Technological Innovations and Efficient Operations of Boilers

Electricity sector in India is undergoing transformation. Historically, Indian Power sector had been deficit which is gradually moving towards power surplus market. This is leading to either reserve shut down or partial loading of the thermal power plants. In this scenario, units ranking low in the merit order are bearing the brunt of the market forces. Workshop theme is very much important in the current scenario. Reduction in cost of power by technological innovations and efficient operations is the need of the hour.

Reducing landed cost of fuel by source rationalization is already under implementation. Improving operational efficiency is the topic of the discussion today. This also helps to reduce environment pollution. In view of increasing pollution level and higher emphasis now being placed on environment protection, the operation of thermal power plants shall strive at maximum utilization of heat value of the fuel without any wastage. The situation for thermal power plants has reached to a level of either perform or perish.

The fleet of thermal units is getting older. NTPC has 126 coal based units of capacity ranging from 14 to 800 MW. These units are subjected to ageing of the equipment and performance improvement and sustenance challenge. Further, varied quality of coal and part load operation of the units adds to the lower than design parameters. However, higher efficiency in new units with enhanced steam parameters as well as new control and operating systems has given a lead for improvement in efficiency of equipment in older units even at part load.

Future scenario shall be more challenging as solar power is going to have exponential growth in 13th plan and there is further thrust on increasing share of renewables. Cost of solar power is coming down due to economy of scale whereas extra capital investment to meet new environmental norms in thermal Power plants shall increase thermal cost of power. All this will put tremendous pressure on coal fired power plants operations. This scenario requires for innovations and efficiency of operations at full load and as well as part load operation of the units.

Technology Innovations at Design Level:

Going back to basics, Rankin cycle efficiency improves with improvement in steam cycle pressure and temperatures. Journey of improvement in technology in coal fired plants is more of a step by step rise. However, a jump start was made in sixties in USA, Germany and Russia with steam parameters of 300 KSC pressure and 600°C temperature or more. These designer dreams were restricted by the limitations of material available at that point of time and units faced teething problems of boiler components reliability.

NTPC started its journey with SSTPS 200 MW units with throttle steam pressure of 135 KSC and boiler outlet temperature of 535°C with a designed coal of 4599 Kcal/Kg GCV and 30% ash. In a next step 500 MW units were brought with a throttle steam pressure of 170 KSC pressure and Boiler outlet temperature of 540°C. Designed Unit heat rate improved by approx. 62 Kcal/KWhr.
In next step, Steam parameter improvement was made at with throttle steam pressure of 170 KSC and Main Steam temperature of 540°C and Reheat steam temperature of 560°C. Designed unit heat rate improved by 12 Kcal/KWhr. These improvement in cycle heat rate became marginal as now boilers design shifted from earlier good coal of 4599 GCV to 3500 Kcal/kg GCV with 41% Ash hitting Boiler efficiency by few percents.

By this time subcritical boilers steam parameters reached at plateau with no further improvement in plant cycle efficiency. However, good news for Industry was firm establishment of supercritical boiler technology commercially after initial setback of sixties due to material related failures in units in Advance countries (USA, Germany and Russia). At this time Indian electricity sector also decided to go for a quantum jump in technology to supercritical boiler with steam pressure around 245 KSC and Main Steam temperature 540°C and Reheat Temperature of 568°C. Designed unit heat rate improved by 63 Kcal/KWhr. Improvement in parameters was not only due to improvement in steam parameter but there are improvements in turbine side as well and on control systems and on auxiliaries efficiencies.

These parameters were further raised to 256 KSC pressure and 568°C MS and 568°C RH steam temperature in BRAH stage II and heat rate improved by 80 Kcal/KWhr wrt to last subcritical unit.

Now in new units of 800 MW steam parameters have been further raised to 270 KSC steam pressure and temperature to 600°C/600°C.

From Telengana onwards NTPC has first time gone for Steam parameters beyond 600°C. Designed cycle efficiency is to improve by 8% over subcritical boilers and 3% over earlier supercritical boilers.

Further, NTPC, BHEL and IGCAR are working for development of material for AUSC (Advanced Ultra Super Critical) with steam parameter of 310 KSC and temperature of 710°C/720°C.

I will now share certain best practices being followed for improvement in Performance of OLD Units through Technological Innovations and Efficiency of Operations:

1. Improvement in performance of Milling system and maintain PF fineness on sustained basis.

   A. Improvement in life of Grinding Media
      * Use of Carbide Insert Grinding Rolls: Earlier Ni hard grinding roll used to give life of maximum 1500-2500 hours only there by giving problems of high rejection and high unburnt. Now life beyond 10,000 hours in some of the plants is not an exception.
      * Ceramic lined Classifier inner cone has improved life of mill internals

   B. Use of Modern Tools: Isokinetic sampling to maintain mill fineness and uniform flow distribution in each corner
C. O& M PRACTICES

- Coal piping orifices replacement during overhaul cycle.
- Maintaining mill outlet temperature
- Avoiding cold air to maintain mill outlet temperature.
- Keeping PA header pressure at minimum
- Running mill near its full capacity.

Good upkeep of milling system not only ensures full utilization of mill capacity but also ensures

- Less unburnt in bottom and fly ash
- Less clinkering
- Less metal temperature excursions.

2. Improvement in Performance of Air Preheater System

- Reduce flue gas exit temperature
- Increase APH outlet air temperatures
- Reduce DP across APH
- Reduce seal leakage

Maintaining healthiness of Air-preheater system in high ash Indian coal is a challenging task but it is the most desirable activity to improve boiler efficiency.

3. Improvement in life of Coal Nozzle, Tips and Burner Bends:

4. Combustion Optimization

Modern C&I controls is essential to optimize combustion on sustained basis.

5. STATE OF ART PI DATA MONITORING SYSTEM

All stations, plant data is made available at remote central location to be monitored by domain experts during normal running and unit start Ups.

On line PI data monitoring system is an information deluge which is extremely useful in root cause analysis of failure by expert group at corporate centre and making short term and long term action plans.

6. WATER CHEMISTRY:

Maintaining water chemistry is not only critical from boiler (different for Sub critical and supercritical boilers) component reliability point of view but equally important in once through boiler from turbine side efficiency sustenance.

Extensive use of stainless steel in new boilers have made SCC as one of major threat for reliability of boiler tubes.
7. **INSULATION SURVEY:**

Thermographic or infrared gun scanning is done on periodic basis and insulation is rectified on the basis of insulation audit report.

8. **REDUCTION IN DUCT PRESSURE DROP AND EROSION.**

CFD modelling of the ducts is to be taken up in the units having high erosion rate and duct accumulation in the ducts. Guide vanes with aero profile and erosion protection measures like wire impregnated plastic refractory at erosion prone locations viz: bends and dividers need to be taken up.

9. **MOINTORING OF TUBE METAL TEMPERATURE**

Extensive monitoring of tube metal temperature in pent house, flue gas path and header temperature is need of the hour to ensure reliability of boiler components and maintaining rated parameters.

10. **UTILISATION OF FLUE GAS HEAT:**

Innovations to utilize waste heat of flue gas is being tried. Following pilot projects are under way:

1. Use of Flue gas heat to run 100 Ton VAM plant.
2. Desalination plant of 100T capacity has been commissioned.
3. Feed water heating plant equivalent to 20 MW capacity is under way at TSTPS.

11. **IMPROVEMENT MEASURES DURING UNIT R&M**

1. Improving unit metallurgy to maintain rated unit parameters even with inferior coal when metal temperature goes higher than predicted in original design.
2. Incorporating state of start DDCMIS to ensure better combustion and unit optimization
3. Incorporating VFD drives.
4. Part load operation features with Unit operation with minimum auxiliaries to be built in during any system modification.

12. **Measures to reduce Boiler Tube Leakage**

1. Maximum Metal temperature limits have been defined for each boiler, any excursion is recoded and discussed.
2. Each boiler tube leakage is analyzed and detailed scope of work with unit specific BTL reduction action plan is made.
3. 100 % Radiography of weld joints during Overhaul in boiler.
4. **MPI** is being done extensively at failure prone attachment joints.
5. **Critical water chemistry and operating parameters are being monitored.**

**New Boilers (under construction):**
1. Headers are being inspected by video image scope for any foreign material.
2. Tubes are being checked by thermography camera for any chocking.

**Conclusion:**

In view of the revised environment norms, which are one of the best in the world, compliance will require lot of technological intervention through installation of FGD, NOx control by deploying low Nox burners and/or installation SCR/ SNCR etc. NTPC has already taken up trial of NOx control technology. However, compliance of these will be capital intensive and challenging.

It is not to overemphasize that Change, Up gradation and improving efficiency of operations are the need of the hour in today’s competition driven, cost and environmentally sensitive market. Now, time has come where we must embrace new technological innovations and improve upon efficiency of operations to become leaders in market rather fighting for survival.

Innovations in coal fired plants technologies must be imbibed on wider scale and efficiency of operations to be maintained to design levels to ensure cleaner environment in future also.