# Energy Conservation and Optimization of Boiler Performance
# G.S.F.C's Experience


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## Indian Scenario

The energy demand in India, not surprisingly, is amongst the lowest in the world on per capita basis. However, for a developing country like ours, we run a very high energy bill. That all efforts must be made to conserve energy, is an understatement and even the most modest attempt in this direction is laudable.

Indian industry, in general, has put in little effort to analyze and practice means for efficient energy utilisation. As a result we have lagged too far behind the other developing nations in the field of effective management of energy. The need of the hour is to accord a very high priority to the subject of energy management to ensure that our business become globally competitive.

India suffers a power deficit of the order of 10% (22% at peak loads) for the last several years, and the availability of energy will have a substantial impact on our country's future growth. In order to manage bulk supply of energy, we to accurately know 'Where' & 'How much" energy is being consumed. Whereas to control the same, it is essential to also know why it is being consumed.

Is it surprising that our country has
1% of world's coal reserves
0.5% of world's Oil reserves
0.4% of world/s NG reserves
&

**16% of world's population to feed on it !!**

India's Industrial sector consumes nearly 45% of total power produced. Most Industrial processes in India consume anywhere between 20-40% more energy per unit of output compared to the specific energy consumed in many advanced countries. Industries in India spend between 0.4 and 20% of their turnover on energy, with an average close to 8%. The average saving potential across the nation is 16%, which translates to an astonishing Rs. 60,000 Million per annum. The figures suggest a scope for substantial energy savings at the industrial level.

## Organization

GSFC is a multi-product, multi-location, joint sector corporate giant – the largest integrated fertilizer & petrochemical complex of the country. The company, registered in 1962, with its head quarters at fertilizer nagar, commissioned its Phase-I fertilizer plants in 1967. This included the Ammonia, Urea, and Phosphatic group of plants. The Phase-II Ammonia and Urea plants are in operation since 1969. Phase-III comprising of the Petrochemical and Industrial product sector, was implemented during the Sulphuric Acid, Caprolactam, Melamine, Nylon-6, Argon and the MEK Oxime plants. Subsequent expansion/ diversification include the coastal DAP Unit at Sikka. Polymer Unit at Jawaharnagar Baroda. Fibre Unit near Surat at 50,000 MTPA caprolactam plant and cogeneration power and steam plants of 90 MW at Fertilizernagar. All these plants are operating extremely well contributing to total turnover of 2053 crore in the year 1999-2000 where energy component is of the order of 19.5%.

## Energy Conservation

Annual power and fuel consumption for the year 1999-2000 is 40.89 million SM3 of gas, 1.3 lac MT of LSHS, and 85 MWH power. Energy available within the complex are various of gases, waste organic liquids, steam from waste heat boilers.

## Energy Conservation Philosophy at GSFC

GSFC operates plants which are highly energy intensive, thereby making it imperative, right from the inception stage, to save energy in all forms.

At GSFC, we believe that Energy Conserved is Energy produced. Thus consistent efforts have been put to realize energy productivity.

For a comprehensive energy conservation program, it is essential to have total participation of employees. Methods need to be evolved to create awareness on energy conservation and to explore new ideas. Again, commitment of the Top-level Management to energy conservation goes a long way to ensure that the energy conservation program fits will within the over-all objectives and structure of the organization.

Once the idea of Energy Conservation is defined, and the audit has established the problem areas. Energy Conservation starts with putting house keeping in order. GSFC has spent more than Rs. 2300 million towards implementation of various energy Conservation.

## Good House Keeping Efforts

Substantial savings of energy and material resources can be achieved through good house keeping efforts which require practically little investments. This can be achieved through of simple rules of monitoring.

- **Condensate Recovery and Recycle:**

  In Ph-II turbine@ 90 TPH (-70%) condensate generated in the condenser is recycled back into the Feed Storage Tank and 30% of fresh polish water is used as make-up, thereby minimizing on the BFW and related chemical consumption.

  All condensate from Low Pressure Heater, Gland Steam Condenser, Ejector is mixed with the condenser condensate and recycled back to Feed storage tank.

  All efforts are made to optimize Blowdown by maintaining good water quality.

  Steam condensate from all plants is either used in respective plant Waste Heat Boilers or is routed to Utility plant were it is used as feed water in medium pressure boilers.

- **Thermal survey:**

  Major energy losses in the thermal system are due to incomplete combustion of fuel due to improper tuning and deterioration of firing equipment's at generation side, surface heat transfer losses due to damaged insulation distribution side as well as escape of steam due to faulty operation of steam traps at user side.

  Energy Conservation Survey of our Urea, Sulphric Acid plants and Yard piping engineering. It revealed that with proper selection and maintenance of steam traps steam conditioning etc. it is possible to save more than Rs. 200 lacs worth energy per year through several small and big modification costing Rs. 85 Lacs.

  Thermal/ Combustion efficiency of both the boilers was recently assessed by third part, it is 90% with almost no scope for further improvements. Insulation survey through Infra red thermography of steam distribution lines using RR thermometer was done long back and had proved to be beneficial. This study will be taken up again to assess thermal losses.

  Recently, we concluded a cooling water system survey in Cogeneration plants, where efficiency of the CW & CCW pumps, FD fans was measured.

  Total saving of about Rs. 1 lacs is estimated by trimming impeller of one pump and optimizing on the running hours of the FD fans.

  Generation of flash steam from condensate in Urea dearation in Waste heat boilers.
  Thus simple good house keeping measures have an insignificant investment and immediate returns. Fine tuning the equipment can help save 5-10% with small investment wherein payback periods may be only a couple of months.

## Combustion Improvement Through Emulsification Additives

For steam boilers using liquids fuels such as LSHS, overall combustion efficiency can be improved by use of emulsifying agent or chemical additives. They ensure better mixing of liquid fuel with air and minimizes deposits on boiler/ heat exchanger tubes. GSFC has successfully applied such emulsification agents in 105 ATA 130 MTPH steam boilers having LSHS firing. Here proprietary emulsifying chemicals are added to LSHS through metered system. Optimization and performance assessment was carried temperature, steam/ neat oil ratios and periodic inspection of boiler internal system. At GSFC oil emulsification is practiced since last 7 years without any problem.

### Benefits:

(i) Average reduction in oil consumption by 4%.
(ii) Improved boiler efficiency.
(iii) Reduced stack temperatures.
(iv) Improved flame pattern.
(v) Improved combustion efficiency, through better atomization.
(vi) Increased Steam/ Oil ratio.

### Estimated Savings:

Saving in fuel @ 4%: Rs. 75600/ day

### Investment

Cost of catalyst: (Rs. 1.50/ litre) = Rs. 13650/ day

### Net Saving:

Rs 410 Lacs Annually for both boilers

### Vapor Treatment for Boiler Water

Untreated water contains several impurities such as lower solubility salts, dissolved gases and suspended particulate matter. These impurities lead to scaling, corrosion and deposit formulation resulting in reduced efficiency, increased operating costs and unscheduled downtime for repairs and maintenance all vapor treatment is the third generation revolutionary zero solid concept in power plant boiler water treatment, offering complete protection to boiler system against deposition, corrosion, carryover, condensate water and pipe corrosion.

### Benefits:

- Replaces three chemicals by a single chemical
  (i) Morpholine
  (ii) Hydrazine
  (iii) Tri Sodium Phosphate
- No additional investment (besides chemical cost) as existing facility will be used for dosing.
- Eliminates problem of High Pressure dosing pump, solution preparation etc.
- In addition it also reduced operational costs as:
  - It reduces blowdown as it does not contribute to any solid addition.
  - substantially saving on costly fuel
  - Realizing precious water
- Reduced downtime

### Estimated savings:

Total saving - 7507 Rs/day

### Investment

(Cost of New chemical)

### Net Savings: 3.5 lacs Annually (Both boilers)

This system is presently under study

### Automatic Blow down control system

In HP boilers the quality of stema needs to be monitored closely so as not to damage expensive and precise machines and processes like heat exchangers and turbines. On the other hand the boiler too has to be run in most efficient manner, keeping the condition of the water at its optimum levels so as to avoid deposition of solids and oxidation of internal heat transfer surfaces. This is achieved by blowing down the boiler, where water from the boiler is purged and replaced by new, clean water.

However non of these methods regulate the levels of the parameters closely and neither do they take into account the variations in the steam load where less/more blow down would actually be required. Also when samples are taken, the temperature of simple is high and the flash steam separates out, leaving a concentrated solution. This gives a higher reading than the actual, thereby leading to a higher blow down than called for. The general philosophy is blow down a little extra to be sage.

**Benefits:**

(i) Automate and accurately control a task that is usually left to judgement
(ii) Blowdown will be only as much as is required and will maintain the value of the parameter close to set point, resulting in substantial fuel savings.
(iii) Saving in fuel (loss of heat energy as the water is heated to its saturation temp)
(iv) Saving in DMW. (treatment cost of water)

**Estimated savings:**

Average blow down (PH-I) – 60 TPD
Total saving – 2656 Rs/day = 8.7 Lacs Annually per boiler

**Investment** - 12 Lacs

Net savings: 6.3 Lacs Annually per boiler.
= 12.6 lacs annually for both boilers.

### Post Operation Chemical Cleaning of Boiler

Water treatment and conditioning technique had to undergo a phenomenal change with the advent of HP boilers. A very high standard of quality is expected in the upkeep of the water chemistry of the power plant. Despite all the care taken, Steam Generator's tubes get effected with Curd Fouling. Though this is an operational process hazard, one can minimize the severity of fouling by meticulous adherence to prescribed operational and maintenance standards. Even then it becomes inevitable to subject the steam generators to periodical post operational chemical leaning.

In GSFC, Ph-I boiler is in operation since 1989 and PH-II since 1990, thereby completing nearly 10 years of service without chemical cleaning.

**Observations:**

(i) R & D's scale analysis report indicated fouling factor in the boiler tubes (>40 $mg/cm^2$) thus falling in very dirty surface category.
(ii) Scale thickness on fire side is between 96.2 to 137 micron and for casting side is between 43.2 to 92.6 micron. Recommended value for chemical cleaning is when scale thickness exceeds 50 micron even if fouling factor is on safer side.

**Benefits:**

(i) Dissolves the normally grown magnetite layer and the overlying deposited debris.
(ii) Enhances heat transfer, thereby preventing overheating and subsequent failure of tubes.
(iii) Decreased superheater outlet temperature

**Investment:**

Cost of chemical cleaning – 6.5 lacs per boiler

### Boiler Performance and Reduction of Auxiliaries Consumption

The biggest consumer of energy is normally power generation plant itself. Out of the total electricity produced nearly 10-13% is consumed by plant auxiliaries like motors & other equipment's. Various methods deployed for optimization of Boiler performance & reduction of auxiliaries consumption in Cogeneration plant are discussed.

### Increase of Resister Draft Loss (Rdl)

GSFC was facing problem of licking of flame in the super heater zone, resulting in longer flame length and higher super heater metal temp. The problem was studied and analyzed in detail and after considering various alternatives the simplest and economical alternative selected was to reduce burner cone diameter for increase of RDL, which in turn resulted in better air to fuel mixing and better combustion of the fuel oil.

**Modification:**

RDL was increased from 125 mm. of WC to 175 mm. of WC, by reducing burner cone diameter.

**Benefits:**

(i) Brighter, shorter flame length
(ii) Considerable increase in combustioefficiency
(iii) Better life of super heaters.
(iv) Reducing breakdown.

### Use of 37 K Steam Instead of 105 K Steam for Soot Blowing Operation

Boiler manufacturer and supplier M/s BHPV had provided a pressure reducing station of 105 $Kg/cm^2$ to 37 $Kg/cm^2g$ and source of steam supply for soot blowing operation was from the up steam of 105 K desuperheater header. Here high pressure steam of 809 kCal/kg enthalpy was used for soot blowing. The soot blowing system was quite inefficient as there was wide pressure fluctuation during soot blowing as the steam was passing through pressure control valve. Moreover we were loosing potential energy to the tune of 63 (809-756) kCal/kg of steam during the soot blowing operation due to throttling of the steam through pressure control valve.

**Modification:**

Use of high pressure steam was discontinued and source of soot blowing steam supply was changed to turbine's 37 K extraction steam line.

**Benefits:**

Additional power generated in TG Unit from 5328 Mt of HP steam = 807000 kWh per year. (Basis 6.6 MT steam required per MW power in 25 MW TG Unit.) Equivalent to Rs. 3 lacs

### Inter connection of make up water system to deaerator.

Two nos of deaerator make up water pumps of 67 kWh each were installed for co-generation Ph-I plant. For Co-generation Ph-II one no. of make up water pump was added in the common header so that pump no. 2 can either be used for co-generation Ph-I or Ph-II. However make up water supply lines staring from the header to deaerators of Ph-I & II were separate. This necessitated operation of on pump per boiler. As per the pump capacity and make up water requirement, one pump was adequate to meet with the requirement.

**Modification:**

Deaerator make up water lines were inter connected and only one pump kept in operation.

**Savings:**

Annual saving of 367000 kWh units. The saving is calculated on the basis of actual power saved. (Reduction in load 80 Amp. X 1.732 X 0.415 X 0.8 X 24 Hours X 333 days). Equivalent to Rs. 2.8 lacs.

### Conservation efforts and future trends

Energy Conservation measures coupled with higher capacity utilization at GSFC has made a significant impact on the energy efficiency of the fertilizer and petrochemical plans. Our energy saving efforts have resulted in a total saving of more than 4 Crore Annually. Most power sectors are busy acquiring, reorganizing downsizing and revamping their cultures for more competitive world. Overall, Energy Conservation efforts have yielded considerable saving in thermal and electric power energy besides improving over-al productivity level.

**Reference book:**

Indian Chemical Engineering Congress 2000
Technical Sessions Transcriptions
Volume I, Calcutta, December 18 – 21, 2000