of 7,000 tonnes per month and at the soaking pits, for bottom making 800 tonnes per month.

Flue Dust : Arising is around 170-180 tonnes per day, with an iron content of 35 to 40%. Experiments at using varying quantities of flue dust as input material for sinter making having proved successful, necessary bins are being installed to store the material and introduce it in predetermined proportions in the ore mix used in the Sinter Plant. Until these installations are completed, the flue dust would continue to be dumped along with Blast Furnace slag.

Dolo Dust : Steel plants provide themselves with facilities for manufacture of burnt dolomite. TISCO has also done the same. In TISCO plant, where raw dolomite is crushed for sizing, a large quantity of dolo dust is generated. With the successful development of super fluxing sinter, approximately 3,000 tonnes of dolo dust per month is being used as part of the input charge, along with crushed limestone, for sinter making.

Waste Pickle Liquor : This Sheet mill effluent from the pickling tanks together with similar effluent from Indian Tube Company forms the raw material for making various shades of iron oxides, the basic material for paint manufacture at Cynides & Pigments Ltd—a subsidiary of TISCO.

Dismantled Refractories : TISCO uses approximately 80,000 tonnes of different grades of refractories every year. At the time of relining of the furnaces, the earlier practice was to use only new refractories. The torn out bricks were dumped as waste. In the wake of a plantwise drive for cost control instituted in 1964, the idea of salvaging and reusing partly the dismantled bricks for reheating furnaces and ladles, caught up. It has been extended as standard practice to salvage as much of the re-usable refractories as possible. Fire clay, basic furnance refractories, silica bricks, checker lining, etc., are used for the production of second grade basic bricks, brick mortars, castables, ramming and gunning mixes, etc.

Cyclone Dust from Superbasic Plant : Raw magnesite is dead burned in the rotary kiln at the super-basic plant. During the process, a large amount of fine dust of partially calcined magnesite is generated which is carried off with the waste gases. The bulk of the dust gets trapped at the cyclones. Earlier, this very fine material was being dumped out as waste. Currently, TISCO has succeeded in using it along with low grade chrome ore, to form brick clots, then fired in chamber kiln and the sintered product recovered for gainful use. Work is well under progress to refine this recovery process to make pellets from the dust for re-charging into the kiln for making the sinter.

Mill Scale : In the Rolling Mills, where the steel ingots or semis are heated and soaked at elevated tempratures before rolling to shapes and sizes, steel scales anywhere from 2% to 4% of the ingots/semis rolled mills scale contains 65-75% Fe. Arisings of scale amount to 6,000 tonnes per month. At one time, this was entirely discarded. The earlier experimentation to consume it as Blast Furnace feed and melt additions at S.M. Shops were not successful. Presently, after screening, approxi-mately 3,000 tonnes of 6mm size scale are used for sinter making. Fine scale from bar twisting yard is used to make rimming compounds.

Oil and Rubber Products : Oil and rubber are two other products where recycling will be particularly attractive, because their disposal by dumping can cause pollution. A beginning to rejuvenate used oil has been made recently at the Material Handling Department (800 lit. p.m.) and by contracting with M/s. Metoil to reclaim used oil from locomotives, loco cranes and other departments. This party is using a process proven by the Indian Institute of Petroleum Research, Dehradun, and hopes to deliver 60-70% of the waste oil as reclaimed product for reuse. This is in the early stages of trial. It is also being tried to interest rubber reclaimers for the discards of hoses, V belts, conveyor belting, etc.

Indirect Contribution from Other Departments

Material Conservation results from betterment in maintenance practices, salvaging of components, tribology studies, standardisation of equipment/parts. Some typical examples should serve to illustrate this.

Hardfacing techniques have paid higher dividends in terms of improved life and reuse of old material. Hardfacing of shear blades of rolling mills resulted in improving the cutting edge of the blade almost equivalent to that of a new blade, and of coke oven hammers by OCR 20 electrodes improved life of hammer tips to 18 days from 7 days.

Tribology, basically a science of study on friction, wear and lubrication, extends its way by providing better and salvagable materials, reconditioning of the spares, recycling and conservation of materials. In the limestone crushers of the Ore Crushing and Sintering Plant, hammers were made of 12% Hadfield manganese steel as per original design. These hammers cannot be remelted and reused as hammers, although the wear is only on the periphery of the hammer head. The material of these hammers were changed to 6% chrome-molybdenum steel. In the result, TISCO not only derived an improvement of life of as much as 4 times, but also remeltability for reuse as hammers. The same material, 6% chrome-molybdenum has given six-fold increase in life in case of upper grizzly discs of coke ovens, which are subjected to high abrasion.

Standardisation of equipments and their components, by virtue of specifying proper material to suit the functional requirements, leads to better life, and, therefore, lower consumption. The variety reduction achieved by standardisation results in reduced inventory of spares. Both of these accomplish the objective of conservation of material. Some typical illustrations are quoted below :

Liners of Conveyors, Chutes, Bins, Hoppers : These liners, as per original design, are huge steel units of various sizes and shapes, unique for each application. If any damage occurs on the liner at a particular region, the earlier practice was to change the complete liner. By standardising these liners to only 14 comparatively small, handy shapes, currently, only the worn-out portions of liners are replaced and not the entire assembly. Addtionally, these standard shapes can be assembled like building blocks to cover any required area. Moreover, special materials can be chosen for use at specific regions to counteract severe service conditions like heavy impact, attrition, etc., whereas normal, less-expensive, wear-resisting material can be used in other areas.

Gear Boxes : The standardisation of gear boxes has achieved a 55% reduction in the varieties being in use hitherto. This was possible merely by matching center distances and reduction ratios into close groupings and replacing complicated and costly drives by simple and economic gear units. The gear boxes with different handings (disposition of shafts) used to be kept as seperate stock items. By having gearboxes with standard handings, number of spares required have also been reduced.

Master Controllers : For the master controllers used in cranes and other ground equipments, wherein 46 different types were being used, only two have been standardised which can be adapted to serve the entire range of requirements of TISCO, by using interchangeable cams. A unique coding system has been developed for proper selection of cams.

More Can Be Done

TISCO'S quest for material conservation and recycling of wastes, means that what is discarded today, should very well be made into a useful product tomorrow. Therefore, a continuous and continuing programme of research and development is maintained throughout the plant. For

Wear is industry's bugbear, since it accounts for material and power losses that take place when machine components are in operating condition. Wear could be due to a single factor or it could be due to complex combination of various factors. According to an eminent tribologist, frictional wear alone accounts for 40-60% of all equipment failure, while limiting the life and availability of critical components and tools. This is not surprising because critically weak points in a machine are the two mating surfaces where force is transmitted between them. In addition, friction also causes power loss, which means the efficiency of transmission of power decreases. Typical example of parts subjected to frictional wear are gear teeth, shaft bearing areas, keyways, valve seats, cams, etc. These two factors, which account for material and power losses, are estimated at 1.6% of gross national product.

Eutectic+Castolin Institute has many years of research and experience in combating the problems of microwear of few thousandths of an inch on critical machine components and in reducing downtime. It uses the latest, most advanced techniques and technologies of powder metallurgy, weld deposition and new alloy formulations. This has led to the development of "powder welding" processes that permit the maintenance and design personnel to derive economies for the industry by slashing the spiralling costs of new parts for replacement and downtime. Power welding helps to restore thousands of previously scrapped worn parts to a condition not only as good as new but, in most cases, far better than new. The average LPF imparted to a worn part through the depositions of recommended application-engineered powder alloy could be between 200% to 5000%. Powder welding enables industry to reclaim worn parts at a fraction of the cost of new parts and, with weld protected parts proforming three times as long as the replacement, savings generated in terms of reduction in replacement costs, downtime, inventories of spare parts are reaching into millions of rupees.

The powder welding processes might be explained as low temperature application method of depositing application-designed weld alloys in powder from, in accurately controlled thickness to virtually any base metal composition, producing a high strength bond without dilution. The powder welding field for repair and reclamation is covered by the following powder welding processes :

(1) Eutalloy Microflo process; (2) RotoTec process.

Eutalloy Microflo Process

The Eutalloy Microflo process is a method of depositing a wide range of application-designed, special process alloys in powder form using a specially designed, oxy-acetylene eutalloy torch, which permits a greater control of deposition than is possible by any other means. The deposits are dense, smooth and uniform and their thickness can be controlled from paper thin 0.003″ upwards. Porosity and oxide inclusions are eliminated.

The self-fluxing type alloy powders, which have been formulated to wet the base material, have hardness characteristics ranging from 10 to 64 Rc. The powder alloy weld-protected coatings are bonded to the base metal sub-strate by the mechanism of surface diffusion, which takes place in solid phase. The metallurgical bond acts as a cushion layer between the deposit and the base metal.

The unique microflow diffusion technique enables surface alloying to be achieved in the solid phase and many parts, previously thought to be beyond repair, can now be precision overlayed or wear-surfaced. The finger-tip control of feed lever on the eutalloy torch considerably reduces deposit wastage and the "finish-as-welded" deposits require minimum finish machining or grinding time.

The key to the succes of microflo powder welding system is the integrated functioning of two components :

1. A group of specially formulated application-designed self-fluxing type of powder alloys; and

2. Simplicity and accuracy of specially designed oxy-acetylene eutalloy torch shown in Fig. 1.

The Eutalloy Torch is a tool designed to be used with standard oxy-acetylene gas equipment. The heart of the torch is a precision gas and powder mixing chamber. It introduces the powdered alloys into the gas system and through the flame they are deposited on the base metals. The

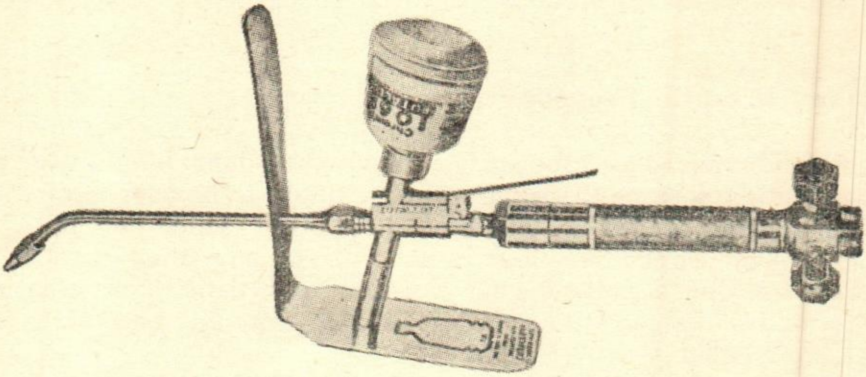

Fig. 1

powder alloys are aspirated in oxygen stream only. This prevents any potential hazards of mixed gases backing up into the powder bellow modules.

The eutalloy microflo powder welding system permits maintenance personnel to return critical machine components and tools to service at a fraction of the cost of new parts and the weld-protected parts perform four times as long as the replacements. The average LPF imparted to worn part through deposition of recommended application-designed powder alloy is 400% and in some cases as much as 2500%.

The Microflo powder alloys are self-fluxing, have homogeneity of composition, particle size, size distribution for maximum aspiration efficiency, and have specific duroptic values to combat specific problems of part wear.

The group of powder welding alloys for use with eutalloy microflo system are listed in the following table.

Since the bond achieved between powder alloy weld deposits with substrate of base metal is that of diffusion, tensile strengths are in excess of 35 tonnes/sq. in. Therefore, microflo process should not be confused with one producing a deposit layer which has a low peel strength.

The versatility of eutalloy microflo powder welding system prolongs the life of thousands of parts that require :

Powder Welding Alloys

No.	*Microflo alloy*	*Type*	*Hardness RC*	*Applications*	*Base metal*
1.	NiTec 10224	Nickel base	8-10	Gears, coolant pumps, impellers, machineways, platen repairs, pump casings, gear hubs, gear boxes, crankcases, sheaves, pulleys, etc.	Cast iron, steels.
2.	ChromTec 10680	Nickel base	10-15	Pinions, quills, shafts, splines, draw bolts, keyways, collars capstans, chutes, cleats, guides, forks, journals, mandrels, etc.	Cast iron, steels.
3.	Bronzochrom 10185	Nickel base	36-42	Pistons, stick reel shafts, shanks, taper adapters, valve seats, keyways, gear teeth, pinions, pins, etc.	Cast Iron, steels.
4.	BoroTec 10009	Nickel chromium base	55-62	Lathe centres, pawls, profile gauges, ratchets, spindles, cams, augers, guides, fan blades, wearpads, etc.	Cast iron, steels
5.	TungTec 10112	Tungsten carbides nickel base matrix	Carbide 68-72 58-60 matrix	Boring bars, flycutters, trip dogs, wear guides, knives, augers, shovels, harrows, extruder screws, drill bits, fan blades, etc.	Cast iron, steels.

1. smooth, uniform deposits from 0.004" upwards (Adds months and years to the life of wear plates, fingers, cams, feed rolls with LPFs of up to 1000% which results in savings of up to 90% on spare parts);

2. precise edge and corner restoration in salvaging expensive scrap like worn or chipped dies, moulds, knives, impellers, keyways to a condition better than new; and

3. build-ups on contoured surfaces like worn wobblers, fan blades, impeller vanes, propellers, (achieved in a fraction of the time pre-

viously required with conventional weld-repair methods. Weld-protected coatings are smooth requiring no finishing operation.)

The microflo powder welding process provides unique powder alloy chemistries for corrosion resistance applications and especially carbide and boride-bearing deposits for combating the most severe abrasive wear problems for parts like debarker blades, augers, screw flights, conveyor components, skid plates, etc.

The Microflo powder welding process has been employed in surfacing of worn components, in many industries. For example, various rolls used in the steel industry have been compositely fabricated from carbon steel overlaid with microflo alloy type BoroTec 10009. A die housing for securing the cutting disc as in Fig. 2 was reclaimed with microflo alloy Bronzochrom 10185. The maintenance costs for roll stand

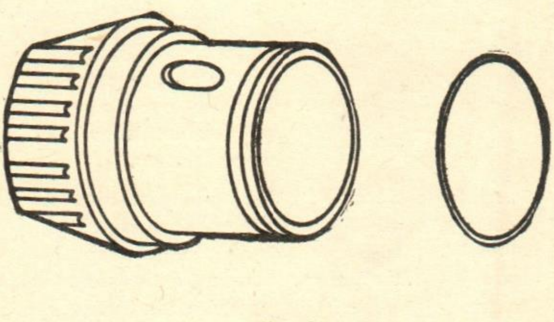

Fig. 2

floating guides (see Fig. 3) was reduced by 97% when microflo powder welding was employed to overlay the guides with powder alloy BoroTec 10009. The wear rate of guides up to 1" per single 8 hour shift was decreased by powder weld protected coating to 0.04" per 8 hour shift. The variable damper and venturi scrubber gas flow control valve for a blast furnace made from AISI 316 stainless steel (see Fig. 4) was subjected to erosive wear due to high velocity hot air blast containing hard microfine abrasive particles. The worn area was overlaid with a 0.015" shoft buffer layer of powder alloy ChromTec 10680 and capped with 0.015" to 0.020" of hard, abrasion-resistant powder alloy deposit TungTec 10112. This resulted in increased service life of part.

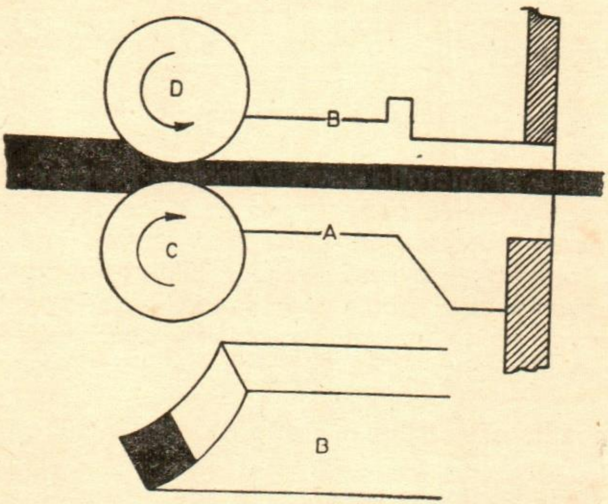

Fig 3

The automotive industry is one such industry which uses microflo powder welding for reclaiming its own, chipped autobody tools and dies.

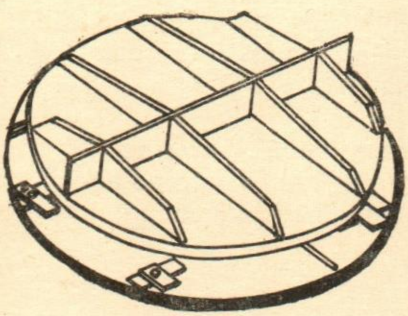

Fig 4

The process has a wide field of application and specific area of applications are :

1. reclaiming damaged die edges due to wear,

2. to fill up indentation on dies from metal scrap,
3. to even out corrugations in the dies from metal flow, and
4. restoration of worn blanking or cropping edges.

The high versatility of microflo powder welding process permits restoration of many critical machine parts and costly tools to conditions better than new and weld protected parts perform better and last longer in service. Any industry—cement, sugar, mining, earthmoving, forging foundry or even a machine shop—can use the Microflo process to upgrade the service life of its plant and machinery to increase productivity, efficiency and profitability.

Among the benefits of eutalloy microflo powder welding process are :

1. The low melting point of deposits avoids fusion of base metal.
2. The absence of fusion permits overhead welding with the same ease as in welding in flat position.
3. The absence of fusion in welding ensures total absence of undercutting.
4. Low heat application by diffusion bonding of the powder alloy deposit to base metal substrate results in minimum distortion, warpage, embrittlement.
5. Deposits of thickness 0.005" upwards in smooth, uniform, dense layers enable "in-situ" repairs to be accomplished with great ease and speed, requiring minimum machining or grinding operations.

RotoTec Process

The other powder welding process of RotoTec permits "cold" weld overlays mainly on worn cylindrical parts, both rotating and sliding (reciprocating) where frictional wear has occured and where distrotion or even moderate heat input cannot be tolerated. The RotoTec powder welding sytem is the most advanced metal spraying system ever developed, representing major improvement over conventional wire metallising techniques, due to much higher peel strength, superiority and greater reliability of Roto-coatings. This "cold" powder welding system permits weld-protected overlays to be accomplished at temperatures never exceeding 250°C. The RotoTec powder welding system has assumed great significance as a maintenance tool due to its amazing capability for restoring worn parts to better than new condition, at a fraction of cost of either purchasing new parts or even reparing them using other methods. The process does not require any special welding or spraying skills. The principal advantages of this new powder welding process are reliability, speed and ease of use.

Roto-coatings are unique, because they not only bring worn bearing areas back to required dimension quickly, but the Roto-coating powder alloys are themselves far superior to the base metals, providing a repair that normally far outlasts the original part. Roto-coatings are complete in "as sprayed" condition and require no subsequent "fusion" or bonding operations.

RotoTec final coat powder alloys yield weld-protected coatings which exhibit controlled permeability accounting for 2-6% of total volume. This network of micro-cavities acts as an internal reservoir for absorbing, retaining and releasing lubricant. This, in turn, permits a thin film of oil to protect mating surfaces and provides an additional factor for reducing frictional wear.

The key to the success of RotoTec process is the superiority and reliability of bond coat powder alloy XuperBond used in conjunction with a specially designed RotoTec oxy-acetylene torch with multi-orifice nozzle. Because of its unique composition, the XuperBond powder particles, upon introduction into the flame, react and generate additional heat due to exothermic reaction. The super-heated molten powder alloy particles are deposited on the prepared work-piece with impact due to force of the flame and form a continuous network of micro welds. The high tempratures generated are confined to the particles themselves, with only negligible amounts of heat transmitted to the work-piece. For this reason the work remains substantially cool. XuperBond powder alloy performs the key role in attaining superior bond strength which gives a Maximum Safety Margin (MSM) of weld-protected coating. In addition, it also provides a surface with optimum characteristics for accepting and holding all the final coat alloys with 100% reliability. Xuper Bond can be used on all commercially available base metals except pure copper which does not permit Xuper Bond to form microwelds due to its higher thermal conductivity compared to other base metals. The peel strength of this premium bond coat powder alloy is up to 50% higher than competitive materials.

The three final coat powder alloys for Roto-Coatings are designed to combat frictional wear and withstand high compressive loads. This precludes its use for applications subjected to line or point loads and impact.

There are four final coat powder alloys recommended for Roto-coating of various applications. The most universally recommended powder alloy for Roto-coating is LubroTec 19985 which is specifically designed to fulfil the service conditions of most applications where a new bearing surface is desired. The high alloy chemistry produces a corrosion-resistant deposit offering exceptional frictional wear resistance in lubricated service. LubroTec 19985 Roto-coatings normally last three times longer than original bearing surface. The recommended applications for Roto-coating with LubroTec 19985 are motor shafts, journals, pump sleeves, machineways, etc.

For applications requiring bronze-type wear-resistant bearing surfaces, powder alloy FrixTec 19850 has been specially developed and its formulation makes it hardest of commercial bronzes and have high degree of purity. Roto-coatings of this powder alloys are smoother, cleaner, brighter and more uniform than conventional bronze type deposits. Frix Tec 19850 is recommended where a highly machinable, copper base, low coefficient of friction bearing surface is required. Deposits work harden in service to provide additional service life. The average LPF imparted by Roto-coating with FrixTec 19850 is 400%. Typical applications for this Roto-coat powder alloy are propeller shafts, end-bell housings, pistons, conveyor shafts, etc.

For applications requiring some abrasion-resistance with high frictional wear resistance, powder alloy DuroTec 19910 has been specially formulated to produce hard coatings. This Roto-coating powder alloy is recommended particularly where the original part is hardened or is of high alloy chemisty. The alloy deposit provides intermetallic layers with especially high micro-hardness. Typical applications recommended for

Roto-coating with DuroTec 19910 include pump impeller shafts, I.D. fan shafts, grinder shafts, hydraulic pistons, spindles, etc. The average LPF obtained on these Roto-coatings is 200%.

The RotoTec process not only prolongs service life of parts by offering far superior frictional wear resistance, but it can,

1. eliminate up to 90% of new part replacement cost,
2. slash needless inventory,
3. reduce waste, scrap and conserve raw material resources,
4. cut downtime, and
5. save thousands of rupees every year.

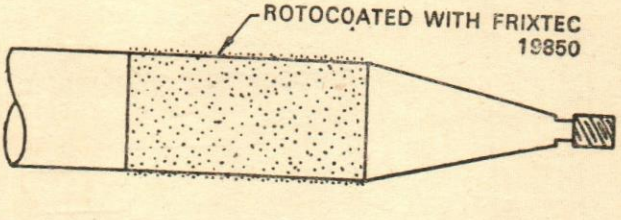

Fig. 5

A marine propeller shaft (Fig. 5) worn out due to corrosion by constant exposure was reclaimed by Roto-coating with FrixTec 19850. Replacement cost of new shaft was estimated at Rs. 7,800. A conventional repair with arc welding requiring a day and a half for machining and straightening was estimated at Rs. 1,810. RotoTec powder welding process was employed to reclaim the shaft and the entire repair (including finish machining) completed in just four hours at a total cost of Rs. 280—a direct saving of Rs. 1,530. In addition, the LPF imparted was 400%.

The worn bearing and oil seal areas of a speed reducing motor shaft repaired by Roto-coating of the motor shaft with LubroTec 19985 are shown in Fig. 6.

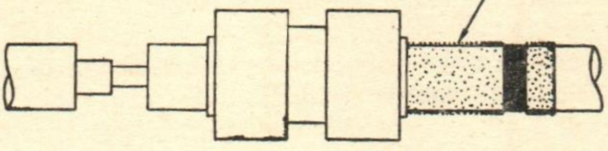

Fig. 6

The worn bearing areas of a water pump shaft (Fig. 7) required repair. Conventional repair methods of preparing a wear sleeve cost Rs. 6,500. The cost of repair with RotoTec process with DuroTec 19910 powder deposit was Rs. 1,250, resulting in cost saving of Rs. 5,250. Annual savings amounted to more than Rs. 50,000, with additional savings resulting from LPF of 300%.

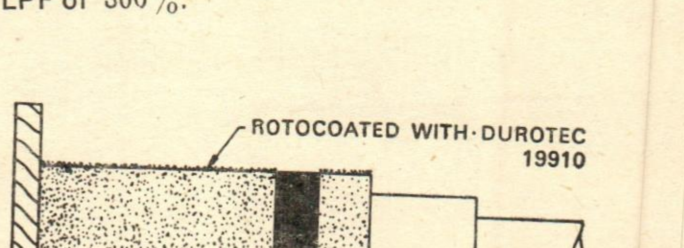

Fig 7

Latest addition in the family of RotoTec powders is ChromTec 19222. This powder has been specially developed for corrosion resistance applications involving liquid media. ChromTec 19222 can be safely used on most applications where corrosive or chemically active liquid media would normally penetrate and attack. This powder also has excellent physical properties. It is best for high pressure hydraulic service. It work-hardens in service and has excellent machinability. ChromTec 19222 deposit is very suitable for application in the case of chemical pump shafts, hydraulic pistons, bearing seals, etc.

Thus the powder welding processes have assumed great importance as a maintenance tool for restoring thousands of previously scrapped worn machine parts and tools to a condition not only as good as new but weld-protected parts perform three to four times longer than new replacements, resulting in substantial savings in terms of reduced replacement costs, reduction in downtime and inventory. Powder welding technology today holds the key to sucessful modern industrial operations that require a high level of efficiency, reliability and maximum service life of the critical costly parts and tools of its plant, machinery and equipment. □

FORM IV

Statement about Ownership and other Particulars about Newspaper PRODUCTIVITY (as per Rule 8)

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I, V.S. Chopra, hereby declare that the particulars given above are correct to the best of my knowledge and belief.

January 15, 1977

(Sd/-) V. S. Chopra
Signature of Publisher

Conservation of Diesel Fuels in Lift Irrigation Pump Sets

R. K. Gupta* & J. S. Ahluwalia**

The price hike of crude oil from about 3.00 dollars per barrel in September 1973 to 14.60 dollars in September 1977 has forced practically all countries to become energy conscious. India's total import bill for the purchase of crude oil and petroleum products alone is likely to exceed Rs. 1400 crores this year. Various short-term as well as long-term measures have been taken to cut down the consumption of petroleum products, in order to reduce the massive drain of foreign exchange. Some short-term measures taken by various countries include price deterrants and switching over to fossil fuels, whereas long-term measures comprise search for alternative fuels and power plants. Long range fuel economy national objectives have also been set for certain applications. For example, in USA, the Federal Government has decreed that all automakers must achieve a 27.5 mpg fleet average fuel consumption by 1985. Comparatively, the fuel consumption of US cars was in the range of 8 to 15 mpg in the year 1973. Attention has also been focussed on conservation, i.e., towards more efficient utilisation of fuels and lubricants. Due to the importance of the subject in our country, a Petroleum Conservation Action Group (PCAG) was formed in 1975 under the aegis of Oil Industry Development Board to implement programmes involving conservation of petroleum products.

A large portion of our petroleum products are used in the agricultural sector, mainly in the running of tractors and lift irrigation pump sets. According to an IIP survey, there are currently over two million diesel operated pumps. Both light diesel oil (LDO) and high speed diesel oil (HSDO) are used in these pumps. Annual consumption of diesel fuel for these pump sets is of the order of 4.5 million kilo-litres. Even 10% saving in diesel consumption in this application is likely to reduce the import bill by about Rs. 45 crores per year.

In view of the great potential of fuel savings in the farm sector, PCAG initiated a project to carry out a systematic and scientific study in the

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field. The project essentially consists of a field study to determine the present status of efficiency and fuel consumption of lift irrigation pump sets and quantification of the possible diesel savings, through actual experiments on the pump sets. Thereafter, recommendations will be made for the benefit of farmers with regard to selection of proper lift irrigation equipment for most economic operation and maintenance. The project has the following main objectives :

1. To determine the present status of efficiency and fuel consumption of existing lift irrigation pump sets and the scope for improvement of these factors by way of proper selection and maintenance of the pump sets.

2. To identify the factors responsible for low efficiency and high fuel consumption.

3. To conduct a limited sample survey to obtian necessary information for locating representative test points for the above purpose.

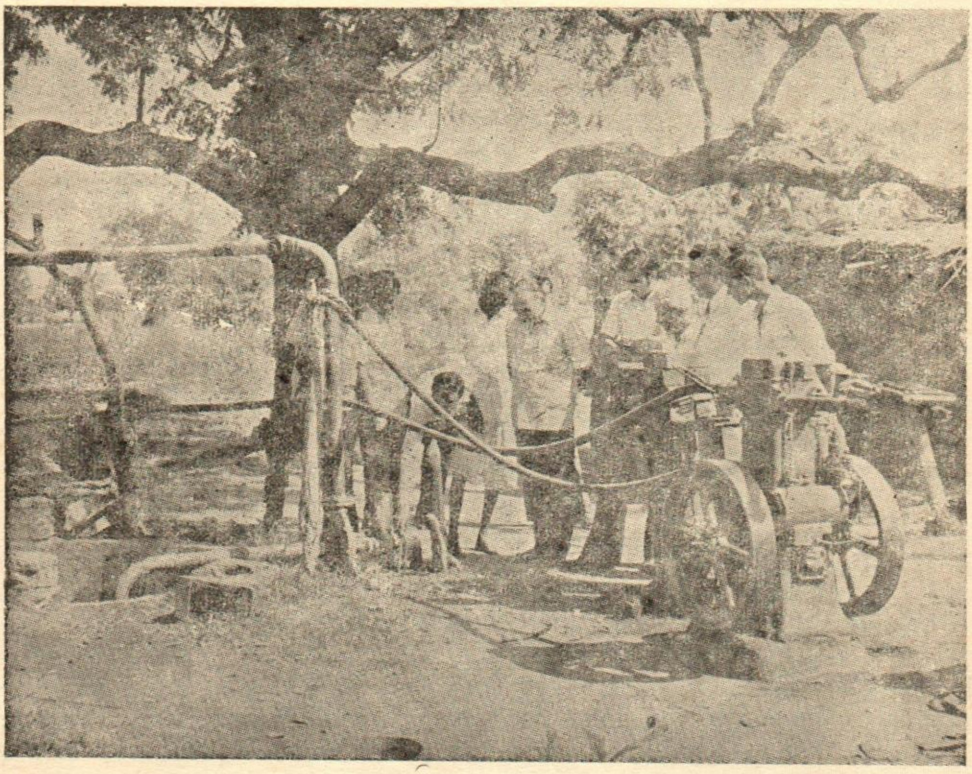
4. To ascertain the present status of extension services and technical guidance available to the farmers for selection and maintenance of pump sets.

5. To prepare technical guidelines for improving the efficiency of diesel pump sets and conservation of fuel based on the findings of the study.

6. To assess the role of standardisation of lift irrigation equipment in achieving conservation of fuel.

Initially, a study is being carried out in the State of Gujarat which depends upon lift irrigation for over 80% of its total irrigation needs. It has over 450,000 diesel operated pump sets, most of which use LDO. The consumption of LDO in Gujarat is about 1/3rd of that in the whole country. Therefore, the impact of the conservation of LDO in the agricultural sector will be maximum in Gujarat.

A similar study may also be undertaken in Uttar Pradesh (UP). This state has over 850,000 pumping units and 65% of the area is irrigated through lift irrigation. Diesel operated pumps account for more than 70% of the total pump sets, the rest being electrically driven. The conditions in UP are entirely different because of various variables such as water table height, type of wells, pumps used, crops and cropping patterns, groundwater availability, type of lift irrigation machinery, etc. The above study will be extended to some other states, if found necessary.



A Diesel Engine-Operated Lift Irrigation Pump Set in Gujarat

The work on this fuel conservation project in Gujarat State started in the month of November 1976, in collaboration with the Institute of Cooperative Management (ICM), Ahmedabad. Initially, survey was conducted in 60 villages in three districts, namely Banaskantha, Junagarh and Rajkot, covering 1724 pump owners through a structured questionnaire. The selected respondents were contacted in person by trained investigators. Detailed information regarding various parameters such as consumption of fuel, areas irrigated, make and condition of lift irrigation equipment, maintenance practice, depth of well, depth of water level, static head in Rabi season etc., was obtained and analysed. It was observed that an extremely large percentage of the pump sets used excessive fuel than the normal. Over 66% of the pump sets surveyed consumed more fuel ranging from 37% to as much as 300%. 22% of the pump sets used excessive fuel in the range of 13% to 37%. Some of the common defects in the lift irrigation pump sets which have been detected are as follows:

1. *Bigger Prime Mover :* Farmers tend to purchase a bigger size prime mover without taking into consideration the horse power required by the pump to operate at a given dynamic head (H) and discharge (Q). If a prime mover operates at part load, its efficiency is lower and fuel consumption more. This is obvious from the typical characteristic curves of a centrifugal pump shown in Figure 1.

A study conducted at the Punjab Agricultural University (PAU), Ludhiana, indicated that if a 5 bhp diesel engine runs at 4 bhp load, 5 to 7.5% more fuel per bhp hour was consumed. If it operated at 3 bhp load, 14 to 20% more diesel was needed and at 2 bhp load, it used 34 to 46% extra fuel.

2. *Lower Pump Efficiency :* In a large number of cases, the characteristic curves of the pumps do not match properly with the system requirements. A centrifugal pump operating at a specific speed, works efficiently only for a particular range of water discharge and head. Farmers seldom look at the characteristic curves or performance charts of different pumps to find out the most suitable pump for their wells. Neither, have they knowledge, or the necessary help from advisory agencies or the manufacturers.

If the pump efficiency falls from 50% to 30%, a farmer will be using 60% more fuel for the same head and discharge.

3. *Coolant Temperature Low :* On the farms, the engines are cooled by a free flow of water coming out of the well. Under normal conditions, the temperature of the water coming out of the engine is in the range of 30 to 35°C. This means, lot of usable heat in the engine is carried away in the cooling water. Engines operating at these low temperatures consume as much as 10% more diesel.

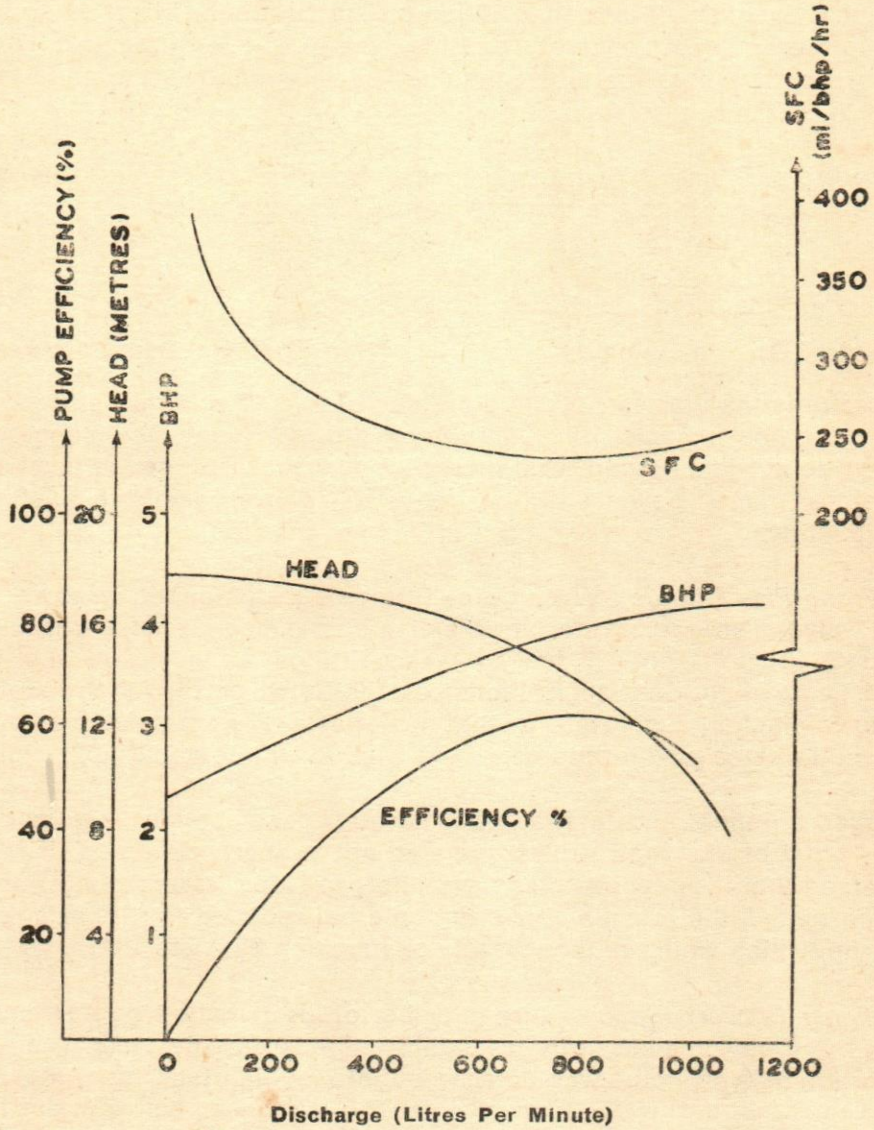


Fig. 1 : Characteristic Curves of a Centrifugal Pump Used with 5 BHP Diesel Engine

Experiments conducted on three Kirloskar AV_1 type engines in PAU showed that the optimum coolant temperature for minimum fuel consumption was between 50 to 70°C. An engine operating at full load showed minimum specific fuel consumption of 250 ml/bhp/hr in the 50 to 70°C cooling water outlet temperature range, whereas at 30° C, it was 270 ml/bhp/hr, i e. 8% more fuel was consumed by operating the engine at lower water jacket temperature.

4. *Undersize Piping :* To transport water from the well upto the pump and from the pump to the command area, pipes are used. Many farmers tend to use undersize pipes.

Frictional head (Hf) is inversely proportional to the 5th power of the diameter (D) of the pipe $Hf = KL \frac{Q^2}{D^5}$. Thus frictional head increases multifold as the diameter of the pipe decreases. If a farmer selects a 2″ diameter pipe instead of 3″ diameter pipe for the same discharge of water, the frictional head will increase as much as seven times and, therefore, more power will be required to overcome the additional frictional head.

5. *Wrong Pipe Fittings :* Wrong pipe fittings such as bends, elbows, T's, foot valves, strainers, etc., in the line also cause excessive frictional losses. Frictional head due to these fittings adds up to the total dynamic head and as such increases the horse power required for the pump to discharge a given quantity of water. For example, if an elbow is used in place of a radius bend, the friction will be about 50% more.

Plugged strainers and rusty foot valves add considerable resistance to flow. Most of the foot valves are also not properly designed. ICM has observed that if undersize pipes and improper foot valves and strainers are corrected, the prime mover size could be reduced to the extent of 2 to 4 hp, which would reduce diesel consumption by 0.5 to 1 litre per hour.

6. *Higher Delivery Pipe :* A large number of lift irrigation pumps had the delivery pipe unnecessarily extending high over the well. The water from the delivery pipe was discharged into a high tank near the well. From the tank, the water flowed into the channels below in the field. The extension in delivery pipe height varied from 1 to 2 meters.

The extra height of the delivery pipe increased the total head and hence the power required from the pump. In addition, by not directly discharging water in the field channels, potential head of the water is lost and is not used for conveying water through pipes or channels.

7. *Poor Engine Maintenance :* Most of the prime movers exhibited poor maintenance and were smoking badly, thus undoubtedly consuming more diesel fuel. Many engines had no intake air filter, which lead to extra wear due to dust particles being ingressed into the engine. Few engines which had oil bath type filters on them, had no oil in them.

Based on the above survey work, now for the second phase starting in November, 1977, sites have been selected for detailed study of 120 pump sets. Actual head, discharge, fuel consumption and other parameters will be measured. Possible fuel savings without altering any equipment, directly attributed to maintenance and good house-keeping will be determined. In the third phase of the project, three types of prime movers and ten to tweleve different sizes of pumps will be utilized to determine the most optimum and matched conditions for 60 pump sets at different places. Results of these studies are likely to throw light on the factors responsible for low efficiency of the lift irrigation pump sets and causes for high fuel consumption and quantify the possible fuel savings.

Results of the first phase field survey of the project have clearly indicated the need of advisory services for the farmers on the proper selection of lift irrigation pump sets. In fact, there is dire need of an agency which could offer the lift irrigation services in full, i.e., right from the selection of a matched prime mover and pump set to the selection of size and type of pipes, fittings, foot valves etc. to the installation and maintenance of the equipment at site. The advisory services could be offered to the farmers through State Government bodies, particularly State departments of agriculture, cooperative, panchayat raj and financial institutions, manufacturers of engines, agricultural universities and oil companies. There is also a need for the standardisation in the design and manufacturing of the pump sets and for efficient after-sales service. Many manufacturers are selling sub-standard diesel engines, which though lower in cost initially, consume more fuel and cause pollution through excessive smoke and require heavy maintenance. Similarly properly designed fittings and foot valves should be manufactured.

There is a great scope for the conservation of diesel fuels in the lift irrigation pump sets. The number of diesel operated pumps in use will continue to increase, because of the slower pace of electrification in the country. However, even if the pumps are electrified, the factors responsible for higher diesel consumption will hold good for higher electric consumption also and the savings in diesel that will accrue as a result of proper lift irrigation equipment now, will later on be savings in electricity. □

Solid Waste Disposal and Recycling of Wastes

K. V. Srinivasan*

Introduction

Solid waste can be defined as a material which is solid and arising out of animal and human life and activities, which is discarded as useless or unwanted. Broadly, it refers to a heterogenous mass of throw aways from the urban community such as domestic refuse and other discarded materials in a homogenous accumulation resulting out of commercial, industrial and agricultural operations.

Domestic refuse includes paper, cardboard, metal, glass, food matter, ashes, plastics, wood and other discarded materials. Commercial refuse includes the waste discarded by markets, shops, restaurants, offices and similar business. Industrial refuse consists of a variety of materials right from the inert materials to highly toxic and explosive compounds. The increase in industrial wastes has been alarming and the problems related in disposal are more complex in view of meteoric growth in industrial production. Agricultural wastes arise from production and processing of food and other crops and slaughtering of livestock.

Solid Waste Management

Solid waste management issues are concerned with development of improved and efficient methods of on-line management of collection and disposal and are for developing adaptable technologies to handle collection, disposal and recycling. The issue of conservation of renewable and non-renewable resources is also significantly related to solid waste management, since reduction of waste flow to the environment will reduce the quantum of virgin materials taken from the environment.

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The views expressed in the paper do not reflect the views of the Department.

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metal, glass and sand fractions.

Research into physical, chemical and biological problems involved in collection, treatment, and disposal of wastes as well as studies on the administrative and socio-economic problems have been of meagre proportions in relation to the rapid technological changes taking place in industry.

Extensive research work which is required to be carried out on new developments and optimisation of separation processes can be effective only when the demands of the recovered material are on the rise. There is, therefore, an urgent need to build up a public opinion to favour an increased usage of recycled materials, thus supplementing the shortages of virgin materials perhaps by offering appropriate incentives. The use of refuse as a supplementary fuel, waste heat recovery in the incinerators for solid waste, the application of pyrolysis to energy recovery from solid wastes, are some of the possible methods of waste utilisation. Anaerobic fermentation of solid wastes and waste water sludges to produce methane offers great possibilities.

Thus the solid waste management today will have to take all aspects into consideration such as long term and short term techniques from simple refuse disposal to materials and energy recovery and there exists a significant need for further research work on unit processes for separation and further refinement of processing operations such as composting, incineration and pyrolysis, waste heat recovery, etc.

Recycling of Wastes Abroad

Sweden : Approximately, 60 million tonnes of w[illegible]

The management of wastes and control of pollution is a complex problem which requires adaptation of operations research or system analysis. The very elements of this approach include (a) systematic evaluation of the importance and inter-relationship of all relevant aspects of the problems such as social, cultural, technical, economic and ecological factors (b) the comprehensive assessment of conversion, recycling and reuse of waste substances including inter-changes affecting the economic feasibility of various alternatives and reduction of the amounts of waste to be finally disposed into land, air and water, (c) the analysis of new approaches involving major innovations such as on-site processing of wastes and (d) cost-benefit analysis on the basis of which policies can be formulated and decisions taken.

An important aspect in the solid waste management which should be tackled with all seriousness is to create more and more technical expertise, as well as information retrieval systems, both national and international.

Waste disposal is currently being carried out all over the world by sanitary land filling, or incineration or composting. The composting method, while not being adapted so extensively as the other two so far, produces a useful end-product, humus, to supplement the fertiliser needs.

In order to recover a great deal of useful material in the solid waste stream, practical material recovery systems need to be evaluated by the [illegible] establishments. Broadly, two categories of [illegible] directly recycled

A well-known group of companies in Sweden handles large quantities of manufacturing and processing waste including metal scrap, paper, plastic, oil and liquid chemicals and is also engaged in handling consumer waste, which amount to about 6 million tonnes per year. This group of companies is responsible for buying, converting, and marketing about a million tonnes of household and industrial waste and another half a million tonne of metal scrap and paper every year.

For many years, Swedish industries have been dependent on organised resource recovery for their supply of raw materials. About 50% of raw material supplied to Swedish Steel Mills consists of metal scrap that is eventually collected and processed. Old ships are broken in dry docks and scrapped automobiles are crushed and sorted at central processing units. Recovery of metals from complex metals and cable scraps are also carried out centrally. Contaminated oil and other chemical wastes are collected at various collection centres throughout Sweden for further processing and recovery or for neutralisation of environmentally dangerous wastes such as those connected with oil products. Dangerous wastes from hospitals and clinics are also specially processed in specially developed ovens for complete combustion. Sludge handling is also effectively dealt in Sweden to produce compost. The protein-rich waste generated by large kitchens, restaurants etc., are also processed to be used as animal feed, etc.

The following table illustrates the relationship between production, consumption and recovery of several important materials in Sweden :

(in '000 tonnes)

Materials	*Production*	*Consumption*	*Recovery*
Paper	5500	1800	450
Iron and Steel	6000	5000	1200
Metals	400	200	70

Today about 30% of paper sold is collected as waste in Sweden and most of it comes from consumer companies such as printing plants, carton producers, offices and marketing organisations. A legislation has also recently been enacted which requires local authorities to organise the collection of newspaper and magazines from households by 1980 and this will result in a considerable increase of recovered paper. An experiment regarding household waste has also been in progress for several years involving the voluntary sorting of paper, glass and metal waste in about 1.5 lakh Swedish households.

More efficient waste handling and increased resources recovery bring about large advantages in terms of both environment and social costs, reducing the exploitation of raw material sources as well as energy.

U.S.A. : In view of easy operations involving refuse of in-house wastes, most of the secondary materials recovered today in USA are as a result of direct recycling programmes. A significant area where the direct recycling is practised in USA is the recovery and reprocessing of scrap metal. About 4 to 5 billion dollars worth of scrap metal are annually recycled and reused in metal processing. The table below indicates the 1969-70 data on amounts and value of materials recycled in the United States, both in-house and non-in-house.

Material	*Consumption of recycled material (1000 tons)*	*Value million $*	*Recycled material as a % of total consumption*
Aluminium	1,056	553	23
Copper & Alloys	1,489	1460	46
Ferrous	65,000	3000	49
Lead	585	175	38
Nickel and Alloys	42.1	209	29
Zinc	182.0	53	12
Paper	11,400	250	19

A considerable amount of recycling of separated scrap metals is being carried out in the United States. About 40 million tonnes of non-in-house ferrous scrap are recycled every year for steel production and about 4 lakh tonnes of tin cans are used for leaching operations in the copper processing Industry.

The non-in-house recovery rates of zinc, nickel and aluminium have, however, been very low. The losses, processing difficulties and economics are the main reasons for this in the case of zinc and nickel, while recovered aluminium, though easy to recycle and requires only about 1/20th of energy required to convert bauxite, for remelting operations, has not been possible to be recovered at a large proportion in view of extensive use in throwaway packages. Systematic recycling operations are now being evolved in the Unlted States, thus making it possible to recover 28,000 tonnes of aluminium cans in 1972 as against only 2000 tonnes in 1970.

Presently, as regards paper, only about 21% are being recycled every year in the United States. Recycling of newsprint is presently being done at several urban areas. Recycling of paper products is at a very crucial stage at present in the United States, because of spiralling prices of paper in view of depletion of forest supplies. On the other hand, considerable attention is now being given to the incineration of paper products in the solid waste stream to produce energy and to conserve irreplaceable fuels such as coal, oil, and natural gas. The future of paper recycling efforts is, therefore, at an uncertain state of affairs.

Direct Recycling of Industrial Wastes

As a result of increasing industrial activity and urbanisation, national utilisation and disposal of wastes has become more important and urgent to avoid public hazards as well as to conserve resources. A coordinated effort is required by industry, public and government in collecting information on different types of wastes and undertaking studies to identify the problems and places of work to solve these problems.

In-house recovery of industrial wastes is highly practicable in case of ferrous metals such as steel scrap, as well as in non-ferrous metals except in case of zinc and nickel due to high losses during brass melting and galvanising of steel, as well as difficulties in separation of minute amount of nickel from alloy steels. Systematic organisational and coordinated efforts will, however, yield results in effective recovery of zinc, nickel or copper.

Most of the plastic wastes which are recycled are reprocessed as in-house wastes and it is rarely possible to recycle a plastic waste after the product has left the production unit, in view of practical difficulties. This is also true for glass recycling, but with a concerted organisational effort, it is possible to recycle sorted glass from outside sources as well. Wood wastes such as saw dust, chips, etc., are now possible to be recycled to convert Into pulp for paper.

Recycling of paper and board wastes—both-in-house wastes from printing houses, newspaper industry etc. or outside such as retailers and collectors of old papers—is practically possible in our country.

Although substantial scrap arising from steel mills and engineering factories are being recycled in our country, to a great extent, items of scrap such as skulls, lower grade of sheet bundles, high speed and stainless steels are being wasted due to lack of facilities to process, and use them in our furnaces. Besides this, large quantities of capital scrap in the shape of discarded iron and steel are also going as a waste. Use of bagasse for paper production instead of burning it in boiler needs to be critically examined. Recycling of drosses, ash, and skimmings in galvanising plants shows great potential.

One of the major areas for utilisation of waste is in steel Industry. In the operation of steel plants, every effort is made to utilise waste materials arising out of various manufacturing processes so that it could contribute to the economics in the production of steel. During carbonisation in the coke ovens, about 20% to 30% by weight of initial charge of coal is evolved as mixed gases and vapours from which important chemicals could be recovered.

Ammonia from the gases is combined with sulphuric acid to produce ammonium sulphate which is used as fertiliser. Naphthalene, a by-product is used for production of lacquers, plastics of various kinds and dyestuffs. Pure benzene, which is also recovered is used in production of dyes, polystyrene, etc. Toulene is also another useful by-product. Pitch is used as a binding material for the manufacture of graphite electrodes and electropaste used in electric arc furnace.

After recovery of chemicals, the gas is used as a fuel separately or with recovered coaltar for heating purposes in the steel plant. The fines generated in the iron ore, unsuitabie as they are for blast furnace operations, can be either pelletised or sintered for agglomeration purposes and used in the blast furnace. The blast furnace gas can be mixed with coke oven gas and used as fuel.

The blast furnace slag can be used as road ballast, raw material for cement, mineral wool, etc.

The flue gases in the furnaces can be recycled through regenerators, increasing the thermal efficiency. The steel-making and finishing evolve a considerable amount of scrap in the form of skulls, sheet trimmings, turnings and borings. Use of scrap is of great importance in electric furnace melting and in the alloy steel industry where the scrap consists of alloys of nickel, chromium, tungsten etc.

Until recent years, little attention was devoted to possible commercial utilisation of steel slag. This was primarily because of the total volume produced in the steel mills was less than that in blast furnaces. Also much of the slag production was recycled through skull cracking plant for recovery of scrap steel and crushed slag re-used as flux-stone in the blast furnaces. Consequently, the need to plan an economic utilisation of steel slag was not felt necessary unlike the blast furnace slag. The recent trends of steel melting, however, have changed this concept where reuse of steel slag has not been possible and consequently the slag will go as a waste, unless a disposal strategy is planned. Steel slag is much heavier per unit of volume than blast furnace slag and its chemistry is different, and because of this, steel slag cannot yet be used with as much confidence of performance of mineral aggregates as in the case of blast furnace slag. Some progress has, however, been made all over the world to use the slag for rail road ballast and as a filling material for the highways. The presence of phosphate in the steel slag has made it possible to be used as fertilising material. A British firm has developed a process for upgrading basic slag from steel-making furnaces to comply with the minimum requirements of specifications for fertlliser for soluble phosphate content. The process consists of a high intensity magnetic separation technique that splits the finely powdered slag into a phosphate-rich fraction and iron-rich fraction. There is need to evolve such new developments in our country for better utilisation of steel slag.

The new technologies in steel melting and processing techniques have caused lesser amount of steel scrap produced in-house and consequently have caused increase in the demand for steel scrap from external sources. To add to this, the decreasing availability of natural resources will also contribute to the need of greater recycling of all the metal products, and to improve upon the systems for in-house scrap recovery in view of processing and transporting difficulties encountered by the non-industrial sources for solid wastes.

Agricultural Wastes

About a million tonnes of minor oil seeds are generated in our country from nearly 90 types of oil bearing trees such as neem, mahua, kusum, etc., and only a fraction of these oil seeds are collected at present for crushing. With co-ordinated efforts it is possible to collect and crush 0.3 to 0.4 million tonnes of oil cakes alongwith oils and fats for use in soaps, medicines, manure, etc. Groundnut cake and flour, after extraction of oil, can be used as protein-rich food. Rice bran is used as cattle feed. A limited amount is being processed for extraction of industrial grade oil by solvent extraction. Edible oil shortage could be solved to a great extent provided all the available rice bran (which is about 2.4 million tonnes) in the country is fully utilised. Presently, rice husk is being used as a fuel in boilers but could also be used for furfural, silicon tetrachloride, activated carbon etc. The ash can be utilised for production of building materials, etc.

Use of bagasse fibre can be effective for paper manufacture, provided the estimated 5.2 million tonnes of bagasse are fully available for utilisation. Sawdust can be used for manufacture of activated carbon, oxalic acid, phenolic moulding powder, hardboard etc. Cocoanut waste such as about 0.88 million tonnes of shells, estimated to be available, could be used for charcoal, activated carbon manufacture, etc. About 6000 tonnes of cocoanut husk available is only partly utilised in coir industry and could be used in the production of high stretch paper. Arecanut husk which is estimated to be about 1 lakh tonnes is mainly used as poultry feed and could be used also for brown wrapping paper making. Cashew waste is finding applications in paints, varnishes, etc. About 25 million tonnes of cotton stalks available are used as a fuel but can also be used for dissolving grade pulp, hardboard packing material, etc. About 2.5 million tonnes of jute waste in the form of sticks, dust etc., is used as fuel but possibility to use it to manufacture paper, newsprint, viscose rayon, etc., exists.

Animal Wastes

Fishery wastes such as prawn shells, lobster wastes, fish wastes, frog wastes, etc. can be profitably utilised for making fish protein concentrates, fish meal, amino-acids etc. It is estimated that about 125 lakh numbers of carcasses are annually available and due to defective flaying and improper curing, a heavy loss is incurred through non-utilisation of other components of carcass such as meat, fat, horns, hoofs etc. The total loss sustained by the country in respect of non-utilisation of animal by-products is estimated to be about Rs. 29 crores per annum, and these by-products could be used for production of various products such as gelatine, poultry feed, stearin etc. Only 1% of the intestines produced in the salughter houses is currently exported to earn about Rs. 120 lakhs in foreign exchange. Nearly two-third of about 55,000 tonnes of animal blood now wasted and is valued at about Rs. 1 crore, could be dried to produce blood meal containing 10-12% nitrogen and 1-2% P_2O_5. After sterilisation, this could be used as a good stock-feed.

Science and Technology Plan on Utilisation and Recycling of Wastes

Every year, huge amounts of agricultural and animal wastes are produced in our country. A sectoral report on the subject has recently been printed by NCST. Many projects on cocoanut, arecanut, cashewnut wastes, tea wastes, jute and cotton wastes, wood wastes, non-edible oil seeds and animal wastes, have been identified and are being implemented by various CSIR and ICAR laboratories. A detailed report on the utilisation of paddy husk has been prepared by Department of Science and Technology. A project on improvement of quality of rice bran for edible oil extraction is being implemented by Food Corporation of India. Preliminary work has been carried out in Andhra Pradesh and Madhya Pradesh about the survey of rice mills and the quantity of available bran. The stabilisation process has also been standardised. A country report on utilisation and recycling of agricultural and animal wastes/ by-products has been forwarded to ESCAP for circulation to different developing countries. A coordinated project on bio-gas technology is also under progress.

In view of enormous potential expected for biogas plants, this project includes understanding of fermentation technology, conditions influencing greater preferential generation of methane, suitability of catalysts, possibility of reducing the value of digester and gas holder, corrosion of gas holders, cost reduction through alternative materials, removal of CO_2 from bio-gas for industry purposes, development of large size community bio-gas plants, logistics of operation of bio-gas plants at community level, and promotion of these plants in the villages as well as training of villagers in the proper maintenance of such plants.

A number of projects on slaughter house waste, identified by NCST, are being implemented by various organisations. A project on preparation of insulin from slaughter house wastes like pancreas, sheep and broire, is being implemented at Haffkine Institute, Bombay and the results will be extremely useful to pharmaceutical industry.

A project on mineral wastes for reclamation of acidic and alkaline soils is under consideration, in consultation with ICAR, Department of Mines, Indian Bureau of Mines, and some CSIR laboratories.

In the field of algae technology, R & D work in the seven centres of an All India co-ordinated project on algae has started this year. Detailed studies on production of spiruline, various growth factors, economics, its potential use as bio-fertiliser have been started. At NEERI, Nagpur, detailed work on growth in sewage stablisation ponds, their ecology, harvest, algae in public water supplies, has started. IVRI is to carry out nutritional and toxicological evaluation. Experiments on chlorella have started at Pondicherry, while feeding trials of different species of algae are being carried out at NIN, Hyderabad, and CFTRI, Mysore.

The nucleus group of Central R & D of HSL at Ranchi has established the practice of using MgO rich slags in blast furnaces at various steel plants with effective economic gains.

Conclusion

Any practical problem in solid waste operation needs, therefore, to be tackled with a view to have long range solutions, taking into account situations overriding short-term benefits and with due consideration to health, conservation, and aesthetic point of view. This, therefore, necessitates the need for effective solid waste management and possible enunciation and implementation of Solid Waste Act, as has been legislated in some countries. The solid waste problem will not be adequately or efficiently solved until the sources of the problems are identified, understood and constrained to the extent possible so as to achieve social goals for a better environment, and just does not lie in simply improving the efficiency of collection and disposal of solid wastes generated by production and consumption sectors of the economy.

Today the recovery of all wastes is not a complex operation. Household refuse, commercial and production waste from industry can be utilised usefully and the major obstacles are the economic ones, where far-reaching decisions are to be taken. Due consideration must be given to the needs and legitimate requirements of future generations. This necessitates national decisions if the economic equation is to be simplified and the degree of recovery increased. The natural resources of this earth are not inexhaustible and are becoming increasingly expensive to process. The economic and moral arguments for recovery of solid wastes are ever increasing and new knowledge about the sensibility of the ecological system, and more definite information on the finiteness of energy sources have forced the people to broaden their sphere of innovative thinking. It is no exaggeration to anticipate that problems of wastes are growing in all industrial countries and they will not be solved unless cities and urban towns are willing to experiment with bold new methods of finance and operations. Waste should be treated as a resource to be used as a new material to the greatest possible extent. Reuse of waste should, therefore, be the basic principle, as guided by creative thinking in order to achieve unconventional and efficient solutions. □

Material Conservation Efforts in USA, UK and Sweden

P. R. Srinivasan* & B. S. Shankara**

The problems of waste management, are not new to any one. What is new, probably, is the understanding of large benefits that could be derived from such wastes and the realisation of these benefits through effective programmes for reduction of waste generation, recovery and recycling of materials from wastes. Of late, importance is being attached to the fact that waste recovery and recycling has a direct bearing on the conservation of all depletable resources. Further, the possible enhancement of human life span, (besides that of available material resources) through providing clean environment for living, has boosted the status and importance of waste management. It is now, by far, established that no nation can survive on mere exploitation of its own resources without taking due care for conservational needs of these resources.

This paper attempts to describe efforts made in a few selected countries, namely, USA, UK and Sweden in the area of material conservation. For purposes of comparison materials like copper, zinc, aluminium, iron and steel have been chosen. Although the factors, causes and criteria for conservation vary widely between the countries and materials, this comparison is made to bring out, chiefly, the systems in operation with a view to finding out the suitability of these for adoption in our country.

1. USA

One of the novel features of conservation system of USA includes, a well developed system of scrap classification for non-ferrous metals. Known as NASMI (National Association for Secondary Metal Industries) classification system, it has established a good base for clear understanding, identification, classification and trading terms for all non-ferrous scraps. In all, 119 types of non ferrous scrap have been classified in this standard, NF-66. This has enabled to simplify the buying and selling of scrap through clear description of the code names for type of scrap, old or new, size, contaminations and their levels, origin of the scrap, etc., as also the terms of delivery, packaging conditions, etc.

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This is in addition to the well established standards for various alloys applicable to specific industrial uses.

The following table gives the quantities of various non-ferrous metal scrap recycled in USA, in 1969.

Table 1

Material	*Consumption of Recycled Material (000' tons)*	*Percentage of Total Consumption*	*Value ($ Million)*
Aluminium	1056	23	553
Copper and Alloys	1489	46	1490
Zinc	182	12	53

The above quantities are further divided into in-house recycling and non-in-house recovery. It is interesting to note the percentage recycled by the units as in-house scrap, which shows the concerted efforts put in by the units and the importance attached to the same. Table 2 gives the percentages of in-house recycling, and non-in–house recovery.

Table 2

Material	*In-house scrap recycled (000' tons)*	*Percentage of Total*	*Recycled Non-in-house scrap (000' tons)*	*Percentage of Total*
Aluminium	885	100	201	15
Copper	132	100	657	40
Zinc	141	68	41	38

A lower percentage for zinc (68%) is due to losses during recycling of zinc in making brass and in galvanising steel. In the latter case, galvanised steel scrap carries with it some quantities of zinc which is totally lost.

In the case of non-in-house scrap the lower percentages of recovery are due to various problems of collection, segregation, bundling and the inherent contamination and losses during these operations.

System of Collection, Segregation and Recycling : The NASMI classification system provides a good basis for classification and segregation of all non-ferrous scrap. This, however, is achieved through the organised working of wholesale dealers, traders, transporting agencies and the associations, to prepare the heterogeneous scrap as per the standard classification and to make it available to the users. The following gives a very brief description of various operations in this regard.

Turnings, borings, punchings etc., are subjected to magnetic separation techniques to remove iron or steel fragments. In some instances degreasing is also carried out to remove adhering contaminations.

Cables with sheathing and insulation are treated in stripping machines or manual removal to recover the materials Slags, ashes, drosses, etc., are ground in hammer mills and sieved to collect metallic contents.

The usual process to avoid spillage of bulky materials and to facilitate efficient transport, is baling in hydraulic presses. This also helps handling and charging in the users end, besides reducing losses.

Copper : One of the concerned problems in recovery of copper is with insulated wires, and iron-bearing wires of copper scrap material. Simple methods of burning are legislated out for environmental protection. Separation of iron from copper such as in the case of junk motors, is very costly as it involves more labour. Better methods are being developed in this field.

Aluminium : It is estimated that when a ton of aluminium is processed into consumer products, about 500 lbs. (about 225 kgs) of scrap is generated. In 1969, about one million tons of aluminium scrap was recycled in USA. It is also estimated that an average shop generates about 20-25% of aluminium scrap.

The first aluminium recycling company was established in 1954, barely 16 years after the first commercial production of aluminium, with the premise that such scrap promises wide reuse. Since 1953, the recycled aluminium has been 18-23% of primary production. Fig. 1 gives the break up of recycled aluminium.

Steps : Many scrap collectors, collect the solid waste including all other materials besides aluminium and sell these to dealers or scrap processors who usually have the facility to sorting, separation, cleaning, baling

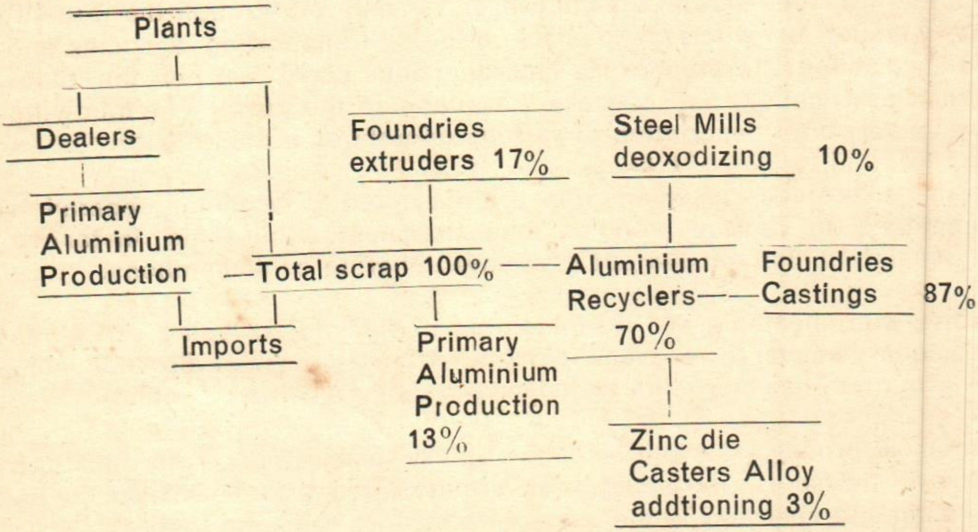

Fig. 1

etc., as per the standard classification system. This is then offered to smelters, foundries and recyclers, who have the required equipment to process them into ingots, after suitably controlling the impurity levels during melting. Various steps in dealing with different types of scrap are shown below :

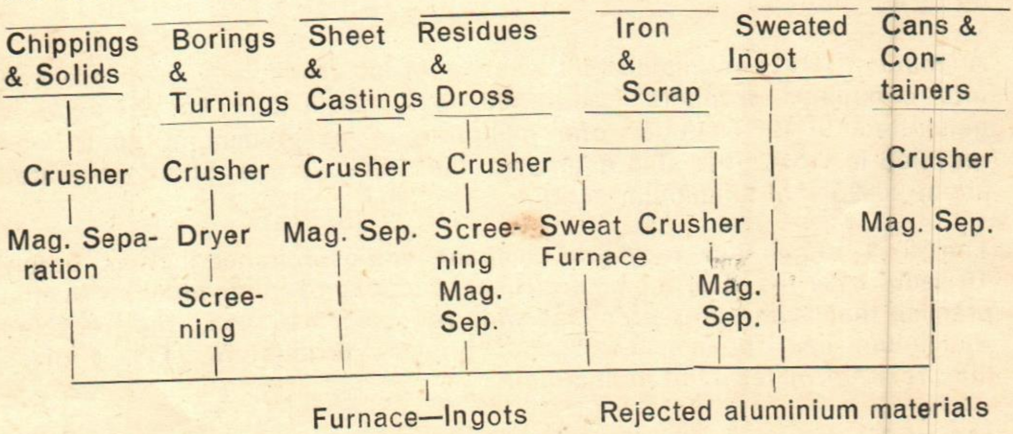

Fig. 2

Major forms of aluminium scrap are old aluminium scrap in the form of discarded utensils or equipment, aluminium cans used for beverages, food packing wire scrap etc. It is anticipated that aluminium cans present a good scope for scrap market in view of increased use of aluminium for these items. It was estimated that by 1975, nearly 100 thousand tons of aluminium was used in making cans. Added to this, more and more aluminium is being used for packing and containers and this holds the prospects for scrap market.

Aluminium can reclamation is practised in a very big way by some of the primary aluminium companies (as a contrast, in our country, no aluminium company has started any reclamation or recycling activity). Alcoa's Can Reclamation Programme is of particular interest to cite. San-Diego, California was chosen as a test place for the programme of can collection. Large bins were made available at all locations where the citizens could redeem used all aluminium cans for cash. The response was more than 500 thousand all-aluminium cans per week. It soon shot up to 600 thousand cans per week weighing 30,000 lbs. After the collector had baled about 60,000 lbs, the bales were shipped to Alcoa's Warrick, Indiana plant for recycling. This programme was immediately followed by two other programmes in Dallas and in Fort Worth, Texas, and presently is able to collect 2 to 3 million lbs every month.

Another important feature of aluminium recycling in USA is developing a logo for recyclable aluminium and to have it marked on such products so that consumers are more aware of it.

Zinc : As in the case of other countries, galvanising is the major zinc consuming industry in USA. Naturally the refore, it is also the major zinc scrap generating industry. On an average 11,500 tons per month of zinc byproduct is produced by this industry. Zinc dross is about half of this quantity.

Slab zinc supplier (primary zinc producer) is usually the buyer of this scrap (in our country, this is still to come into practice). Zinc dross and steel-mill-top skimmings which are metallic in form, carry the highest value nearly two-thirds to three quarters of zinc slab price.

Other forms of zinc scrap are galvanising residues scrap, printer plates, zinc castings, formed sheet and die-cast scrap. However, over 80% of these scrap is made up of die-cast scrap.

Secondary zinc smelter, usually buys from a smaller supplier, than a primary smelter, because of simple buying methods and prompt payment. However, the die caster will purchase from a more selective and less contaminated scrap source, and remelts it to make die cast alloys.

Processing equipments are of common design mainly consisting of refining equipments (by distillation) crucibles small electric furnaces and casting equipments for ingots.

Iron & Steel : Iron & Steel scrap in USA is a fundamental part of foundry and steel industry. About 20-30% of raw steel produced is the quantity of in-plant ferrous scrap.

Open hearth uses about 50% of charge as scrap. BOS process uses about 40% and Electrical furnace upto 100% scrap. Certain speciality steel producers rely entirely on carefully selected scrap to make heavy and wide plates, tank materials, military steel etc.

In 1965, about 95 million tons of iron and steel scrap was consumed in USA. There are about 3500 ferrous scrap dealers and 200 brokers who locate the buyers and scrap sources and do the sales. Prices for principal grades are published in Iron Age and American Metal Market.

Automotive scrap tonnage is about 15% of total ferrous scrap. For processing purposes, scrap yards usually have over-head cranes, balers shears, weighing scale, mobile crane and other cutting tools. Other facilities such as power, gas, railway siding are available with larger scrap yards. They also possess a small laboratory for chemical composition. Recent additions to equipments are shredders, fragmentisers, nodularisers. Large shredders are capable of handling 150,000 tons/yr.

The feed stock to auto shredders are vehicle bulks stripped of motor blocks, transmissions, tyres, gas tanks and radiators. After shredding, the ferrous scrap is separated from non-ferrous scrap by magnetic separators and compacted after heating. Electric arc furnaces are the major consuming plants for shredded scrap.

Scrap Market : Integrated steel plants do not prefer purchased scrap but hot metal. Next to hot metal only house scrap is used. In USA open hearth consume more scrap than integrated plants. Although Number 1 scrap (Min 4" thick) is mostly preferred, Number 2 scrap ($\frac{1}{8}$") is used at times where it is economical. The yields from this is about 85 to 90% and copper content 0.1 to 0.2%. Use of electric furnace will improve the yield to almost 97%.

Automotive scrap is largely used in foundries. About 35 million tons of molten metal is the output for all the foundries and about 5-7 million tons of automotive scrap is used by them in a year.

Auto Scrap : Automotive scrap is a special area in USA. Where as the automobile contains sizeable quantities of non-ferrous metals which could be reclaimed, these are also the source of contaminations as far as steel scrap is concerned. Because of this, the auto wreckers are fed after removing valuable items such as battery, electric motors, electrical wires, motor block etc. Heavier steel parts such as frame is also removed for selling as Number 2 scrap. The rest weighing about 500 kgs. is sent for shredding and further processing. On an average, an automobile weighing 1500-1800 kgs. would yield about 1000 kgs. of steel, 200 kgs. of cast iron, 25kgs. of zinc and aluminium, 15 kgs. of copper, 8-10 kgs. of lead and the rest being non-metallics.

2. United Kingdom

In contrast to USA where waste disposal and material recovery is largely carried out by private agencies and associations of scrap merchants etc., UK follows the legislation path in managing the wastes—its collection, recovery and disposal. The responsibility is mostly of municipal authorities. The Government has passed certain legislations and acts such as Civic Amenities Act, Environmental Protection Act, etc. Under these acts, the local authorities are required to provide sites for the deposition of wastes by public and also to process the collected refuse in the so-called transfer stations, which are over 30 in Greater London itself. The collection, hauling and deposition of refuse and bulky derelict vehicles, etc., is carried out by private agencies but under contract of local authorities. One of the advantages of this centralised governmental approach is the benefit of economies of scale of operation.

The following table gives the statistics of non-ferrous metal scrap generated in UK and the recycled quantities with the estimated values.

Table 1

(*metric tons*)

	1969	*1970*	*1971*	*Value (Est. 1971)*
1. *Aluminium* Scrap arisings	261037	249749	240202	@ £ 145/ton
Estimated Recycled Recovery	201873	199010	188949	£ 27,397,605
2. *Copper* (Copper Content)	295570	277734	256613	@ £ 444/ton £ 173,936,172
3. *Lead* Scrap Consumption	208621	197090	194087	@ £ 104/ton £ 20, 185, 048
4. *Zinc* Scrap Consumption	93427	92510	81110	@ £ 127/ton £ 10,300,970
			Total :	£ 171,819,795

Sources : New scrap in the form of cuts, swarf, trimmings from the factories, domestic scrap such as geysers, back boilers, gas cookers, are providing a large source of scrap in view of increased conversion from coal to gas systems. Big source of scrap is also generated by Central Electricity Generation Board, GPO and automotive scrap. Building demolition and ship wrecking bring substantial scrap quantities. An estimated ½ ton per day per 100,000 population of incenerator scrap is the non-ferrous metal content.

A special programme, developing clinker treatment process for incenerator scrap to get back aluminium rich and copper-rich products, is sponsored at Warren Spring's Laboratory. These two products are priced at £60-80 per ton and £200 per ton respectively.

Collection : Domestic scrap collection is by agencies under contract with the local authorities. Industrial wastes collection is by private dealers and scrap processors possessing (some of them) elaborate equipments such as shears, balers, strippers, cable burning furnaces, etc.

Handling : The volume of scrap in each of the non-ferrous metals is given in Table 1.

Most of the ALUMINIUM scrap is reused by smelters for casting alloys. Sorting of the scrap is carried out as per the specifications established by the UK National Association of Non-ferrous Scrap Metal Merchants. Mainly the following grades are in great demand and use :

Group 1 :	Pure Aluminium
Group 2 :	Dural-Aluminium and Copper
Group 3 :	Aluminium and Magnesium : Mg above 1.5%
Group 7 :	Aluminium and Zinc
Group 8 :	Aluminium and Silicon.
Other :	Commercial castings, specification castings, rolled aluminium, turnings & borings with iron and moisture limits.

Scrap aluminium of all alloys are similar, and hence specific spot tests are developed such as, hammer tests, file tests, nick tests, drilling tests and some acid tests.

COPPER scrap is also handled in a similar fashion. The main grades of copper scrap are (i) copper wires of different grades (ii) heavy copper scrap (iii) mixed scrap with a maximum of 1% foreign substances (iv) wrought copper (min 98% cu) and (v) other forms such as turnings, borings etc.

ZINC recovery and recycling is relatively less important in relation to its overall availability. However, the main zinc scrap from automobiles and die-casting is recovered and reused as per the quantities indicated in Table 1. It is estimated that in view of increased use of zinc in automobiles and other die-casting applications, the scrap quantities may also go up considerably. Mention should also be made here that sufficiant information is not available on how the galvaniser dross, ash and the used dry cell batteries are recycled.

One of the points to highlight in the UK system of non-ferrous metal scrap recycling is the availability of many independent laboratories to help small scale units to identify and assess the composition of scrap. Independent representatives also work on the customers site to settle disputes on scrap grade between supplier and the customer. Once again a good system of scrap classification developed by UK National Association of Scrap Metal Merchants, is worthy of consideration for adopting a similar system.

UK consumes about 20 million tonnes of IRON AND STEEL scrap 75% of this quantity being consumed by steel producing industry. In doing so, it conserves 25 million tonnes of ore, 10 million tonnes of coke, 4 million tonnes of limestone per year. Besides this, it solves the major problem of scrap disposal.

Three types of iron & steel scrap are discussed, namely (i) circulating scrap which is the in-house scrap when steel is converted into usable products, (ii) process scrap which is generated when finished steel is converted into products through the processes such as shearing, welding, casting, forming, machining, etc., and (iii) capital scrap which comes from discarded items after their useful life span.

UK generated and consumed roughly 7.6 million tonnes of circulating scrap in 1970, which is about 28% of crude steel production. However, in view of continuous casting and rolling coming in vogue and because of better yields now being attempted, it is estimated that this percentage may come down to 6%.

Process scrap which is a function of finished steel consumption, forms 13% of steel production. The major portion of process scrap is automobile scrap. Generation of scrap in automobile industry is 3% of steel consumption as against 5% in construction industry.

Capital scrap is made of motor cars, machinery and cans. The life span varies from 1 year for cans to 60-70 years for others. Average life is taken to be 15-20 years. In 1975, this scrap was estimated to be around 4.6 million tonnes.

Steel making capacity and scrap consumption : As is widely well known, electric arc steel process can take up 100% scrap as its charge compared to 35-60% for open hearth and 30% of basic-oxygen process. The latter is coming into being because of its lower cycle time. The following table suggests this trend.

Table

	1968	1975
1. Open hearth	14.04 m tonnes	4.98 m tonnes
scrap ratios	50.08 %	58.05 %
2. Converters	8.00	20.03
scrap ratios	28.05 %	30.05 %
3. Electric process	4.22	6.91
scrap ratios	103.09 %	103.00 %
4. Total	26.92	32.1a
scrap ratio	52.09 %	50.05 %

3. Sweden

Conservation of materials and waste disposal is not new in Sweden. In fact, well established organisations are carrying out various activities in this field. Some of the major organisations entirely devoted to the field of recycling, recovery, waste handling, sludge water treatment, waste water treatment of major industries etc., to name few, are, (1) PLM Atervinning, (2) AB industrileveranser (paper) (3) Bilfragmentering AB, (automobiles), Metab AB (comples scrap and cables) (4) RECI industry AB, (chemical wastes) (5) Returpappers centralen i uppsala AB (waste paper) PLM paper and Glass division (packaging paper and packaging glass) (6) Division in Sweden of Andco-torrax (conversion of urban waste to urban ore) (7) Maskinverken AB (energy recovery from waste (8) Governmental Agency, namely state council for technical development and Swedish Environmental Potection Agency etc., and (9) Alfa-Laval group of industries engaged in manufacture of equipment for treating muncipal sludge, food wastes, marine wastes, mechanical engineering and metal working industry wastes (reclamation cutting oil, coolants and dry particles).

Non-ferrous Metals : The Swedish government has banned, in the first place export of scrap metal of copper, lead, tin, nickel and aluminium. Only zinc is an exception (because the country dose not have any zinc processing plant). According to available figures, in Sweden, about 70,000 tonnes of metals are recovered every year. This does not include aluminium which itself is 30,000 tonnes and iron and steel which is about 1.2 million tonnes. In terms of percentages of consumption the corresponding figures are 35% for metals, 20% for aluminium and 20% for iron and steel.

One of the leading companies alone processes 12,000 tons of scrap metal every year. (incidentally, metal scrap includes all the metal scrap except iron and steel). In Sweden also, as in USA and UK, scrap metal sorting is classified into 150 different quantities. FM-sules have been worked out by the Association of Metal Wholesalers. Copper recovery and refining occupies a major place in Swedish metal industry.

Iron and Steel : More than half of new steel is manufactured from scrap. About 75% of scrap used by Swedish steel works is in-country scrap. The remainder is imported. As is common to all steel scrap requirements, pure scrap, uniform scrap and thick scrap are preferable. For this the collection systems has to be very efficient. One of the ways in which this is done is to have direct contracts which heavy industry and develop individual solutions to the problems of collection, storage and transport. This is practised by PLM groups.

Scrapped automobiles are a big source of scrap, so are the so-called white goods-refrigerators, washing machines, freezers etc. But they are difficult to break-up also. Fragmentation method—an advancement–has been in operation to do this job in Sweden. Battery, radiator, engine, petrol tank and seats are removed at the scrap depots round the country. Then they are hammer milled to a size of one's fist and is separated in a magnetic separator. The capacities are of the order of 40,000 tonnes per year.

Breaking up of ships is another major activity in recovery of iron and steel. The PLM company has its own way and can receive ships of 20,000 dwt. This company supplies 5000-10,000 tons of break-up scrap every year to the industry.

Tin cans are yet another scource of recovery. It is estimated that 10,000-20,000 tons of tin cans, of the total quantity of 70,000 tons could be recovered every year in Sweden. PLM group has developed the so-called Recolator Process for this recovery. No detinning facility is available in Sweden. But tin cans are used as used as such for making lower grade steel re-inforcement bars.

In all material conservation in Sweden can be said to be viewed as "waste recovery as an industry" and "waste as another resource of materials". Household waste collection is an organised and legislated activity. Waste newspaper sorting is regulated by law. (Swedes are among the major paper consumers in the world, at 181 kilos per head and with a forecast of 345 kilos per head in 1990). Substantial involvement of muncipalities is also taken as they have the legal responsibility for clean environments. Suitable procedures, steps and classifications for sorting household wastes are issued to every house. To motivate every citizen, the *way* and *how* of sorting were described in detail with proper compaigns. Test programmes were carried out before launching voluntary separation of household wastes (one of the test programmes included 150,000 households and the results were overwhelming. 70-80% of sorting resulted by participation and the household waste volume reduced by 25-30%. Nearly 2 kgs. of paper and 1 kg. of glass or metal was netted per week per family).

4. Conclusions

From the outlines of material conservation efforts in the three countries described above, the following can be concluded :

1) A well developed scrap classification system is available in all these countries which greatly facilitates, sorting, classification, and scrap trading. It thus increases the scope and market for recovered or secondary metal. It also improves the quality of products from secondary raw material and reduces the great hardships of small foundries and other scrap consuming industries.

2) Iron and Steel scrap is a part and parcel ot steel making and foundry industries. Without the availability of iron and steel scrap, the very functioning of these is threatened. Also the generation, and consumption of iron and steel scrap is greatly influenced by the technology of steel making and the efforts put in for achieving higher yields.

Obsolescent scrap and auto scrap form major sources of scrap in these countries. Hence, better systems and handling, stripping, fragmentising equipments have been developed. Latest techniques of Cryogenic separation are being introduced.

3) Urban and Municipal Wastes, besides paper and glass, have gained the maximum attention of governments in these countries from the view of environmental protection. Incidentally, the scrap industries have well exploited them as potential sources of recovery materials. Hence, the development of incinerator residue treatment plants and production of urban ore. They have also developed very good energy recovery systems from these.

4) Motivation of common being, citizens and the responsible authorities such as local authorities, the federal government etc., have been the major elements in the success of material conservation programmes. For this purpose, large scale compaigning, literature printing and distribution, seminars, educational programmes, have been employed (It is worth mentioning the publication of Readers' Digest handy booklet on "Conservation in Your Home").

5) Two countries, namely Britain and Sweden have employed legislation to achieve greater results.

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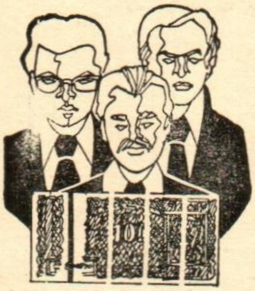
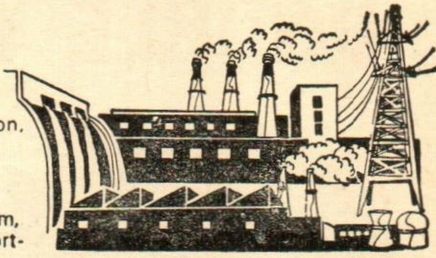


STRUCTURE—2
Production

BHEL has achieved a rate of production of over 4000 MW per annum. Its nine units together produce a comprehensive range of equipment for power generation, transmission and utilization:

BHEL is also deeply involved in industry. Fertilizers, steel, cement, paper, sugar, petroleum, aluminium, mining and transportation are some vital industries being served by BHEL with sophisticated equipment and services.



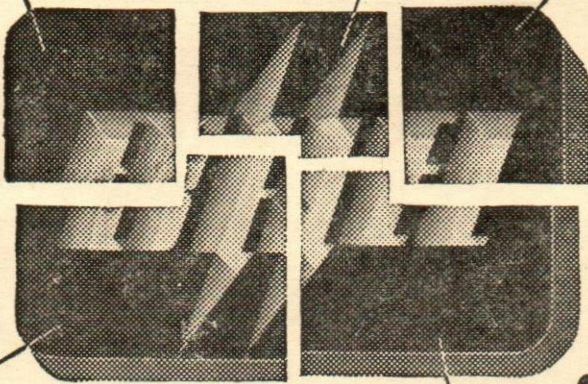
STRUCTURE—1
Organisation

At BHEL, constant organisational development has led to the optimum utilization of resources: human, financial and managerial.

BHEL has 53,000 people—7,000 of them qualified engineers. Talents that have been fused into a dynamic team—consistently guided by sound management policies. Judicious financial planning has enabled BHEL to increasingly generate funds from internal resources for future growth programmes.

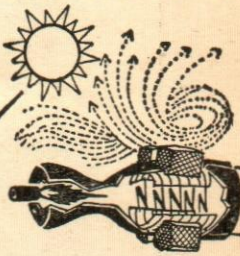
The strength of BHEL lies in its structure—a unique synthesis of different capabilities. In organisation, in production, in technology, in total service. And these capabilities have enabled BHEL to keep pace with the fast changing requirements of a complex environment. Providing not just products, but a total service for energy. In India and abroad.

THE ANATOMY OF POWER



STRUCTURE—3
Technology

BHEL's technological capabilities in power equipment are progressing from 30 MW to 1000 MW sets. Also, transformers up to 400 kV. BHEL is now poised for the development of 500 MW sets.



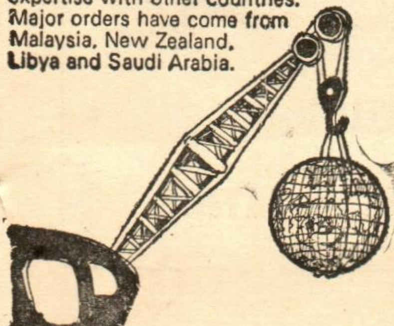
Research is under way for the utilization of solar energy, wind power, MHD and geothermal energy.

Increasing technological capabilities have led to diversifications—like oil rigs, seamless steel tubes, high-speed turbines, centrifugal compressors, heavy castings and forgings.

STRUCTURE—5
Exports

Today, BHEL has developed its organisation, technology and services to the level where these are recognised internationally.

BHEL is now sharing its expertise with other countries. Major orders have come from Malaysia, New Zealand, Libya and Saudi Arabia.



STRUCTURE—4
Total service

From concept to commissioning—BHEL offers comprehensive turnkey services to its customers. Services ranging from project engineering and complete systems design to erection, commissioning, training, operation and after-sales.

Power to the people

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Book Reviews

Cases in Management

Francis A. Menezes

Tata McGraw Hill Publishing Co. Ltd. 1977, pp 254

Reviewed by S. Neelamegham*

Instruction through case method is the most effective way of helping the people to learn from experience. Some of the essential qualities which distinguish an able administrator, namely, the ability to think and act responsibly, to work cooperatively with others, the capacity to make sound judgements and to effectively communicate one's ideas to others—cannot be wholly learnt by listening to lectures or reading books alone. Learning from experience, not necessarily one's own, is an essential supplement to this learning process from lectures etc. Case method has been evolved from this need. It seeks to develop these qualities in the individual by enabling him to discuss and analyse the recorded experience of business people.

Case method has certain distinctive advantages which make it an effective tool of business education. The method encourages active participation of the students in the process of learning. By presenting the real life problems faced by practical administrators, each case tries to communicate to the students "the field of an administrator situation". Confronted with specific business situation, it requires a decision to be made, each participant has to place himself in the position of an executive and present his views and analysis of the situation which are subjected to criticism by his fellow participants. Such personal involvement not only ensures but enhances the dynamic participation of the students in the process of learning.

Further, the case method provides a good mental exercise in decision making and helps to develop logical and constructive thinking on the part of the students.

In India, case method of instruction is fast becoming an important instrument of management education. As early as 1955, the Faculty of Management Studies at the University of Delhi started collecting cases based on Indian Management experience. Subsequently from 1961 the Administrative Staff College of India began its case research work. At

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present in addition to the Staff College, Universities, three Institutes of Management, several Management Associations, Productivity Councils and Industrial organisations are using cases in Management Training Programmes.

Case Studies in order to be successful should be true to life. They should describe people and events which the students can easily identify. This is particularly so in case of India where the socio-economic factors which influence the managerial decision making process are somewhat different from those in the western countries.

In this context Francis A. Menezes and his associates have made a useful contribution by developing cases based on Indian Management experience and making them available for wider use by the educational institutions and professional bodies in their educational and training programmes.

The thirty four case studies which are included in the book cover a wide range of issues and problems related to business policy, corporate strategy, marketing, finance, production and personnel management, materials management, technology and organisational change. All the cases have been drawn from Tata Enterprises. The firms studied vary greatly in size, scope and nature of operation. Problems in each case are unique and range from simple to complex and specific to general.

The case situations presented in the book reflect the diverse socio-economic factors which characterise the Indian management today. They describe events, persons and situations faced by managers in the context of a growing economy.

The Directors of the Tata Enterprise deserve appreciation for giving their enthusiastic support to bring out this publication. It is hoped that the example set by them will soon be followed by other organisations in strengthening management education in the country.

The book should be of use not only to the students and teachers of management but also to the practising executives. □

Behaviour of Prices in India

S. K. Chakraborty

Macmillan Co. of India Ltd., 1977, pp. 202, Rs. 50.00

Reviewed by Sarathi Acharya*

The book under review is an econometric study on the behaviour of prices in India. The author has separately tried to explain the price behaviour of cereals and manufactures and also the average wage earnings. Later, a systems model is constructed and estimated using two-stage least squares method, followed by a simulation exercise. Various price and income elasticities are computed, and some policy guidelines are evolved.

The period of the study is restricted to 1952-66 span, though some final forms are re-estimated, using data upto 1970. The mere fact that the book is published in 1977, renders the book a historical significance only. The author has only and extensively used the regression methods for evaluating the various hypotheses put forward, the usage of which in its own framework is commendable. The inferences are, however, devoid of any other judgements than the regression results.

In an earlier chapter a review of the existing literature on prices in India is carried out, where the author suggests to treat prices as a part of the general economic framework. Yet, in the model constructed by the author all variables other than prices are treated as exogenous. The numerous arguments of growth affecting prices and itself being affected by prices, which have become the central theme of the discussion today, are altogether by-passed.

The models constructed by the author follow from different hypotheses that have been put forward by him for the determination of the prices of cereal and manufactures. The cereal prices, it is suggested, are determined by a market clearing mechanism, i. e., the forces of demand and supply interact to give an equilibrium price level. The prices of manufactures, it is suggested, are determined by some mark-up formula. Though the regression equations satisfy all the statistical requirements commonly sought after, a few points need mention.

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The first point is with respect to agriculture. The historical nature of the study is precipitated by the fact that after 1969 foodgrains could hardly be treated as ones where a market-clearing mechanism would work. Firstly, after the so-called green revolution, considerable input investment has been put in agriculture, at least in the major food crops in North India. Secondly, there was a vast input of food during the late sixties, and a long-term buffer stock programme was also introduced. Thirdly, there was a base price fixed by the Government for cereal procurement. In view of the above three considerations agricultural prices cannot be considered to be determined by forces of demand and supply alone. Hence, a mark-up formula would be necessary.

The second point is in respect to Industries. Firstly, the manufactures cannot be treated as a single unit, whose composite price is determined by a common mark-up. It is well-known that prices of essential commodities are influenced by different market demand forces than of the luxury and fancy items. Different demand criteria, introduced accordingly for their individual price determination would serve the purpose better. Secondly, the treatment of raw material prices is not as elegant as is desired. It may be agreeable that the market-clearing forces determine the prices of raw materials, but the proxi variable used for doing so is not so satisfying. The actual industrial output to raw material produced ratio (which is used as an explanatory variable for raw materials), assuming that the raw materials produced are more or less consumed on a continuous basis, should be a constant and determined by the technical relationship alone.

The third point is in respect to the model as a whole. The simultaneity described in the model and subsequent simulation exercise suggests that the origin of prices lie in the growth strategy and the structure of the economy. Thus, to derive any meaningful policy conclusions, it would be necessary to treat prices as a variable in a dynamic macro model. Therefore, this partial treatment, though rigorous, has little operational value.

To conclude this review, it should be mentioned that the econometric exercise is elegantly carried out, but model validation requires alternative hypotheses to be tested. The model serves purposes of establishing certain causalities but for policy implication the exercise is not sufficient. The data used is not upto date and this further undermines the practical nature of the study. □

Capital Formation and its Financing in India

Ram N. Lal

Allied Publishers, 1977, pp. xiii+274, Rs. 60.00

Reviewed by V. S. Mahajan*

Here is a book which makes in-depth study—perhaps for the first time in this country—of the intricate subject of capital formation. The problems of measurement of capital formation as well as of capital consumption (or depreciation) are dealt in detail in the first two chapters, and here the author also brings out clearly the conceptual and statistical problems involved in measurement of capital formation and capital consumption. In the light of these discussions as well as experience gained in the measurement of capital formation by experts in the field (Chapter 3), Lal develops a simple methodology for the estimation of capital formation in India (Chapter 4).

In the rest of the book, the author makes an exhaustive study of capital formation in different production sectors in the economy, as well as in private (split into corporate and household) and public (split into central, states and public bodies) sectors. He makes a detailed study of capital formation in different states of the country (the study is again split into different economic sectors). Capital formation by types of services as well as by types of capital goods produced has also been attempted. Thus there is hardly any sector/activity in the economy which has escaped the notice of the author, and it certainly goes to his credit that whether he is working at macro level or at micro level, he has made a scholarly and thought-provoking contribution.

Lal has provided us with detailed data of both gross and net capital formation for a period of twenty-two years from 1950-51 to 1972-73, and further applying suitable deflators he has worked out figures of capital formation at constant prices (with 1960-61 as the base period). All this (and particularly a close scrutiny of the time series data on different aspects of capital accumulation), would be found of great help by the writers on Indian economy. They could as well have now—on the basis of material furnished in the book—a better understanding of the

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factors responsible for the recent structural changes in the Indian economy and the role of capital accumulation in it.

There is also a chapter on the financing of capital formation. Here the author provides a detailed profile of savings in India (private corporate as well as household and public sector savings). The importance the household sector occupies over alternative (corporate and public) sectors in providing savings for financing capital formation has been clearly brought out by the author. However, its significance in terms of the nature and quality of capital formation needs to be further probed.

This book would rank as a distinct contribution in the field of quantitative economics. □

Business Statistics

S. P. Gupta and M. P. Gupta

Sultan Chand & Sons, New Delhi, 2nd Edition 1977, pp.xix + 767, Rs. 17.50 (Student Edition)

Reviewed by Rajendra Prasad*

Success of an enterprise depends solely on the appropriateness of the decisions taken by the entrepreneur or by his executives. Sometimes the decision is a minor one having limited bearing on other functions while at times it is of a complex nature enveloping the whole enterprise. In either case, there are more than one course of action open. Selection of the best course of action can be done intuitively based on hunches or objectively with the help of statistical tools and techniques. While in the former case it is not possible to estimate the amount of risk involved in taking a decision, it is not so in the case of the latter. As a result, use of statistical methods for decision making in many spheres, including business, is becoming increasingly popular.

There is no dearth of books illustrating the use of statistical methods in the field of business. The book under review is yet another addition to the list. It is, however, distinguishable from the others as the one by Indian authors having been published in India and containing illustrative examples suited to Indian conditions.

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The coverage of the book ranges from tools and techniques of data collection to correlation and regression analysis both with single and multiple regressors, one and two-way analysis of variance testing of hypothesis, and a separate discussion on chi-square test with test of goodness of fit. The authors have also discussed elementary mathematical probability and the three classical probability distributions, namely, Binomial, Poisson and Normal. A brief discussion on point and interval estimation and also on statistical decision theory are included in two separate chapters. Furthermore, one chapter each on sampling techniques and statistical quality control also form a part of the book.

The selection of illustrative examples are mostly from the area of business management and at the end of each chapter a good collection of unsolved examples are also given. Some of the illustrations, however do not appear to have been chosen with care. The questionnaire which has been presented as an illustration of an ideal one lacks in quality when viewed against the prescribed general principles immediately preceding it.

The chapter on testing of hypothesis is very brief and should have received better coverage with a view to giving a good working knowledge of the statistical tests. Further, it would have been beneficial if mention of elementary non-parametric tests were also included in the book.

Undoubtedly, the book would serve as a good text for the student of business statistics. A unique feature, where the authors have given "merits and limitations" of most of the statistical techniques discussed, would prove very helpful to the reader. The book has many printing errors and readers are well advised to be careful about these and correct them.

□

Management of Trade Unions

Ishwar Dayal and Baldev R. Sharma

Shri Ram Centre for Industrial Relations and Human Resources, New Delhi, 1976, pp. 67, Rs. 15.00

Reviewed by D. P. Upadhyay*

Shri Ram Centre for Industrial Relations and Human Resources has been bringing out a number of useful publications. The title 'Management of Trade Unions' is cetainly another valuable contribution of the Centre as it deals with entirely new area of the functioning of trade unions.

The authors have divided their study into three parts : profile of trade union members, profile of trade union leaders and the managing systems of trade unions. After analysing data from questionnaire interviews to examine the behaviour of members and discussing the special characteristics of the unions' functioning, the study suggests the direction in which unions have to move in order to develop viable work systems.

The authors have drawn certain conclusions on the basis of data collected and analysed which may be quite useful not only for trade unionists but also for those engaged in the formulation of personnel and industrial relations policy and in dealing with labour problems. The finding that substantial majority of rank and file members of unions are against compulsory union membership indicates that no legislation for compulsory union membership is needed as advocated by several trade union leaders.

Analysis of data on attitude of workers towards the unions reveal, "The almost universal recognition of the need to have a union was, however, not accompanied by a similarly high degree of interest in the unions."

In the chapter on profile of trade union members, study has been made of attitude of union members towards Government, Government's role in settlement of disputes and union members' awareness about this process besides union members' involvement in the activities of unions and their effectiveness. In the study of profile of trade union leaders, valuable

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information with regard to average age, caste pattern, rural *versus* urban leaders, education and work experience, etc., are given.

The best part of the study is on managing systems of trade unions which throws light on motive forces of leadership and its pattern of functioning. Analysing the replies of rank and file union workers about the reasons for the success of a trade union leader, the study reveals that 95 percent of union members attributed it to, (i) the confidence of workers in the leader, and (ii) his ability to solve the problems of workers.

The authors have also examined leaders' attitude and behaviour about militancy, inter-union rivalries, relationship with national trade union organisations and outside support. After analysing the reasons for slow development of the managing systems of trade unions, certain suggestions have been made for developing a viable trade union management system. The main suggestions are sensitive appreciation of the needs of members, supply of adequate leadership from within the union, training of leadership and development of professional union cadres.

The publication is a valuable contribution because of the study of newer areas. However, it is not comprehensive in nature. It would have been better if this study included such aspects as management of finance, administration, membership services and outside leadership *versus* enterprise level union leadership. □

Labour Demands and Their Adjudication

Volume-II

G. M. Kothari

N. M. Tripathi Private Ltd. Bombay, 1977, pp. 868, Rs. 80.00

Reviewed by M. F. Abbasi*

Even in this age of peaceful 'co-existence', 'participative management' and changing patterns of industrial relations, there is no industrial peace, and there is continued tension and distrust.

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Our former President, Shri V. V. Giri, described adjudication as enemy of productivity. And yet, cases with regard to labour demands are mounting up and are being referred to State Labour Departments and other Labour Courts for adjudication.

In the present context, Dr. G. M. Kothari's book on 'Labour Demands and Their Adudication' which runs into 861 pages and has got 36 chapters, is a significant contribution to the Industrial Law.

Dr. Kothari, Advocate, Jurist, Professor of Labour Law and a learned and distinguished Arbitrator on Labour and International Commercial Disputes has gone deep into the undercurrents of social philosophy, the labour economics and the revolutionary throbbings of the poor working class and has taken pains to cover almost all the irritant factors in Part I and Part II.

The subjects like wages, dearness allowance, disciplinary law, allowances and fringe benefits, housing, shifts working, retirement age, gratuity and pensions have been covered with care and judicial dexterity. The cases have been narrated with the detachment and the skill of a historian.

The book will, undoubtedly, be found highly useful to the employers, the workmen, the unions, the personnel managers/labour officers and students interested in labour problems and labour laws.

Dr. Kothari's book is a pleasure to read. In this second volume, he also succintly summarised the mood of the labour and the trend of the labour courts. The style being plain, even a lay reader will find the reading easy. It is indeed a novel piece of compilation. □

Problems of Working Capital with Reference to Selected Public Undertakings in India

Ram Kumar Mishra

Somaiya Publications Pvt. Ltd., Bombay, pp. 283, Rs. 50.00

Reviewed by Hardip Singh*

An underdeveloped country like India can ill afford to bear continuous losses in public sector enterprises, where major investments have been made. Unfortunately, the position has been so till recently. By March 31, 1968, eighty-three undertakings were owned by the Central Government with an investment of the order of Rs. 33.33 billion. The accumulated losses of the running concerns upto March 31, 1968 were reported to the tune of Rs. 2 billion. It was also observed that alongwith the increase in losses, the number of enterprises bearing losses was also on the increase.

The Committee on Public Undertakings studied this problem and concluded that "Public Sector Undertakings in India have suffered losses due to over-investment in fixed capital, under-utilisation of the capacity created, heavy expenditure on the provision of township and local amenities, surplus staff and labour trouble". There was no mention of the imprudent management of working capital by these enterprises. Prof. Mishra takes up the hypothesis that, "had public enterprises in India managed working capital in an efficient and effective manner, they would not only have generated resources for their own expansion but also would have contributed towards economic growth".

The author has selected six companies for an in-depth analysis. The period covered is from 1960-61 to 1967-68. The book is spread over seven chapters.

In the second chapter, after dealing with conceptual and contextual analysis of working capital, the study by the author of the turnover of current assets in selected enterprises reveals that the turnover was both low and stagnant and the use of working capital was highly unprofitable. In the next four chapters, he studies this problem in detail.

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Total working capital is segmented into four major components Inventory, Receivables, Cash and Working Finance. Each of them is analysed in a separate chapter.

As regards inventory control, it has been found that the 'total' inventory of all the selected undertakings was valued at 13.2 months' value of production in 1960 and at 10.0 months' value of production in 1967-68, against an average of 3.5 months' value of production for the private corporate sector. The problem of over-stocking of inventory originated because of defective inventory management, paucity of indigenous and imported supply, issue of import licences, etc. Understandably, some of these problems are very much within the control of the management of these enterprises.

Similarly, the efficiency of the use of working funds in receivables is found to be abnormally low, thanks to generous credit granting, comprehensive credit and collection policies and their half-hearted follow up. The size of cash has also been found on the high side in terms of operational requirements, due to lack of proper planning and control of cash.

The size of working capital is rather high, 10.4 months' value of production as against 5 months' optimum level. Slow transmutation of working capital and the unfavourable terms of purchase and sale are mainly responsible for this. The author brings this critical and analytical exercise to its expected culmination and makes some sound recommendations for ameliorating the working of these enterprises.

Among other changes to streamline the management of working capital, the author suggests the Government to take particular care of the project economics of the public enterprises, change its present policy of making investment in the public enterprises in the form of 50:50 debt and equity to 33.67 debt and equity, adopt cost-conscious pricing policies and choose saleable product-mix.

The study, however, suffers from some hanicaps, as mentioned in the Foreword by Mr. P. J. Fernandes, former Director General, Bureau of Public Enterprises. The sample of six units is rather small for a study of this nature and, therefore, the findings cannot be generalised for the public sector, as a whole. Moreover, two of these enterprises started operations only in 1964-65. The period of study extends upto 1967-68[1]. Since then, the inventory level of public sector companies has gone down om 6.7 months' value of production to 4.4 months' value of production d most of the enterprises have started making profits.

ch handicaps are, however, the common lot of most of the research orks, hence need not discount the utility of this otherwise competent work. The study is of good value to managers of commercial enterprises, particularly, of public sector undertakings, research workers and students of public enterprises. □

Books Received

1. **The Management of Management;** R. K. Laxman; published by *All India Management Association*, New Delhi; 1977; pp. 96; Rs. 6.00

2 **Management : Concepts and Analysis;** Navin Chandra Joshi; Published by *Vikas Publishing Company*, Delhi; October 1977; pp. 253; Rs. 48.00

3. **Profile of Indian Managers;** Mirza S. Saiyadain & Arun Monappa; published by *Vidya Vahini*, New Delhi; 1977; pp. 53; Rs. 15.00

1. Position during 1969-70 has been discussed in Addendum, pp. 215-226.