MESSAGE

In today’s competitive market, companies need to adopt innovative productivity and environment management tools like **Material Flow Cost Accounting (MFCA)** that not only saves material losses, but also improves the environmental performance, helps reduce cost, and improves the Company’s Productivity. MFCA helps the key decision makers of the company in providing precise data, by tracing and identifying the material losses in a company that also include material losses due to supply chain management both upstream and downstream, that is, suppliers and consumers, and identifying remedial measures to prevent these material losses.

With support from **Asian Productivity Organization (APO), and Japan Productivity Centre (JPC), Tokyo, Japan and National Productivity Council (NPC), Gandhinagar**, the concept of MFCA has been promoted and propagated in the state of Gujarat, during the period between June 2012 and March 2014. MFCA expert(s) were deputed from Japan, to create awareness and train the consultants from NPC and officials from the model demonstration companies in Gujarat.

To start with, four model companies in Gujarat have implemented MFCA and reaped benefits, with the assistance from Japanese expert(s) and NPC consultants. The findings of the report were disseminated to various stakeholders, for wider propagation and creation of multiplier effect in the country.

Looking into the huge potential of MFCA, the Department of Industrial Policy and Promotion (DIPP), Ministry of Commerce and Industry, Government of India, has entrusted NPC the task to promote and propagate MFCA across nation, through Awareness and Practice Oriented Certificate Programs. As a part of this campaign, this booklet on MFCA is developed, which not only provides a useful insight into the basics of MFCA but also discusses “Success Stories of MFCA implementation and its sustenance in model demonstration units”.

MFCA being a new concept in India needs to be extensively promoted and propagated, for wider reach, to target maximum people. The idea behind publishing this booklet is that the readers can make use of the MFCA tools in their own companies, especially, Micro, Small & Medium Enterprises and get benefitted. MFCA is applicable to all, as it is a concept that can be applied everywhere that involves usage of material, energy and resources.

I sincerely believe that this booklet will be very useful, for the readers. I sincerely thank **DIPP, APO, JPC, model companies and related stakeholders** for their kind support and co-operation in taking MFCA forward.
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MATERIAL FLOW COST ACCOUNTING

1.0 INTRODUCTION

Material flow cost accounting (MFCA), is an environmental management accounting developed in Germany in the late 1990s and since adopted widely in Japan, focuses on tracing waste, emissions and non products, and can help boost an organization’s economic and environmental performance.

Climate change, environmental legislation, and the global economy are in the headlines more than ever, highlighting the fact that effective management of environmental and economic affairs has become a vital social issue. In response, manufacturers and other businesses are under pressure to increase productivity while reducing environmental impact. MFCA can help organizations to achieve such objectives by identifying emissions and waste within a process in cost and physical terms. Such precise data can motivate managers to enhance material productivity and significantly reduce waste far more effectively than relying only on conventional production and cost accounting information.

The original concept of MFCA was developed in Germany by Professor Bernd Wagner and colleagues at IMU (Institute für Management und Umwelt) in Augsburg, Germany, and introduced in Japan around 2000. Many Japanese companies have since adopted MFCA, supported by the Japanese Ministry of Economy, Trade and Industry. In 2008, the Japanese Industrial Standards Committee (JISC) submitted an MFCA proposal to ISO/TC 207, resulting in the creation of a new working group, WG 8, in March 2008, to develop ISO 14051.

2.0 ABOUT MFCA

Under MFCA, the flows and stocks of materials within an organization are traced and quantified in physical units (e.g. mass, volume) and the costs associated with those material flows are also evaluated. The resulting information can act as a motivator for organizations and managers to seek opportunities to simultaneously generate financial benefits and reduce adverse environmental impacts. MFCA is applicable to any organization that uses materials and energy, regardless of their products, services, size, structure, location, and existing management and accounting systems.

MFCA is a management information system that traces all input materials flowing through production processes, and measures output in finished products and waste. For example, where 100 kg of materials is input into a production process and 70 kg of finished products is obtained, 30 kg of waste has also been produced. An equivalent cost evaluation of the finished product and waste can then be made. In MFCA, finished products and waste are respectively termed positive and negative products. The essential point of MFCA is to recognize waste as non-marketable (second) products in the sense that materials are consumed and manufacturing facilities are used.
MFCA can be extended to other organizations in the supply chain, both upstream and downstream, thus helping to develop an integrated approach to improving material and energy efficiency in the supply chain. This extension can be beneficial because waste generation in an organization is often driven by the nature or quality of materials provided by a supplier, or the specification of the product requested by a customer.

3.0 BENEFITS OF MFCA

MFCA can provide internal and external benefits, enabling an organization to make a greater profit with less environmental impact. A typical internal benefit is the strengthening of an organization’s competitiveness, since MFCA delivers both increased profits and material productivity. MFCA can also bring external environmental benefits by enabling organizations to manufacture the same amount of finished product with less input. As a result, they can reduce environmental impacts such as CO2 emissions and consumption of natural resources. Balancing environmental and economic factors are vital issues confronting many organizations wishing to achieve sustainable development. MFCA can be of great assistance in this endeavour. It has become recognized as a valuable management tool because it links the environment to economics. MFCA offers the potential for:

i. Increased production efficiency through capital investment, based on appropriate and accurate evaluation of investment projects;

ii. Cost reduction through changes in product design and raw materials based on precise evaluation of manufacturing cost;

iii. Revitalizing on-site improvement activities (e.g. environmental and quality management systems) by providing specific targets;

iv. Possible extension to the supply chain and social cost management;

v. Applicability to any organization, regardless of type, size, activity and location, and in developing as well as developed countries.

MFCA implementation need not involve advanced computer-based information databases since simple spreadsheet calculations and the use of a calculator are often sufficient – an advantage for small and medium-sized enterprises.
4.0 UTILIZING MFCA AS AN INDICATOR FOR EXTERNAL ENVIRONMENTAL MANAGEMENT EVALUATION

MFCA makes visible the quantities and monetary values of internal losses, for the purpose of corporate internal management. It is desirable to evaluate the external impact of the company at the same time, for more effective environmental management.

The scopes of application of these methods by businesses are categorized into “products” and “business sites (factories)” as the targets of business activities. As for “products,” businesses will typically apply these methods to individual functions directly related to manufacturing, such as design and development, procurement, production and sales. More specifically, common application targets will include environmentally-conscious design, green procurement, production control, and product promotion using environmental quality. On the other hand, typical applications to “business sites (factories)” will be based on the Plan, Do, Check and Action (PDCA) cycle of the entire environmental management systems. For example, common applications include the setting of environmental targets for the entire business site, capital investment, environmental performance evaluation, environmental reporting and others.

When a company seeks to introduce such integrated environmental impact assessment methods in combination with MFCA, it is important to select appropriate methods based on their characteristics.


The most intuitive part of Material Flow Cost Accounting is probably the planning phase. The ISO norm suggests that you start by involving the company’s management and continue by determining whether your staff is suitably qualified and fully accepts being involved. This is most certainly a wise procedure with whatever planning you have going on; our norm calls it determination of necessary expertise. Step 3 in the planning phase sets the pace for all the other steps, since this is the time when you specify a system boundary and a time period. In other words, how detailed should the accounting become? Basically, the boundaries can span a single or several process (es), the whole organisation or even entire supply chains.

The last step in the Plan phase consists of defining what are called quantity centers. What’s that? Different interpretations are mentioned, reaching from the vague, “any potentially loss-causing point”, to the precise processes of “receiving, cutting, assembling, heating and packing”. But really, defining quantity centers means getting a good sketch of what’s happening throughout your production.

2. Do: Model Material and Financial Flows

Having the quantity center sketch as a basis, you can easily discover the in- and outputs for each process. This first step in the Do-phase, and the fifth step overall, is called
identification of inputs and outputs for each quantity center. Next, these throughputs need to get a physical unit for quantification. This quantification refines inputs and outputs, making it possible to see material flows. Ah, right: because the method we’re dealing with is a cost accounting one, not only do we need a physical unit, but also a financial one. It’s as simple as that: steps six and seven deal with quantification of the material flows in physical and monetary units.

In order to accomplish these steps, you can either hire a busload of mathematically fit day laborers, or apply a neat computer model. A precondition for enhancing material efficiency is a high transparency of material flows within or even across companies and the corresponding material costs.

Material Flows in physical units. And here: If you finish this model, you successfully complete step 6 of 10 in Material Flow Cost Accounting with ISO 14051.
Same production, but instead of physical units (kg material), you now see material flows in monetary flows (Euro). If you finish this model, you successfully complete step 7 of 10 in Material Flow Cost Accounting with ISO 14051. Very neatly, you see how expensive your material losses get.

3. Check: Interpret + Communicate Results

Phase three has two steps that are a logical consequence of creating the model in the previous phase. In step 8, data summary and interpretation, the necessary conclusions are drawn from the material flow models. In step 9, these results are communicated.

Under MFCA, the flows and stocks of materials within an organization are traced and quantified in physical units (e.g. mass, volume) and the costs associated with those material flows are also evaluated. The resulting information can act as a motivator for organizations and managers to seek opportunities to simultaneously generate financial benefits and reduce adverse environmental impacts. MFCA is applicable to any organization that uses materials and energy, regardless of their products, services, size, structure, location, and existing management and accounting systems.

4. Act: Improve

The final MFCA step, identification and assessment of improvement opportunities, is up to you.
5.0 MFCA GUIDE FOR COMPANIES

Estimate the monetary value of your company’s waste. Look up your environmental report for material balance, which indicates the environmental impact of your production facilities by means of input (major materials used) and output (waste generation). The material balance data provides approximate quantities of overall materials used and of overall materials wasted (“negative product”). You will have the quantity of materials made into company products (“positive product”) by subtracting the negative product from the overall material input. Your company’s data on raw material cost will be found in the securities report or similar documentation. Estimate the unit price of input materials using that data. For example, you will have the unit material price by dividing the overall material cost by the overall material input. By multiplying the above negative and positive products by such unit price, you will have approximate positive and negative product costs (“material cost”).

The table above indicates an example of estimating the amount of “gold” in your waste, in terms of quantity and monetary value. Estimate “gold” in your company’s waste in the same method, using the table below.

<table>
<thead>
<tr>
<th>Input: materials used</th>
<th>Output: waste (a gold mine)</th>
<th>Output: company products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major materials</td>
<td>Waste (negative product)</td>
<td>Company products (positive product)</td>
</tr>
<tr>
<td>Steel materials</td>
<td>Industrial waste</td>
<td></td>
</tr>
<tr>
<td>Aluminum materials</td>
<td>Recyclable waste</td>
<td></td>
</tr>
<tr>
<td>Chemical materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (tons)</td>
<td>Total (tons)</td>
<td>Total (tons)</td>
</tr>
<tr>
<td>Quantity percentage</td>
<td>100%</td>
<td>38.5%</td>
</tr>
<tr>
<td>Cost of input materials</td>
<td>Cost of wasted materials (negative product)</td>
<td>Cost of materials used for positive product</td>
</tr>
<tr>
<td>Total (million yen)</td>
<td>50,000</td>
<td>19,226</td>
</tr>
</tbody>
</table>

How large is your company’s gold mine? If you succeed in reducing your negative product, you will receive a gift of “cost reduction” in return. (In the above calculation, the quantities and material costs of material loss are made visible. MFCA enables you to have a clearer...
picture of overall loss, including processing cost and other expenses. You will also have data calculated by product and by process. MFCA is an extremely effective tool to realize both waste and cost reduction at the same time.

**Waste from Manufacturing Process = Material Loss**

In a processing-type manufacturing, waste and resource loss occur in various steps of the manufacturing process. Waste generated from processing includes the following.

i. Material loss during processing (e.g. listing, swarf), defective products, impurities
ii. Materials remaining in manufacturing equipment following set-ups
iii. Auxiliary materials (e.g. solvents and other volatile materials, detergents to wash equipment before set-ups)
iv. Raw materials, work-in-process and stock products discarded due to deterioration or other unusable reasons

MFCA traces equally the both flows of final products and emissions (wastes) in processes. And MFCA recognizes even the emissions as one product. MFCA calls products "positive products" and the emissions "negative products".

**Material Flow and MFCA**

One of the methods to clarify material loss in the manufacturing process is material flow analysis. An example of material flow analysis is shown below;
In the above figure, 1,000 kg of main materials are input in Process A, and causes loss of 100 kg in Process A and 90 kg in Process B. While 100 kg of main materials lost in Process A is recycled by an external business, while 90 kg in Process B is discarded as waste. Of sub materials input in Process A, 10 kg and 9 kg are lost in Processes A and B respectively. A total of 19 kg of sub materials are discarded as waste. Auxiliary materials of 1 kg are input in Process B, all of which becomes waste. Consequently, 1,101 kg of materials are input in this process, of which 891 kg become company products and 210 kg are regarded as material loss. As 100 kg are recycled by an external business, the final material loss is estimated at 110 kg.

Material flow cost analysis identifies economic loss (loss cost) indicates the costs of main, sub and auxiliary materials that became waste, which are given by multiplying individual waste quantities by purchased unit prices (shown in figure below).

If a company has the data of its material balance, it can easily calculate the above material loss cost by multiplying individual quantities (kg) by their unit prices. The figures indicate that even if you recover some material cost by external recycling, it is miniscule compared to the material loss cost (negative product cost). Although external recycling is an important activity, you will see that it is more significant to reduce waste generation itself if you consider economics. Economic loss (loss cost) caused by lost materials is not limited to the material cost. As long as each process requires the input of labor, depreciation, energy and other costs, material
loss causes the loss on such costs as well. Emitted waste needs to be treated, which also requires treatment costs.

For calculation, MFCA adds all the cost information including material, processing, energy, waste treatment and other costs to the quantity data based on material flow, thereby tracking the flow of each raw material throughout and adding the quantity and cost information to that flow.

Therefore, a business can analyze with MFCA the economic loss (loss cost) by material loss not only in terms of material cost but also as loss relating the entire manufacturing cost including processing, energy, waste treatment and all other comprising costs.

**MFCA makes loss “visible” for each process**

The figure shown below indicates the calculation of MFCA, using a simplified MFCA trial tool, using template data provided for trial experience of MFCA calculation. The diagram shows the image of a calculation flow chart with cost figures (Waste treatment cost is omitted).

In this example, a total material loss cost of 19.3 yen is provided as procurement cost for lost materials, based on the quantity of waste. MFCA includes processing and energy costs put into negative product (wasted materials) in the “negative product cost.” In this example, the total negative product cost pertaining to processing cost and overheads throughout the manufacturing process is 40.7 yen, while the total negative product energy cost is 4.1 yen. By adding these two to the negative product material cost above, you will have the overall loss cost in the manufacturing process, which stands at 64.0 yen in this example. This takes up 29.8% of all costs (215.0 yen).
Such negative product cost is identified on a process-by-process basis in MFCA. In the above example, respective negative product costs for material processing, parts processing and finishing processes are 15.8, 21.6 and 26.6 yen. The quantity percents for positive and negative products are calculated as 15% and 85% respectively, in materials put into each process. Because processing and other costs from the previous process are included in the negative product cost, manufacturing loss causes greater negative product cost in later processes.
6.0 ISO 14051:2011

The standard, ISO 14051:2011, Environmental management – Material flow cost accounting – General framework, assists organizations to better understand the environmental and financial consequences of their material and energy use practices, so that they can identify opportunities for improvement. ISO 14051:2011 establishes a management information system approach called MFCA, which can be used to trace and quantify material input and output flows and stocks within an organization. The system helps identify material and energy use practices, and understand these in costs and physical terms. The information can then be applied to reduce losses and increase gains.

Many organizations are unaware of the full extent of the cost of their material losses because this data is often difficult to extract from conventional information, accounting and environmental management systems. MFCA produces such precise and clear data that it can motivate managers to enhance material productivity and significantly reduce unnecessary waste far more effectively than through conventional means.”

“The bottom line is that not only do organizations increase profits, but they improve their environmental performance and contribute to sustainable development.

MFCA is applicable to all industries that use materials and energy, including extractive, manufacturing, service and other industries. It can be implemented by organizations of any type and scale, with or without environmental management systems in place, in emerging economies as well as in industrialized countries.

MFCA is one of the major tools of environmental management accounting and is primarily designed for use within a single facility or organization. However, MFCA can be extended to multiple organizations within a supply chain, to help them develop and integrated approach to more efficient use of materials and energy.

ISO 14051 was developed by ISO technical committee ISO/TC 207, Environmental Management.

ISO 14051:2011 provides a general framework for material flow cost accounting (MFCA). By definition, management accounting and environmental management accounting (EMA) focus on providing organizations with information for internal decision-making. MFCA, one of the major tools of EMA, also focuses on information for internal decision-making, and is intended to complement existing environmental management and management accounting practices. Although an organization can choose to include external costs in an MFCA analysis, external costs are outside the scope of ISO 14051:2011.
The MFCA framework presented in ISO 14051:2011 includes common terminologies, objective and principles, fundamental elements, and implementation steps. However, detailed calculation procedures or information on techniques for improving material or energy efficiency are outside the scope of ISO 14051:2011. ISO 14051:2011 can be considered as a standard for sustainable development. However, implementation of the cost accounting method is not within its scope and is not intended for the purpose of third party certification.

7.0 INTEGRATION WITH ISO 14000

MFCA can be integrated into the ISO 14000 family of EMS standards and is complementary to life cycle assessment (LCA), environmental performance evaluation (EPE) and greenhouse gas management standards. With regard to EMS integration, MFCA can provide significant information to an organization in the Plan-Do-Check-Act (PDCA) cycle. LCA generally regards the lifecycle of a product and service as a system, and analyses the environmental influence in the lifecycle but does not currently include economic aspects of an organization. MFCA supports this point.

Concerning EPE – the PDCA continual improvement process – ISO 14031 in principle sets the outline necessary to monitor material flows within organizations, but does not relate this information to financial information systems and business decisions regarding costs and the setting of product prices. However, MFCA provides this link.

In addition, the assessment of CO2 emissions in many sectors is based on the evaluation of the material input of energy carriers, which need to be thoroughly registered in technical as well as monetary information systems. MFCA, again, provides this link.
8.0 MFCA INITIATION IN INDIA

The Asian Productivity Organization (APO), Tokyo, Japan, has selected India for conduct of 2 years Member Country Support Program (MCSP) on Material Flow Cost Accounting. The MCSP was started on June 2012 and completes on March 2014. National Productivity Council of India (NPC) is executing this Project with support from Japan Productivity Center (JPC), Tokyo, Japan.

MFCA expert(s) from Japan were deputed to India for capacity building of consultants and company personnel. As a part of this project 4 model companies (SME’s) were chosen for MFCA assessment and implementation. The list of the selected model companies is shown below;

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of Model Company</th>
<th>Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>M/s Somany Ceramics Ltd., Kadi</td>
<td>Ceramic</td>
</tr>
<tr>
<td>2.</td>
<td>M/s Sainest Tubes Pvt. Ltd., Chatral</td>
<td>Steel Re-rolling</td>
</tr>
<tr>
<td>3.</td>
<td>M/s Bhagwati Spherocast Pvt. Ltd., Odhav</td>
<td>Foundry</td>
</tr>
<tr>
<td>4.</td>
<td>M/s Baroda Molds and Dies, Vadodara</td>
<td>Moulds and Dies</td>
</tr>
</tbody>
</table>

The partnering organizations towards the execution of the project include the Micro Small and Medium Enterprises Development Institute (MSME-DI) and Centre for Promotion of Foundry Education & Research (CFER).

The objective of the program was strengthening of NPC and partnering Organization by upgrading the capacities for productivity promotion, consultancy and training through the application of MFCA from the assigned APO experts. The program scope is mentioned below;

i. Introduction to MFCA
ii. Understanding the MFCA concept, principles & methodology
iii. Implementing of MFCA in selected demonstration/model companies
iv. Documenting MFCA implementation
v. Understanding problems faced during implementation and how to overcome them
vi. Developing expertise in the implementation of MFCA in SME’s
vii. Developing in house MFCA consultants within India
viii. Dissemination of MFCA for Multiplier effect

MFCA Expert(s) from Japan, Mr. Hiroshi Tachikawa/Mr. Yoshikuni Furukawa has made seven numbers of visits to Model Companies, wherein MFCA study/assessment was undertaken. The MFCA study undertaken and implemented in model companies has resulted in the following benefits;
<table>
<thead>
<tr>
<th>Name of Model Company</th>
<th>Investment (Rs.)</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Simple Payback Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>M/s Somany Ceramics Ltd.</td>
<td>2,00,000/-</td>
<td>35,00,000/-</td>
<td>Immediate</td>
</tr>
<tr>
<td>M/s Sainest Tubes Pvt. Ltd.</td>
<td>4,95,000/-</td>
<td>2,09,43,924/-</td>
<td>09 days</td>
</tr>
<tr>
<td>M/s Bhagwati Spherocast Pvt. Ltd.</td>
<td>1,00,00,000/-</td>
<td>1,74,17,496/-</td>
<td>About 1Year</td>
</tr>
<tr>
<td>M/s Baroda Molds and Dies</td>
<td>2,00,00,000/-</td>
<td>2,47,00,000/-</td>
<td>About 1Year</td>
</tr>
</tbody>
</table>

The application of MFCA in above mentioned Model Companies, has resulted in the improvement of their overall material, resource and energy savings bringing about enhanced monetary savings to the companies with improvement in overall productivity. The individual case studies are explained in subsequent chapters.
9.0 MFCA CASE STUDY OF M/s SAINEST TUBES PVT. LTD., CHATRAL

9.1 INTRODUCTION

Established in the year 1988, M/s Sainest Tubes Pvt. Ltd. located at Gandhinagar, Gujarat is engaged in the manufacture of product(s) such as Seamless Carbon / Alloy steel tubes & Pipes, with annual production capacity of approximately 12000 Tonnes. The company is an ISO 9001, ISO 14001, OHSAS 18001 certified company. About 250 employees are working in the organization and runs 24 hours each day.

The MFCA expert from Japan, along with NPC officials has undertaken six numbers of visits to the company. During his visits, detailed material flow cost accounting model was developed, depicting all the input resources, processes and material losses along with their quantification. Based on which, MFCA solutions were arrived at, in consultation with MFCA expert from Japan, NPC officials, company personnel and are/going to be implemented. The adoption of MFCA in the unit has resulted in Capacity Building of our personnel and made plant personnel understand process particulars in a better way. Further, MFCA has resulted in reduced consumption of resources with improved environmental and energy performance and improved productivity.

CASE STUDIES DISCUSSED

1. M/s Sainest Tubes Pvt. Ltd., Chatral
2. M/s Bhagwati Spherocast Pvt. Ltd., Odhav
3. M/s Somany Ceramics Ltd., kadi
4. M/s Baroda Moulds and Dies, Waghodia
9.2 PROCESS DESCRIPTION

9.3 MFCA FLOW MODEL – BEFORE IMPLEMENTATION

**INPUT = GREEN COLOUR BOX**

**PROCESS (STAGES / QTY CENTER) = YELLOW COLOUR BOX**

**WASTAGE FROM EACH PROCESS = PINK COLOUR BOX**
### 9.4 ILLUSTRATIVE REPRESENTATION OF MFCA SOLUTIONS

<table>
<thead>
<tr>
<th>Previous</th>
<th>Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Wall Thickness Eccentricity up to 0.4 MM)</td>
<td>(Wall Thickness Eccentricity up to 0.15 MM)</td>
</tr>
</tbody>
</table>

**Serial 1.1:** (Before, After and During MFCA implementation)
<table>
<thead>
<tr>
<th>Serial 1.3:</th>
<th>Serial 1.4:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumatic Cylinder for Annealed Tube Unloading</td>
<td>Added Cooling Zone</td>
</tr>
<tr>
<td>Serial 1.8:</td>
<td>Serial 1.10:</td>
</tr>
<tr>
<td>Taper stands for excess oil Drain to tank</td>
<td>Vertical Cylinder for Stiffest gripping</td>
</tr>
</tbody>
</table>
Material Flow Cost Accounting

Serial 1.12:- Previous Wooden Box

Serial 1.12:- Present Wooden Crete

Serial 21.:- Use of emission excess flue gas temp. to HWG @ Pickling
### Material Flow Cost Accounting

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>MFCA Solution Description</th>
<th>Type of Benefit and Quantification (Material, Energy/Resource/Environment)</th>
<th>Investment (Rs.)</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Simple Payback Period (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Used Material with 0.4 mm W.T. eccentricity</td>
<td>[Material Saving] 9.75 Rs./Tube is saved &amp; Approx. 19500 Tubes are issued per month</td>
<td>Training given to the suppliers 2281500</td>
<td>---</td>
<td>-</td>
</tr>
<tr>
<td>1.2</td>
<td>Loading 1 MT/Hr. at Furnace</td>
<td>[Energy/Resource/Environment Saving] Cost of Rs./Kg is reduced from 2.21 Rs. to 1.60 Rs. (i.e. 0.61 Rs./kg.). Loading per month is approx. 600000 kg/month</td>
<td>---</td>
<td>4392000</td>
<td>-</td>
</tr>
<tr>
<td>1.3</td>
<td>6 Men @ unloading at Furnace</td>
<td>[Resource Saving] Saving by reducing 3 Men/Shift. By considering 25 working days &amp; 250 Rs. salary, 25 x 3 x 2 x 250 = 37500 Rs. Saved/Month</td>
<td>50000</td>
<td>450000</td>
<td>40</td>
</tr>
<tr>
<td>1.4</td>
<td>Less Loading @ 500 Kg/Hr. furnace due to insufficient cooling of annealed material. (Annealed material was over heated by introducing one more cooling zone for sufficient cooling. So, Loading is increased by 50 %)</td>
<td>[Energy/Resource/Environment Saving] Cost of Rs./Kg. is reduced from 6.00 Rs. To 2.75 Rs. (i.e. 3.25 Rs./Kg.). Loading per month is approx. 200000 KG./Month (26 Working days considered/Month)</td>
<td>35000</td>
<td>7800000</td>
<td>2</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>MFCA Solution Description</td>
<td>Type of Benefit and Quantification (Material, Energy/Resource/Environment)</td>
<td>Investment (Rs.)</td>
<td>Annual Monetary Savings (Rs.)</td>
<td>Simple Payback Period (Days)</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>-------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>1.5</td>
<td>More breakdowns in Furnace</td>
<td>[Energy/Resource Saving] Breakdown hours are reduced from 100 Hours to 50 Hours &amp; increased utilization. Loading/Hr. is 300 Kg. In saved 50 hours we can load more 300 x 50 = 15000 Kg. Material.</td>
<td>Training given to concern people.</td>
<td>495000</td>
<td>-</td>
</tr>
<tr>
<td>1.6</td>
<td>Point length was 8 &quot; / Tube</td>
<td>[Material Saving] 5.70 Rs./Tube is saved &amp; Approx. 19500 Tubes are drawn per month</td>
<td>175000</td>
<td>1333800</td>
<td>47</td>
</tr>
<tr>
<td>1.7</td>
<td>Machine was running in un-load too.</td>
<td>[Energy Saving] Approx. 450 KWH/Month/Draw bench is saved. Rate of KWH is calculated 6.80 Rs. We have 10 Nos. of draw benches</td>
<td>12000</td>
<td>367200</td>
<td>12</td>
</tr>
<tr>
<td>1.8</td>
<td>Wastage of drawing Oil was more</td>
<td>[Resource Saving] Rate of Draw Oil is 270 Rs./Kg. And approx. 25 kg. oil/month, we are preventing to be wasted.</td>
<td>20000</td>
<td>81000</td>
<td>89</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>MFCA Solution Description</td>
<td>Type of Benefit and Quantification (Material, Energy/Resource/Environment)</td>
<td>Investment (Rs.)</td>
<td>Annual Monetary Savings (Rs.)</td>
<td>Simple Payback Period (Days)</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------</td>
<td>------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>1.9</td>
<td>Drained in to the tank</td>
<td>[Energy Saving] Approx. 675 KWH/Month/Cutting M/c is saved. Rate of KWH is calculated 6.80 Rs. We have 02 Nos. of abrasive cutting machines.</td>
<td>2400</td>
<td>110160</td>
<td>8</td>
</tr>
<tr>
<td>1.10</td>
<td>At abrassive cutting, Machine was running in un-load too.</td>
<td>Machine stop while no cutting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Energy Saving] Approx. 675 KWH/Month/Cutting M/c is saved.</td>
<td>Rate of KWH is calculated 6.80 Rs. We have 02 Nos. of abrasive cutting machines.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.11</td>
<td>Process scrap was more due to in-sufficient gripping</td>
<td>One more verticle pneumatic cylinder is attached for sufficient gripping</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.12</td>
<td>New marking slate was used for every size</td>
<td>[Resource/Environment Saving] Consumption of marking slate is reduced from 100 to 40. Rate of 1 Marking slate is 131 Rs.</td>
<td>---</td>
<td>94320</td>
<td>-</td>
</tr>
<tr>
<td>1.12</td>
<td>Fully covered wooden boxes used with 1&quot; thick wood</td>
<td>Wooden crates are used with 0.75 &quot; thick wood.</td>
<td>---</td>
<td>600000</td>
<td>-</td>
</tr>
<tr>
<td>Sl. No.</td>
<td>MFCA Solution Description</td>
<td>Type of Benefit and Quantification (Material, Energy/Resources/Environment)</td>
<td>Investment (Rs.)</td>
<td>Annual Monetary Savings (Rs.)</td>
<td>Simple Payback Period (Days)</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------</td>
<td>--------------------------------------------------</td>
<td>------------------</td>
<td>-------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>1.</td>
<td>Short Term MFCA Solutions (to be implemented within 6 months)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Previous</td>
<td>Present</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Use of effluent gas temp. to HWG @ Pickling</td>
<td>[Energy/Resource] Approx. 5000 SCM PNG is saved. Cost of PNG is calculated 38 Rs./SCM</td>
<td>200000</td>
<td>2280000</td>
<td>32</td>
</tr>
<tr>
<td>2.</td>
<td>Medium Term MFCA Solutions (to be implemented between 6 to 18 months)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Previous</td>
<td>Present</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>No Length segregate from supplier</td>
<td>If small length ordered than cost will be less. Can order of raw material as per trend of length used.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Long Term MFCA Solutions (to be implemented after 18 months)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Other benefits are as below.**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>MFCA Solution Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous</td>
<td>Present</td>
</tr>
<tr>
<td>1.</td>
<td>No length segregate from supplier</td>
</tr>
<tr>
<td>2.</td>
<td>No length segregate from supplier</td>
</tr>
<tr>
<td>3.</td>
<td>More inventory (2500 MT)</td>
</tr>
<tr>
<td>4.</td>
<td>Cleaning of whole lot of tubes</td>
</tr>
<tr>
<td>5.</td>
<td>Direct dip in Acid</td>
</tr>
<tr>
<td>6.</td>
<td>Treatment of acid &amp; acidic waste water</td>
</tr>
<tr>
<td>7.</td>
<td>Soap discarding (Alkaly)</td>
</tr>
<tr>
<td>8.</td>
<td>No Temp. control in soap bath</td>
</tr>
<tr>
<td>9.</td>
<td>Sludge</td>
</tr>
<tr>
<td>10.</td>
<td>Area of Oil tank was more. More evaporation of oil</td>
</tr>
<tr>
<td>11.</td>
<td>Other method to replace oil removal by cotton?</td>
</tr>
<tr>
<td>12.</td>
<td>Oil wastage was more</td>
</tr>
<tr>
<td>13.</td>
<td>One tube wit Fix length was reject due to sample cutting for TPI</td>
</tr>
</tbody>
</table>

### 9.5 RESULTS

The results indicate that by the adoption of Green Productivity practices such as MFCA in the company has resulted in environmental, economic and social benefits to the company. Thus, by an investment of Rs. 4,95,000/- (Rupees Four Lakhs Ninety Five Thousand only), the company has an overall annual savings of Rs. 2,09,43,924/- (Rupees Two Crores Nine Lakhs Forty Three Thousand Nine Hundred Twenty Four only), with a simple payback of 09 days.
10.0 MFCA CASE STUDY OF M/s BHAGWATI SPHEROCAST PVT. LTD., ODHAV

10.1 INTRODUCTION

Bhagwati Spherocast Pvt Ltd. located 8 kms. away from Ahmedabad City, at GIDC Estate, Odhav, is a medium scale private limited company, setup in 1977, this unit has an annual capacity of 17400 tons and is producing high duty grey iron and ductile iron castings as per any International Standards for various OEM industries. The unit has a R&D laboratory approved by the Dept. of Science & Technology, Govt. of India and is an ISO 9001-2008 certified company. The company has About 250 employees are working in the organization and runs 24 hours each day.

The MFCA expert from Japan, Mr. Hiroshi Tachikawa, along with NPC officials have undertaken six number of visits to our company during 6th September 2031, 10th December 2012, 14th March 2013, 11th July 2013, 09th September 2013, 2nd December 2013 respectively. During his visits to our company, detailed material flow cost accounting model was developed, depicting all the input resources, processes and material losses along with their quantification. Based on which, MFCA solutions were arrived at, in consultation with MFCA expert from Japan, NPC officials, company personnel and are/going to be implemented. The adoption of MFCA in our unit has resulted in Capacity Building of our personnel and made us understand our process particulars in a better way. Further, MFCA has resulted in reduced consumption of resources with improved environmental and energy performance and improved productivity.

10.2 PROCESS DESCRIPTION

A foundry is the process (producing castings); split up in several smaller processes each performing part of the job. The result must be a casting, which is, conforms to the requirements of the customer. The sub processes are related one to the other and each process have an influence on the next one (next step in the total process). So it can be said that each department is the supplier of another and the customer of the previous (according to the total process) one. The process has three major steps, which are not all done one after another in time. Some of them are running simultaneous. The flow chart below is indicating all steps.

10.2.1 Pattern

The pattern is the “start” of a casting. The pattern has a large influence on the cost, the dimensions and soundness of the material section as well as the surface condition of the
casting. To get “the best” pattern, a cooperation between foundry, machining shop and pattern shop is absolutely necessary. A low cost casting can be the start of an expensive casting, which keeps expensive during the whole lifetime. A “bad pattern” can also be the start of a continuously troubling quality and delivery.
10.2.2  Core Shop (Cold Box and Shell Core)

- Cold Box Core
  The process is a three part binder system consisting of Part 1, a phenolic resin, Part 2 a polymeric isocyanate and an amine type Part 3 catalyst, capable of being vaporized.

- Shell Core
  In conventional sand moulding, sand grains are bonded by clay and moisture while in shell moulding clay is replaced by synthetic resin. Since the resin gives bond only after heating there are chemical changes taking place during heat transfer.

10.2.3  Moulding

It is important to describe the process of mould fabrication in order to recognize all possible influences on the result of moulding to the condition of the casting. Moulding consist of four important steps:

i. Filling the mould and core boxes
ii. Finishing mould and cores (correcting, coating...)
iii. Assembling and closing mould and cores
iv. Preparing for pouring (clamping and weighting).

Green sand is used for moulding. Green sand is consist of bentonite, coal dust and water with pure silica sand. All these have an influence on the result, single and in combination with each other.

10.2.4  Melting

Melting involves four major steps: charge for melting, melting itself (furnace and holding furnace), stay in the ladle and pouring. This is clearly indicated in the next flow chart.

The result of melting is very important because it has an influence on the chemical composition, the mechanical and physical properties, the soundness of the material section (porosity, inclusions...) as well as on the surface condition.

The most important feature of liquid metal is its "living" behaviour. This means that it is continuously changing in time. This means that each test done, gives the situation on the time of taken the sample or performing the measurement and not at the time of knowing the result.
10.2.5 Pouring

Pouring will bring the metal from the ladle into the pouring system of the mould and this as clean as possible.
10.2.6 Cooling

The moulding sand and castings are cooled by evaporation of residual water in the sand and water is sprayed into the drum. A counter air flow through the drum removes the resulting water vapour and increases the cooling effect.

Castings are tumbled gently with the sand in a smooth process lasting 20-30 minutes. Sand lumps are broken and the sand is effectively blended prior to screening off in the drum end screening section. The cooled castings are discharged at the Disacool outlet.

As no grinding media is used for sand separation in the Disacool, the sand is free of these metal fragments and can be directly recycled back to the sand plant.

10.2.7 Knockout

The wedge is employed for the removal of runners and risers. The working process is based on the driving force of a movable wedge. The wedge is with its spreading jaws, is placed between the work piece and riser to be removed. If no counter-support is available on the work piece, an artificial support must be created.

10.2.8 Shotblasting

The polygonal blast cleaning drum with batch-wise loading is designed for blast cleaning of grey iron castings, ductile iron castings. Blast cleaning systems for descaling or cleaning of aluminium. Work pieces are of a different design concept, due to the fire and explosion hazards posed by the generated dust. Therefore, the blast cleaning system supplied must not be used for descaling or blast cleaning of aluminium work pieces. Using the blast cleaning drum for purposes other than those Mentioned above is considered contrary to its designated use.

10.2.9 Fettling

Fettling is the most underestimated part of the foundry. Perhaps this is due to the fact that
i. it is hard and dirty work that can be done by nearly every one?
ii. its workers are low skilled?
iii. the fettling department has to correct the non correct performance of the previous departments?
The fettling department has an opportunity to be the judge of the foundry by seeing the quality of all done in previous departments: pattern shop, mould- and core-shop, melting shop and pouring. The casting can be seen “at first” and an estimation of the extra work can be done. This extra work is only partly unavoidable; a lot of it can be decreased tremendously. Fettling is the “window on performance evaluation” for a foundry concerning cost and quality. Combined with the evaluation through the quality control (defects after NDT inspection) will complete the total evaluation.

10.2.10 Dispatch

Primarily in this department, primer coating is done on casting and casting are dispatched as per customer requirement.

10.3 MFCA FLOW MODEL (BEFORE AND AFTER IMPLEMENTATION)
10.4 PHOTOGRAPHS OF MFCA SOLUTIONS (BEFORE, AFTER AND DURING MFCA IMPLEMENTATION)

- Work Centre: Core Shop

<table>
<thead>
<tr>
<th>Item Name</th>
<th>No. of Core / Month</th>
<th>Shooting Print Core Wt. (kg)</th>
<th>Reduce Core Wt. (kg)</th>
<th>Yearly Req.</th>
<th>Yearly Saving (kg)</th>
<th>Cost Rs.10.7/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spicer Diff</td>
<td>60000</td>
<td>0.010</td>
<td>0.006</td>
<td>720000</td>
<td>4320</td>
<td>46224</td>
</tr>
<tr>
<td>Cyl Head T+B</td>
<td>30000</td>
<td>0.040</td>
<td>0.020</td>
<td>360000</td>
<td>7200</td>
<td>77040</td>
</tr>
</tbody>
</table>

Total Savings: Rs. 1,23,264/-
### Already Implemented MFCA Solutions

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>MFCA Solution Description</th>
<th>Type of Benefit and Quantification (Material/Energy/Resource/Environment)</th>
<th>Investment (Rs.)</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Simple Payback Period (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Productivity increased in Shell core by introducing multiple cavity core box</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Weigh reduction in shooting area in shell core box.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Short Term MFCA Solutions (to be implemented within 6 months)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>MFCA Solution Description</th>
<th>Type of Benefit and Quantification (Material/Energy/Resource/Environment)</th>
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<th>Annual Monetary Savings (Rs.)</th>
<th>Simple Payback Period (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>Other six items will be taken for core weight reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Medium Term MFCA Solutions (to be implemented between 6 to 18 months)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>MFCA Solution Description</th>
<th>Type of Benefit and Quantification (Material/Energy/Resource/Environment)</th>
<th>Investment (Rs.)</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Simple Payback Period (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>Heat losses to be reduced in shell core heater plate by providing heat insulation.</td>
<td>-Shell core energy consumption will be reduced.(Approx. 5000 units per month)</td>
<td>25,000/-</td>
<td>390000/-</td>
<td>27 Days</td>
</tr>
</tbody>
</table>
Material Flow Cost Accounting

- Work Center: Machine Moulding

The company has reduced and then eliminated adding dextrine and soda ash to green sand preparation, without affecting quality.

Saved = Rs. 17,45,009/- in Dextrine and Rs. 83,520/- in Soda ash. Total saving amounts to Rs. 18,28,529/-

<table>
<thead>
<tr>
<th>Reduction in PNG consumption:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before: Temperature sensing point on Gas burner. Temp setting 180 deg Celsius</td>
</tr>
<tr>
<td>After: Location of sensing point shifted filter bag unit Temp setting 50 deg Celsius</td>
</tr>
<tr>
<td>Sl. No.</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td><strong>Already Implemented MFCA Solutions</strong></td>
</tr>
</tbody>
</table>
| 1. | Eliminate addition of Dextrin & Soda Ash in green sand preparation. | Dextrin – Rs. 17,45,009/-  
Soda Ash – Rs. 83,520/- | | 18,28,529/- | |
| 2. | Temperature sensing location changed in Gas burner unit for hot air generation. | -Gas consumption bill reduced. | NIL | 18,00,000/- | Immediate |
| **Medium Term MFCA Solutions (to be implemented between 6 to 18 months)** | | | | | |
| 3. | For green sand preparation we will be installed intensive mixer. | To reduced bentonite and coal dust consumption | 75,00,000/- | | |
| **Long Term MFCA Solutions (to be implemented after 18 months)** | | | | | |
| 4. | We will installed sand reclamation plant for reused of system sand | To replace new sand in core shop | 6,00,00,000/- | | |
> Work Centre: Melting

**Reduction of Fe-Silicon Magnesium by redesign of the Treatment Ladle**

**Pic:01**

**Pic:02**

---

**% Consumption**

---

**% Fe-Silicon Magnesium**

---

**INR**

---

**Saving in Rs.**

---
Cooling tower fan motor operation is controlled by temperature controller which senses the temperature of cooling tower.
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Already Implemented MFCA Solutions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Raw Material Fe-Silicon-Magnesium alloy. Treatment ladle design changed. Previously alloy pocket height was 80 mm, we have increased that height to 180 mm. And delayed the reaction time.</td>
<td>Addition rate reduced by 0.22% and saved Rs. 28,15,174/-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Energy consumption (Furnace Power). Accurate weigh of raw material during charge. We have strengthened the quality control on input scraps (Steel scrap), like bundle size, rust free and also chemistry.</td>
<td>Energy saving of melting the metal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Short Term MFCA Solutions (to be implemented within 6 months)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>'Flexi pour'(Semi auto pour) will be installed within 1-2 Months</td>
<td>We will save metal by means of spillage during pouring process as well as metallurgical related rejection.</td>
<td>55,00,000/-</td>
<td>9,00,000/-</td>
<td>6 Years</td>
</tr>
<tr>
<td></td>
<td><strong>Long Term MFCA Solutions (to be implemented after 18 months)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>We will be plan for installed a slag mill for recover metal from slag</td>
<td>We will able to further reduce melting loss.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td>55,00,000/-</td>
<td>55,17,703/-</td>
<td></td>
</tr>
</tbody>
</table>
### Already Implemented MFCA Solutions

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>MFCA Solution Description</th>
<th>Type of Benefit and Quantification (Material/Energy/Resource/Environment)</th>
<th>Investment (Rs.)</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Simple Payback Period (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Casting Weight Reduction</td>
<td>Material saved i.e. machining allowance reduced without affecting Production/Quality</td>
<td>51,00,000/-</td>
<td>Upto October 2013</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Rs. 51,00,000/- saved upto October 2013</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Medium Term MFCA Solutions (to be implemented between 6 to 18 months)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>MFCA Solution Description</th>
<th>Type of Benefit and Quantification (Material/Energy/Resource/Environment)</th>
<th>Investment (Rs.)</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Simple Payback Period (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Yield Improvement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Long Term MFCA Solutions (to be implemented after 18 months)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>MFCA Solution Description</th>
<th>Type of Benefit and Quantification (Material/Energy/Resource/Environment)</th>
<th>Investment (Rs.)</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Simple Payback Period (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.</td>
<td>White Light Scanner</td>
<td>Tooling Development</td>
<td>30,00,000/-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Cover Housing with 1.5mm Machine Allowance</td>
<td>Material will be saved by 2 kg / pc.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Modification of Heat Treatment Furnace

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>H.T Furnace Rating</td>
<td>180 kW</td>
<td>100 kW</td>
</tr>
<tr>
<td>2.</td>
<td>Normalizing Treatment</td>
<td>1.04 kWh/kg</td>
<td>0.82 kWh/kg</td>
</tr>
<tr>
<td>3.</td>
<td>Annealing Treatment</td>
<td>0.44 kWh/kg</td>
<td>0.30 kWh/kg</td>
</tr>
<tr>
<td>4.</td>
<td>Stress Release Treatment</td>
<td>0.25 kWh/kg</td>
<td>0.13 kWh/kg</td>
</tr>
</tbody>
</table>

Reduction in Air Consumption

Before : Open Air Pipe for Cleaning

After : Air Blow Gun Provided at (10 Location)
Reduction in Power Consumption  
(Centralize Lighting)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>High Incoming Voltage</td>
<td>250 V</td>
<td>205 V</td>
</tr>
</tbody>
</table>
## Material Flow Cost Accounting

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>MFCA Solution Description</th>
<th>Type of Benefit and Quantification (Material/Energy/Resource/Environment)</th>
<th>Investment (Rs.)</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Simple Payback Period (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>(A) Plant lighting voltage reduced by 250V to 205V. (By setting Lighting transformer tap) (B) 250W HPMV Lamp replaced by 23W CFL. (In tunnel, Walkway, and in plant where low intensity lighting required) - 30 Nos.</td>
<td>- Lighting energy consumption reduced from 30,000 units to 13,500 units (16,500 units saved) per month. - Lamp, choke, capacitor consumption reduced.</td>
<td>(A) NIL</td>
<td>12,48,000/-</td>
<td>10 Days</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(B) 30,000/-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>(A) Air compressor location changed. (B) Air blow gun provided at open air point.- 10 Points. (C) Air leakage stopped. (D) Pressure setting reduced from 7.2 kg/cm2 to 6.9 kg/cm2.</td>
<td>- One 340 CFM compressor stopped. - Energy consumption reduced from 85,000 units to 55,000 units (30,000 unit saved) per month.</td>
<td>(A) 2, 50,000/-</td>
<td>24,00,000/-</td>
<td>45 Days</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(B) 20,000/-</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Short Term MFCA Solutions (to be implemented within 6 months)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Gas consumption to be eliminated by furnace heat recovery system.</td>
<td>-Gas consumption will be nil for hot air generation.</td>
<td>15,000/-</td>
<td>15,50,000/-</td>
<td>4 Days</td>
</tr>
<tr>
<td><strong>Medium Term MFCA Solutions (to be implemented between 6 to 18 months)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Heat losses to be reduced in shell core heater plate by providing heat insulation.</td>
<td>-Shell core energy consumption will be reduced.(Approx. 5000 units per month) -Heater life will be increased.</td>
<td>25,000/-</td>
<td>3,90,000/-</td>
<td>27 Days</td>
</tr>
</tbody>
</table>
10.5 RESULTS

The results indicate that by the adoption of MFCA in the company, has resulted in generation of environmental, economic and social benefits to the unit. Thus, the company has an overall annual savings of Rs. 1,74,17,496 (Rupees One Crore Seventy Four Lakh Seventy Thousand Four Hundred Ninety Six Only). The overall MFCA findings are mentioned hereunder;

<table>
<thead>
<tr>
<th>COST</th>
<th>Unit</th>
<th>Material</th>
<th>Energy</th>
<th>System</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before MFCA Implementation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Product</strong></td>
<td>Rs.</td>
<td>34,133,957.7</td>
<td>6,671,032.5</td>
<td>3,491,377.0</td>
<td>44,296,367.1</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>95.54</td>
<td>95.54</td>
<td>95.54</td>
<td>95.54</td>
</tr>
<tr>
<td><strong>Material Loss</strong></td>
<td>Rs.</td>
<td>1,593,442.0</td>
<td>311,417.3</td>
<td>162,984.5</td>
<td>2,067,843.8</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>4.46</td>
<td>4.46</td>
<td>4.46</td>
<td>4.46</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>Rs.</td>
<td>35,727,399.7</td>
<td>6,982,449.7</td>
<td>3,654,361.5</td>
<td>46,364,210.9</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COST</th>
<th>Unit</th>
<th>Material</th>
<th>Energy</th>
<th>System</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>After MFCA Implementation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Product</strong></td>
<td>Rs.</td>
<td>36,618,748.3</td>
<td>7,517,911.9</td>
<td>4,261,468.5</td>
<td>48,398,128.7</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>96.21</td>
<td>96.21</td>
<td>96.21</td>
<td>96.21</td>
</tr>
<tr>
<td><strong>Material Loss</strong></td>
<td>Rs.</td>
<td>1,442,522.1</td>
<td>296,153.1</td>
<td>167,872.0</td>
<td>1,906,547.2</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>3.79</td>
<td>3.79</td>
<td>3.79</td>
<td>3.79</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>Rs.</td>
<td>38,061,270.4</td>
<td>7,814,065.0</td>
<td>4,429,340.5</td>
<td>50,304,675.9</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>
11.0  MFCA CASE STUDY OF M/s SOMANY CERAMICS LTD., KADI

11.1  INTRODUCTION

Established in the year 2012-13, M/s Somany Ceramics Ltd., located at Kadi, Gujarat, India is engaged in the manufacture of product(s) such as Floor and Wall Ceramics Glazed Tiles, with annual production capacity of approximately 60 lakhs sq. meter. The company is an ISO 9000, 14000, certified company. The company has won awards such as Power brand, About 860 employees are working in the organization and runs Roun o’Clock hours each day.

The MFCA expert from Japan, Mr. Hiroshi Tachikawa, along with NPC officials have undertaken seven number of visits to the company during 19th June 2012, 6th September 2012, 12th December 2012,12th March 2013, 12th July 2013, 10th September 2013 and during December 2013 respectively. During his visits to the company, detailed material flow cost accounting model was developed, depicting all the input resources, processes and material losses along with their quantification. Based on which, MFCA solutions were arrived at, in consultation with MFCA expert from Japan, NPC officials, company personnel and are implemented. The adoption of MFCA in the unit has resulted in Capacity Building of plant personnel and made officials understand their process particulars in a better way. Further, MFCA has resulted in reduced consumption of resources with improved environmental and energy performance and improved productivity.

11.2  PROCESS DESCRIPTION

The brief process description is mentioned below;

i. Preparation of Dust (Body Materials) for Press input from different Clays and Minerals with Wet Grinding Process

ii. Preparation of Green Tiles from dust prepared by pressing.

iii. Preparation of Glaze, Engobe & color Paste from different Frits, Clays and Minerals.

iv. After application of Glaze with print, firing in kiln.

v. Glazed fired tiles send to Sizing, Sorting & Packing according to quality Norms.

Flow Chart for Floor Tiles:
Material Flow Cost Accounting

- BALL MILL
- Storage Tank
- SPRAY DRYER
- Dust Storage Silos
- Printing
- GLAZE Application
- ENGOBE Application
- Pressing
- Predyer
- Kiln
- Squaring & Chamfering
- Sorting/QA Check
- ware housing for Despatch.
- Packing
3.0 MATERIAL FLOW COST ACCOUNTING

FLOW CHART FOR FLOOR TILE

SOMANY CERAMIC LTD.

FLOW CHART FOR FLOOR TILE

- GLAZE MATERIAL
- GLAZE MILL 2 NOS
- GLAZE AGITATOR
- SCREENING
- GLAZE VAT
- MAGNET
- GLAZING LINE 3 NOS
- ROLLER KILN (PIN) 2 NOS
- WAREHOUSE PACKING
- SELECTION TABLE
- SIZING AND CHAMFERING
- DUST SILO 6 NOS
- SCREENING
- DRIER 1 FTP: 1 HORIZONTAL 2 FTP: 2 VERTICAL
- TIE PRESS 2 NOS
- FEED TANK 2 NOS
- SCREENING
- SCRAPER BLUNGER 1 NOS
- STORAGE ARC 4 NOS
- BALL MILL 4 NOS
- SCREENING
- GREEN GLAZE BISCUIT DUCT FROM FILTRATION UNIT
- BODY RAW MATERIAL GODOWN + BISCUIT PITCHER

Fig. 2: MFCA Chart prepared before Implementation dated 6th September 2012.
11.3 MATERIAL FLOW COST ACCOUNTING FLOW MODELS

A. MFCA Chart prepared before Implementation dated 6th September 2012.
B. MFCA Chart prepared after and during Implementation dated 31st October 2012.
11.4 PHOTOGRAPHS OF MFCA SOLUTIONS

Annexure B:

New System is in house designed & developed for higher size granule on line grinding roller machine for direct use, earlier higher granule material was recycled by Scrap Blunting
Annexure: C

New Used Low cost Tyre Sealing for Wet Grinding Ball mill use, earlier minor spillage found during Grinding.
Annexure: D

In Press Dust feeding System limit setting change for movement according to requirement of Size if tiles to be press to avoid excess dust loss, Earlier it remains fix.
Annexure: E

Defected Tiles at Kiln Exit collected in Closed Box earlier, now Collected on pallet for defect analysis to reduce the Gloss Pitcher loss.
### 11.5 MATERIAL FLOW COST ACCOUNTING ASSESSMENT

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>MFCA Solution Description</th>
<th>Type of Benefit and Quantification (Material/Energy/Resource/Environment)</th>
<th>Investment (Rs.)</th>
<th>Annual Monetary Savings (Rs.)</th>
<th>Simple Payback Period (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Deflocculants consumption &amp; Cost reduced by modifying body composition from 7 Clays to 4 clays, Overall body cost reduced in last two months September 2013 and October 2013. It also continues from December 2013 onwards</td>
<td>Deflocculant cost is reduced. Annexure: F</td>
<td>Process I/P Change</td>
<td>69.12 Lakhs</td>
<td>Immediate</td>
</tr>
<tr>
<td>2</td>
<td>Glaze reduced from Dipping Departments during months of September 2013 &amp; October 2013.</td>
<td>Quantity reduced by well monitoring and Planning. Annexure: I</td>
<td>Under study</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.a</td>
<td>Slip Spillage of Ball mill avoided during Grinding.</td>
<td>Slip saving by adopting new sealing with waste material: Qty. cumulative effect in final report. Annexure: C</td>
<td>1 Lakh + Monitoring &amp; Control</td>
<td>51.12 Lakhs</td>
<td>Immediate</td>
</tr>
<tr>
<td>3.b</td>
<td>One system is invented: for Online Bigger size Dust Granule Grinding and Direct convert at usable level at Press. This is the First time in Ceramics Industries.</td>
<td>Recycling eliminated Qty: cumulative effect in final report. Annexure: B</td>
<td>1 Lakh + Monitoring &amp; Control</td>
<td>51.12 Lakhs</td>
<td>Immediate</td>
</tr>
<tr>
<td>3.d</td>
<td>Dust Collector flying Dust collected, increased by increase in speed of Suction</td>
<td>Power consumption is increased but environment and loss of fine powder material saved.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sl. No.</td>
<td>MFCA Solution Description</td>
<td>Type of Benefit and Quantification (Material/Energy/Resource/Environment)</td>
<td>Investment (Rs.)</td>
<td>Annual Monetary Savings (Rs.)</td>
<td>Simple Payback Period (Years)</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------</td>
<td>-----------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>3.e</td>
<td>Press Charging System Modified by limiting movement of filler to the charger to avoid spillage.</td>
<td>Save excess material spillage loss.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annexure: D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Green Glazed Pitcher Reduced.</td>
<td>Minor Bad Print Green tiles earlier, Scrap and sent to reprocess, but after knowing the Recycle cost six times higher than Input raw material, It is Sent to final firing application and get reprocess cost saved. Lot of benefited by 3rd &amp; 4th Grading.GGP reduced from 3.43% to 2.81%.</td>
<td>Monitoring</td>
<td>11.19 Lakhs</td>
<td>Immediate</td>
</tr>
<tr>
<td></td>
<td>Annexure: G</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Glaze Scrubbed from wall tiles GGP, used as engobe , floor tiles.</td>
<td>Material saved: DFF: 40.6 ton &amp; FTP: 24.95 for last 10 month.</td>
<td>1 Lakh</td>
<td>14.14 Lakhs</td>
<td>15 days</td>
</tr>
</tbody>
</table>
Annexure F: Reduction of Deflocculant Cost and Quantity by changing Body Composition

<table>
<thead>
<tr>
<th>Period</th>
<th>Body (Cost/MT)</th>
<th>Deflocuent (Cost/MT)</th>
<th>Body Material Cons (MT/Month)</th>
<th>Body Material Cost (Rs. Lakhs)</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Apr to Aug 13</td>
<td>1151</td>
<td>529</td>
<td>10067</td>
<td>169.13</td>
<td>Reference</td>
</tr>
<tr>
<td>Avg. Sept to Oct</td>
<td>1227</td>
<td>407</td>
<td>10650</td>
<td>163.37</td>
<td>3.40%</td>
</tr>
<tr>
<td>Difference</td>
<td>-76</td>
<td>+122</td>
<td></td>
<td>+5.76</td>
<td></td>
</tr>
<tr>
<td>Annual Saving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Annual Saving: 69.12

Annexure G: Saving of Glaze Material and cost due to Reduction of Green Glazed Pitcher Floor & Mono

<table>
<thead>
<tr>
<th>Green Glazed Pitcher Floor Period</th>
<th>Production (Sq. m)</th>
<th>GGP (Sq.m)</th>
<th>GGP %</th>
<th>Glaze Material Saved (Kg)</th>
<th>Cost/Kg (Rs.)</th>
<th>Saving/Month (Rs. in Lakhs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Jan to Mar 13</td>
<td>328087</td>
<td>11643</td>
<td>3.43%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg. Apr to Oct 13</td>
<td>334512</td>
<td>9677</td>
<td>2.81%</td>
<td>2247</td>
<td>41.48</td>
<td>0.93</td>
</tr>
<tr>
<td>Annual Saving</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.19</td>
</tr>
</tbody>
</table>
Material Flow Cost Accounting

Annexure H: Reduction in Scrap Blunger Reprocess for Dust & GGP by 28.14 %

<table>
<thead>
<tr>
<th>Period</th>
<th>Avg. Recycled / Month (MT)</th>
<th>Cost / MT (Power &amp; Fuel) (Rs.)</th>
<th>Reduction %</th>
<th>Saving / Month (Rs. in Lakhs)</th>
<th>Annual Saving (Rs. in Lakhs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Jan to Mar 13</td>
<td>835</td>
<td>1812</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>235</td>
<td>1812</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Annexure I: The residual Glaze return from User Department is reduced, to save material Loss. This practice is started recently (Process is under study)

<table>
<thead>
<tr>
<th>Glaze</th>
<th>Sept' 13 kgs</th>
<th>Oct' 13 kgs</th>
</tr>
</thead>
<tbody>
<tr>
<td>DFF</td>
<td>234096.85</td>
<td>214252.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>451.75</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>0.21</td>
</tr>
<tr>
<td>FTP</td>
<td>189158.14</td>
<td>210485.41</td>
</tr>
<tr>
<td></td>
<td>6249.82</td>
<td>3950.12</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>3.30</td>
</tr>
<tr>
<td>MP</td>
<td>137210.58</td>
<td>96277.61</td>
</tr>
<tr>
<td></td>
<td>3714.30</td>
<td>1645.22</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>2.71</td>
</tr>
<tr>
<td></td>
<td>Reduction in %</td>
<td>1.00</td>
</tr>
</tbody>
</table>
11.6 SOME SNAPSHOTS DURING MFCA EXECUTION
Material Flow Cost Accounting
List of Quantity Centers

- Slip House-Slip Preparation.
- Spray Drying
- Pressing & Drying
- Screen & Glaze preparation
- Glaze line
- Kiln
- Sizing, Sorting & Packing.

• QC.1 Slip Preparation. (Oct.13)

Clays Minerals Defloculant Water (Wet Grinding in Ball Mill.) Material Issue: 4708 MT

Op.Stock: 125MT
Recycle Waste: 415 MT (8.78 %)

Non Recoverable Loss: 66 MT (1.40 %)

Slip House-Slip Preparation

Benefit: Sept 12: 13.87 %
Oct 13: 8.78 %
Reduction: 5.09 %
Savings: Action Sheet

Closing Stock: 106 MT
Homogenous grinded & Mixed Slip for Spray Drying Dept. 5076 MT
• QC.2 Spray Drying (Sept. 12)

Homogenous ground & Mixed Slip 4988 MT

Opening stock: Nil.

Material sent to Recycle: 125 MT (2.5%)

Spray Drying

Non Recoverable Loss: Moisture and Chimney Exhaust: 299 Mt + 75 MT = 374 MT

Closing stock: 340 MT

Granulated Powder Dust sent to Press: 4149 MT

• QC.2 Spray Drying (Oct. 12)

Homogenous ground & Mixed Slip 5076 MT

Opening stock: 425 MT.

Material sent to Recycle: 76 MT (1.5%)

Spray Drying

Non Recoverable Loss: Moisture and Chimney Exhaust: 355 Mt + 76 MT = 431 MT

Closing stock: 400 MT

Granulated Powder Dust sent to Press: 4593 MT

Benefit:
Sept. 12: 2.5%
Oct. 13: 1.5%
Reduction: 1.0%
Savings: Action Sheet
• QC.3 Pressing & Drying. (Sept.12)

Granulated Powder Dust from Spray Dryer 4149 MT
- Opening Stock: 5.0 MT
- Loss Sent to Recycle: 124.48 MT (3%)
- Closing Stock: 8 MT
- Pressed & Dried Tiles sent to Dipping Line 4022 MT

• QC.2 Spray Drying. (Sept.12)

Homogenous Ground & Mixed Slip 4988 MT
- Opening stock: Nil.
- Material sent to Recycle: 125 MT (2.5%)
- Closing stock: 340 MT
- Granulated Powder Dust sent to Press: 4149 MT

Non Recoverable Loss Moisture and Chimney Exhaust: 299 Mt + 75 Mt = 374 MT
**QC.2 Spray Drying (Oct.12)**

- Non Recoverable Loss: Moisture and Chimney Exhaust: 355 MT + 76 MT = 431 MT
- Opening Stock: 425 MT
- Material sent to Recycle: 76 MT (1.5%)
- Closing Stock: 400 MT
- Granulated Powder Dust sent to Press: 4593 MT

**Benefit:**
- Sept 12: 2.3 %
- Oct 13: 1.3 %
- Reduction: 1.0 %
- Savings: Action Sheet

**QC.4 Glaze Preparation (Sept.12)**

- Frit De flocculent Minerals Clays Water (Wet Grinding Process) 250 MT
- Opening Stock: 43 MT
- Glaze Loss: 2.5 MT (1.01 %) Loss.
- Closing Stock: 46 MT
- Sent To Dipping Dept for Application 245 MT.

- ETP Process For Reuse as Body Material
**QC.5 Glaze Line (Oct.13)**

- DriedTiles From Pressing & Drying: 4501 MT
- Opening Stock Glaze material: 14.8 MT
- Green Glaze Pitcher Loss GGP Recycled: 134 MT (2.83%)
- Closing Stock Glaze Material: 5 MT

Glaze & Screen Preparation: 235 MT

Glazed and Printed tiles to Kiln: 4611 MT

**Benefit:**
- Sept 12: 60%
- Oct 13: 2.83%
- Reduction: 3.17%
- Savings Action Sheet

**QC.4 Glaze Preparation (Oct.13)**

- Frit De flocculent Minerals Clays Water (Wet Grinding Process): 227 MT
- Opening Stock: 55 MT
- Glaze loss: 2.36 MT (1.3%) Loss
- Closing Stock: 45 MT

Glaze Preparation

- ETP Process For Reuse as Body Material

Sent To Dipping Dept. for Application: 235 MT.
**QC.4 Glaze Preparation (Sept. 12)**

- Frit & De-flocculent Minerals
- Clays & Water (Wet Grinding Process) 250 MT

**Glaze Preparation**

- Opening Stock 43 MT
- Glaze Loss 2.5 MT (1.01% Loss)

**ETP Process For Reuse as Body Material**

- Closing Stock 46 MT
- Sent To Dipping Dept. for Application 245 MT

---

**QC.2 Spray Drying (Oct. 12)**

- Homogenously ground & Mixed Slip 5076 MT

**Spray Drying**

- Opening Stock 425 MT
- Material sent to Recycle: 76 MT (1.5%)

**Benefit:**
- Sept. 12: 2.5%
- Oct. 13: 1.5%
- Reduction: 1.0%
- Savings: Action Sheet

- Closing Stock: 400 MT
- Granulated Powder Dust sent to Press: 4593 MT
• QC.3 Pressing & Drying (Sept. 12)

- Granulated Powder Dust from Spray Dryer 4149 MT
- Opening Stock: 5.0 MT
- Loss Sent to Recycle: 124.48 MT (3%)
- Closing Stock: 8 MT
- Pressed & Dried Tiles sent to Dipping Line 4022 MT

• QC.2 Spray Drying (Sept. 12)

- Homogenous Ground & Mixed Slip 4988 MT
- Opening stock Nil.
- Material sent to Recycle: 125 MT (2.5%)
- Closing stock: 340 MT
- Granulated Powder Dust sent to Press: 4149 MT
- Non-Recoverable Loss Moisture and Chimney Exhaust: 299Mt + 75 MT = 374 MT
• QC.2 Spray Drying. (Oct.12)

Non Recoverable Loss
Moisture and Chimney
Exhaust: 355Mt+76
MT=431 MT

Spray Drying

Homogenous ground &
Mixed Slip
5076 MT

Opening stock: 425 MT.

Material sent to Recycle: 76
MT (1.5%)

Benefit:
Sept. 12: 2.36%
Oct. 13: 1.85%
Reduction: 1.0%
Savings: Action Sheet

Granulated Powder Dust
sent to Press:
4593 MT

• QC.4 Glaze Preparation. (Sept.12)

Frit
Deflocculent
Minerals
Clays
Water
(Wet
Grinding
Process)
250 MT

Opening Stock 43 MT

Glaze Preparation

Glaze loss
2.5
MT (1.01%)
Loss.

ETP Process For Reuse as
Body Material

Closing Stock 46 MT

Sent To
Dipping Dept.
for Application
245 MT.
QC.6 Kiln (Oct. 13)

Ignition Loss—Normal Loss—Non recoverable: 271.19 MT (6.2%)

Green Glaze tiles from Dipping for Firing: 4611 MT

Kiln-Firing Process

Opening Stock: 7.02 MT

Closing Stock: 3.79 MT

Glost Fired Tiles sent to Sizing and Sorting Dept.: 4344 MT

QC.7 Sizing and Sorting (Sept. 12)

Glost Pitcher: 75.21 Mt (2%)

Glost Fired Tiles sent to Sizing and Sorting Dept. from Kiln: 3760.65 MT

Sizing & Sorting Process

Opening Stock: 5 MT

Powder scrap during Sizing: 115 MT (3.25%) (Recycled)

Closing Stock: 33.30 MT

Net Packed Products: 3542 MT.
• QC.4 Glaze Preparation (Sept.12)

- Frit De flocculent Minerals Clays Water (Wet Grinding Process) 250 MT
- Opening Stock 43 MT
- Glaze Preparation
- Glaze loss 2.5 MT (1.01%) Loss.
- Closing Stock 46 MT
- ETP Process For Reuse as Body Material
- Sent To Dipping Dept. for Application 245 MT.

• QC.2 Spray Drying (Oct.12)

- Homogenous ground Mixed Slip 5076 MT
- Opening stock: 425 MT.
- Spray Drying
- Material sent to Recycle: 76 MT (1.5%)
- Closing stock: 400 MT
- Non Recoverable Loss: Moisture and Chimney Exhaust: 355MT+76 MT=431 MT
- Granulated Powder Dust sent to Press: 4593 MT

Benefit:
- Sept.12: 2.5%
- Oct.13: 1.5%
- Reduction: 1.0%
- Savings: Action Sheet
QC.7 Sizing and Sorting. (Oct.13)

Glost Fired Tiles sent to Sizing and Sorting Dept. from Kiln 4344 MT

Sizing & Sorting Process

Opening Stock: 12.3 MT

Powder scrap during Sizing: 112 MT (2.58 Mt Recycled)

Closing Stock: 26 MT

Net Packed Products: 4148 MT

Glost Pitcher: 69 Mt (1.6%)

Benefit:
Sept 12: 2.0%
Oct 13: 1.6%
Reduction: 0.4%
Savings: Action Sheet
Glaze Material Loss Reduced.

- Glaze Scrubbed from wall tiles GGP, used as engobe for floor tiles.
- Material saved: DFF: 40.6 ton & FTP: 24.95 for last 10 month.
- Investment: Rs.1 Lacs.
- ROI: 15 Days.
Green Glazed Pitcher loss Reduced.

- Minor Bad Print Green tiles earlier, Scrap and sent to reprocess, but after knowing the Recycle cost, six times higher than Input raw material, It is Sent to final firing application and get reprocess cost saved. Lot of benefited by 3rd & 4th Grading. GGP reduced from 3.43% to 2.81%
- Savings: 11.19 Lacs/Annum.

Reprocess Reduced

- Cumulative action for One line Big Granule Grinding system, Monitoring GGP control at All Probable points and Press Charger limit adjustment to avoid Spillage of Dust material Results in to reduction in Reprocess:
  - Investment: 1 Lacs + Monitoring and Control.
  - Savings: Rs. 51.12 Lacs./Annum.
11.7 RESULTS

The results indicate that by the adoption of Green Productivity practices such as MFCA in the company results in generation of environmental, economic and social benefits to the company. Thus, by an investment of Rs.2,00,000/- (Rupees Two Lakhs only), the company has an overall annual monetary savings to the tune of Rs. 1,45,00,000/- (Rupees One Hundred and Forty Five Lakhs only), providing immediate payback. In addition, to implement and practice MFCA, the company has started UDAN (Kaizen) drive to collect the precious suggestion from all Stakeholders to improve overall productivity of process in the plant: About 175 Suggestions/Kaizens were gathered of which the company has implemented 93 suggestions & 20 suggestions are under study for consideration.
12.0 MFCA CASE STUDY OF M/s BARODA MOULDS AND DIES, VADODARA

12.1 INTRODUCTION

Established in the year 1990, M/s Baroda Moulds and Dies located at 48 and 30, 31, 32, GIDC Estate, Waghodia, District Vadodara, Gujarat, India is engaged in the manufacture of product(s) such as Epoxy Resin Cast Insulators, Bushings & other Epoxy Moulded Components, with annual production capacity of approximately 550 Ton approximately. The company is an ISO 9001-2008 certified company. The company has won awards for “Successful implementation of Lean Manufacturing”. About 250 employees are working in the organization and runs 24 hours each day.

The MFCA expert from Japan, Mr. Hiroshi Tachikawa, along with NPC officials has undertaken six numbers of visits to our company. During his visits to our company, detailed material flow cost accounting model was developed, depicting all the input resources, processes and material losses along with their quantification. Based on which, MFCA solutions were arrived at, in consultation with MFCA expert from Japan, NPC officials, company personnel and are/going to be implemented. The adoption of MFCA in our unit has resulted in Capacity Building of our personnel and made us understand our process particulars in a better way. Further, MFCA has resulted in reduced consumption of resources with improved environmental and energy performance and improved productivity.

12.2 PROCESS DESCRIPTION

The company is engaged in manufacture and supply of Epoxy Resin Cast Insulators, Bushings & other Epoxy Moulded Components & our manufacturing process is as under

Step-1 Preparation of Epoxy Mix (Ingredients Resin, Hardner, Silica Powder, Pigment)

Step-2 Clamping of moulds on APG (Air Pressure Gelation) clamping machine

Step-3 Injection of Epoxy material in the moulds through air pressure

Step-4 Keep the Epoxy in the Mould with certain degree of temperature to allow it to gel, that is, gelation process

Step-5 De-moulding the component

Step-6 Post curing for 10-12 Hours @140o C-150o C

Step-7 De-flashing, removing of parting lines, finishing & color touching

Step-8 Final Visual Inspection & Electrical Testing
## 12.3 PROCESS INPUT RAW MATERIAL, STORAGE & WASTAGE

<table>
<thead>
<tr>
<th>Input Raw Materials</th>
<th>Wastage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Resin</td>
<td>1. Epoxy Mix Wastage</td>
</tr>
<tr>
<td>2. Hardner</td>
<td>2. Copper / Aluminum Conductors</td>
</tr>
<tr>
<td>3. Silica</td>
<td>3. Inserts (Brass / MS / Aluminum)</td>
</tr>
<tr>
<td>4. Pigment</td>
<td></td>
</tr>
<tr>
<td>5. Copper / Aluminum Bars &amp; Flats</td>
<td></td>
</tr>
<tr>
<td>6. Inserts (Brass / MS / Aluminum)</td>
<td></td>
</tr>
<tr>
<td>7. Packing Material</td>
<td></td>
</tr>
<tr>
<td>a. Wooden Box</td>
<td></td>
</tr>
<tr>
<td>b. Corrugated Box</td>
<td></td>
</tr>
<tr>
<td>c. Plastic Strips</td>
<td></td>
</tr>
<tr>
<td>d. Cello Tapes</td>
<td></td>
</tr>
<tr>
<td>e. Bubble Sheet</td>
<td></td>
</tr>
<tr>
<td>8. Machine Parts</td>
<td></td>
</tr>
<tr>
<td>a. Oil Seals</td>
<td></td>
</tr>
<tr>
<td>b. Washers</td>
<td></td>
</tr>
<tr>
<td>c. Nut &amp; Bolts</td>
<td></td>
</tr>
<tr>
<td>9. Oil</td>
<td></td>
</tr>
<tr>
<td>a. Cutting Oil</td>
<td></td>
</tr>
<tr>
<td>b. Cooling Oil</td>
<td></td>
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<tr>
<td>c. Transformer Oil</td>
<td></td>
</tr>
</tbody>
</table>
12.4 BENEFITS DERIVED BY IMPLEMENTING MFCA

Reduction in Waste

a. Reduce waste of Epoxy Mix...

Before MFCA

i. Manual Epoxy Mixing & Dispensing arrangement
ii. More travelling time is needed
iii. Waste increases due to non-homogeneous mix
iv. Lesser output because of time constraint
v. More Rejection ratio of final component because of non-standardized operating systems

After MFCA

i. Installation of Hedrich Plant for Automatic Metering, Mixing & Dispensing of Epoxy Mix
ii. Reduces travelling time
iii. Waste reduces due to homogeneous mix
iv. Output increased because of time saving
v. Reduce rejection ratio from 4% to 3% approx...
b. Reduce Waste of Copper/Aluminum Conductors

Before MFCA

i. Waste of Copper / Aluminum generated due to more tolerance given for cutting & machining activities

ii. Normally we take 5mm to 7mm cutting tolerance length

After MFCA

i. We reduce the cutting tolerance from 5mm to 7mm to 3mm to 4mm

ii. We could able to save INR 1,95,000/- p.a. material cost

iii. Saving in material would be around 500 Kgs. P.a.
Reduction in Process & Labour Cost

c. Reduce Process Cost...

Before MFCA

i. We used to process material mixing & dispensing on manual basis

ii. Process time from material mixing to feeding on to the machine is more because of manual traveling of material

iii. Normal time for material mixing to final dispensing is around 2 Hrs.

iv. No any consistency in material quality

After MFCA

i. No any manual procedure is required for material measuring, mixing & dispensing

ii. Because of Automatic process, lesser travelling time is required

iii. Normal time for material mixing to final dispensing is around 2 Hrs.

iv. Consistent material quality
d. Reduce Labour Cost...

Before MFCA

i. We used to employ 10 persons for epoxy material processing
ii. Total salary payable was around INR 91,000 per month

After MFCA

i. Now, we used to employ 06 person for automatic plant
ii. Total salary payable was around INR 54,600 per month
iii. Total salary saved amounting to INR 36,400 per month

12.5 RESULTS

By adoption of MFCA in the company has resulted in generation of environmental, economic and social benefits to the company. Thus, by an investment of Rs. 200,00,000/- (Rupees Two Crores only), the company can achieve an overall annual savings of Rs. 247,00,000/- (Rupees Two Crores Forty Seven Lakhs only), with a simple payback of less than a year.