Write-up on Energy Management at

Kirloskar Ferrous Industries Limited

SBU – PIG IRON PLANT & FOUNDRY

About Kirloskar Ferrous Industries Limited:

Kirloskar Ferrous Industries Limited (KFIL) was born with the unique advantage of having been conceived with ideas accumulated through experience and expertise of the Kirloskar group in the field of foundry business, at a time when the de-licensing and liberalisation policies of the government came forth in the year 1992 resulting in rapid growth in automotive and farm sectors.

The principal products of KFIL are broadly classified as – Grey iron castings and pigiron. Grey iron castings of grades from 20 to 30 are manufactured for various customers in the automotive and farm sectors viz, Mahindra nd Mahindra, Maruti Udyog, TAFE, Escorts, TELCO, Carraro, Punjab tractors etc. Pig iron manufactured in 3 grades supplied to various foundries all over India.

KFIL's state-of-the-art technology was the answer to the high volume demands of these sectors, which requires thin walled castings with very small machining allowance and above all accurate dimensions absolutely essential for machining on sophisticated machining centres in single pass. Being well aware of the fact that only the desired quality of raw material can produce the best castings in cost effective manner, KFIL simultaneously went in for pig iron plant which enabled direct entry of hot metal into foundry, resulting into massive savings on the energy front.

Located at the banks of Tungabhadra reservoir in Karnataka and nearer to the rich iron ore belt of Hospet Bellary range, KFIL, with the philosophy of adopting to new Kirloskar technology, today enjoys many inbuilt advantages. KFIL in fact is all set to deliver castings of international quality to meet the highest level of customer satisfaction. Kirloskar Ferrous Industries Limited, the only foundry in Asia with backward integration to liquid metal, has global capacities to meet high volumes at consistent quality. The company has obtained ISO 9002 ceritification in 1995 and subsequently was cerified for QS 9000 and ISO 14001 in the years 2001 and 2002 respectively.

Process at KFIL:

The Process flow diagram (fig.1) gives you a brief idea of the general manufacturing process in KFIL. The business at KFIL divided into two divisions, one is the Pig iron manufacturing unit (called as "Pig iron SBU" – Strategic Business Unit) and the other is Foundry unit (called as Foundry SBU). The process starts with the manufacture of pig iron. The pig iron division consists of 2 Mini blast furnaces of 250 M^3 working volume each. The raw material for blast furnaces (iron ore, Coke, quartzite, dolomite, manganese and Lime stone) are fed to the furnace. The blowing system absorbs atmospheric air and blows it to the preheating section at a pressure of 1.25 Kg/cm^2 and a volume of approximately 35000 Nm^3/hr. This air is preheated in the preheater section to a temperature of 700 – 750^oC. This hot high pressure air is then blown into the furnace. The air is blow from bottom, while the raw material is fed from top. Because of the hot air following in the counter flow direction, reduction of iron ore takes place. The coke in the raw materials acts as the main fuel to accelerate reduction of iron ore to iron in the form of liquid metal at 1500^oC. The molten metal is then tapped out of the furnace and cast in the form of bricks called as pig. This casting process is carried out in the pig casting machine, where the molten metal is poured onto moulds and sprayed with water, for faster solidification of iron.

Some amount of molten metal is transferred by means of ladles to foundry. This molten metal is transferred onto the induction furnace in foundry, where the metal is prepared for giving it the desired cast iron property, by adding some additives like, ferro-silicon, ferro-manganese, steel scrap. Now cast iron is readily available in liquid state for pouring. The Moulds required for pouring are prepared in an automated moulding line. Sand required for moulding is fed to the moulding machine. This machine compresses the sand on the patterns placed inside moulding boxes, with enormous amount of force. This gives it a proper casting shape. The mould boxes further move down the line to the core setting area. The cores are used to create cavities inside the castings. These cores are made of resin coated sand and is slightly harder than the moulding sand. The cores are prepared in core shooting machines and then shifted to the moulding line. The prepared cores are placed in the mould boxes and the boxes move to the pouring section. The prepared liquid metal is transferred to the pouring unit, where the liquid metal is poured into the mould boxes. These mould boxes are allowed to cool and then the casting is removed from the mould box by shaking it out. The casting in it's rough from is shaped in the shot blasting and fettling section. These castings are finally ready for despatch.

Energy conservation cell:

We are having "Cross Functional Team" and "Quality Circles", which are engaged in energy conservation activities. The team consists of members from various departments, whose work could contribute towards energy conservation.

A "Quality circle" (cross-functional team) functions to identify all opportunities for energy conservation. This team meets regularly, reviews the status of activities and identifies opportunities for improvement. The highlights of meetings are recorded.

Salient Features of "Quality Circles":

We put forward a plan for energy conservation activities, to the "Annual meeting of the Board of Directors". We get budget approval for procuring all necessary equipments required for the activity. The "Quality circles" come together to implement the energy conservation measures. The measures are implemented and results reviewed to check the effectiveness. The "Quality Circles" have implemented the following;

Energy Measurement / Accounting

a) Measurement of electrical energy consumption is carried out on day to day basis and appropriate instruments are placed at consumption points. Flow meters are also in place at all fuel consumption points to keep track of fuel oil consumption.

b) User departments prepare daily power and fuel consumption report. This data is stored in our company's database and maintained by our EDP department. Various reports are extracted from these data, for review and analysis. The consumption is further consolidated and reviewed on monthly basis. The same is presented before the top management, every month. These data are reviewed and used as input for further improvements.

c) Calibration of meters is done as per our schedule in the QMS (Quality Management System).

Energy policy :

Kirloskar Ferrous Industries Ltd has defined it's commitment towards energy conservation in the Environmental Management System (EMS) policy. The policy stated is as follows;

" In accordance with our mission of 'Destined to scale new heights',

We at Kirloskar Ferrous Industries Limited, manufacturers of Pig iron and Grey iron castings, commit to protect and upgrade our environment through:

- *Systematic and cost effective methods for waste management.*
- *Control of all pollutants within prevailing acceptable limits through best available technology resources and periodic reviews enabling continuous improvement.*
- ***Optimal utilisation and conservation of resources through effective recycling and reuse practices.***
- *Compliance of all applicable environmental laws and regulation.*
- *Environmental awareness programmes to all employees through training.*
- *Communication of this policy to interested parties for their participation & involvement into the preservation of our environmental norms."*

Energy conservation activities are planned and taken up under the programmes identified by EMS.

Energy Manager :

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Energy Audit :

A formal electrical energy audit was conducted in 2001 for electrical power consumed downstream and an analysis was done. Our in-house team consisting of engineers from electrical maintenance department conducted this audit. The aim of this audit was to check for the scope of improving system power factor and reducing distribution. As a result we installed HT capacitors for motors of capacity 300 KW and 350 KW. The power factor at these motors was improved from 0.87 to 0.92. This particular project for power factor improvement was carried out as a programme in our Environment management system.

Similarly, opportunities for waste heat recovery were identified during January 2003, by engaging TERI (Tata Energy Research Institute) in auditing all sources for waste heat recovery. Two processes were identified for using the waste heat recovery generated in the preheating section (refer Process Diagram). One was the core drying process and the other was sand drying process, both in foundry. We are in the process of implementing these proposals.

After getting a detailed report from TERI, we engaged a consultant (R. M. Page of Pune) for suggesting the implementation of the waste heat recovery proposals. The project is presently in approval stage.

Constraints:

Our plant is a continuous process plant, with minimum shutdowns. We generally take shutdown of 20 hours every month. This makes it difficult to carry out any such energy conservation projects where lot of time has to be spared for installation. Such long duration shutdowns are taken once in 3 or 4 years. This is the ideal time for carrying out modifications.

Approach :

The targets and norms for energy consumption are decided before preparing annual operating plan. The target in terms of specific power consumption (per tonne of hot metal) is decided, based on which, an annual operating plan is prepared. This is further reviewed, revised and finally approved by top management. The operational parameters are derived from the AOP and monthly targets are decided. The operation is controlled to achieve the monthly targets.

During the year 2003 – 2004 some energy saving and wastage reduction options were considered after having studied the possibility. The options studied were as follows;

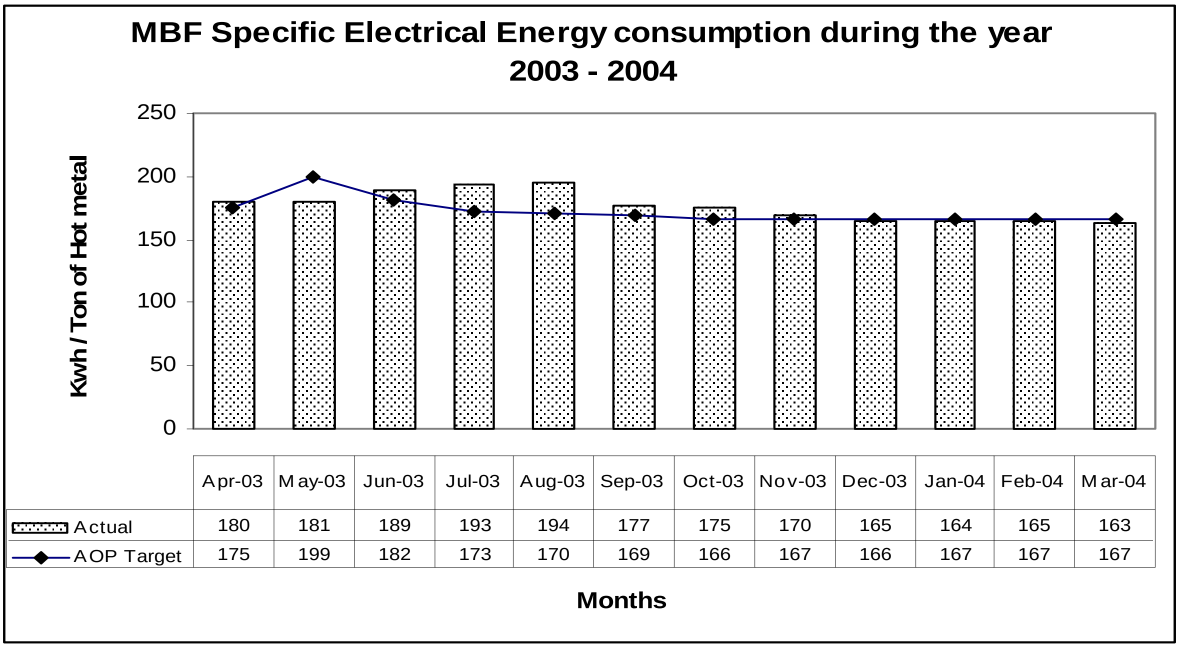
I. Installation of Modified venturis at MBF2
II. Replacement of pump used for Pig casting machine water spray (at MBF1)
III. Auto ignition of Flare stack.
IV. Use of one FD fan for MBP.

These options were studied and then tried. The first two options were implemented, while the third option is in the process of implementation. The fourth option was tried but was not successful. So we are reviewing the action taken. These options have been explained in detail in the later sections.

As stated previously after conducting studies a plan is drawn for improvements. All improvements, which do not require capital equipments, are implemented after being approved by the Department head or Divisional head. However, plans for which substantial investment is needed and that which requires installation of capital equipments, is put up for approval through our capital equipment purchase procedure (Request for appropriation – RFA). This is reviewed and approved by our top management.

Review of achievements during the year 2003 – 2004

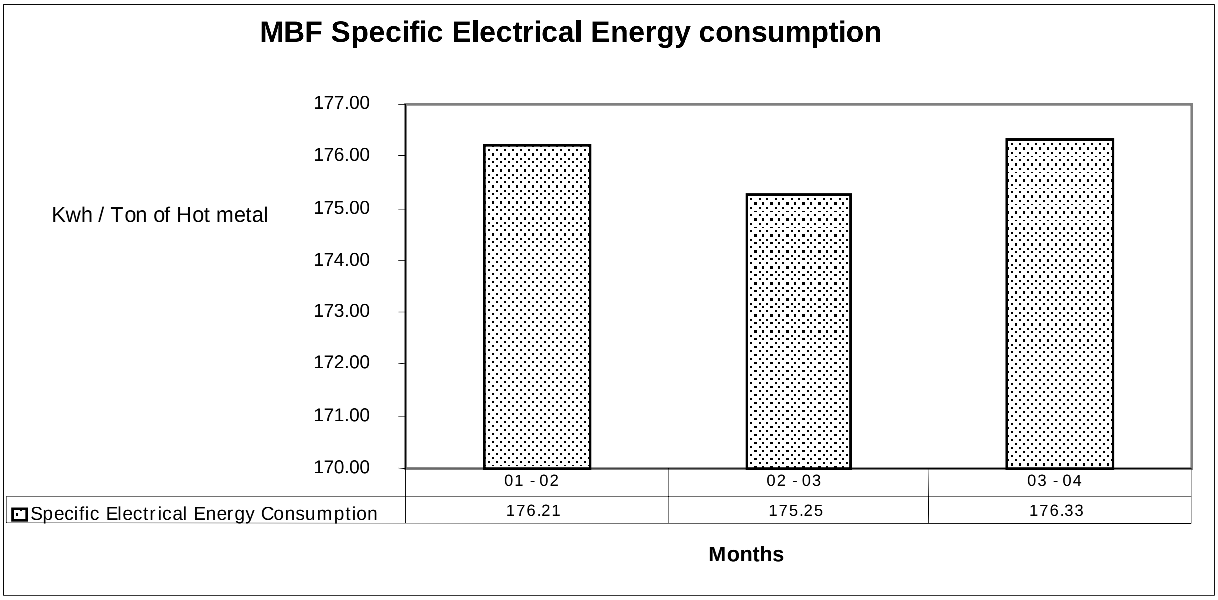
The performance of Pig iron plant in terms of Electrical and heat energy is as shown below;



	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04
Actual	180	181	189	193	194	177	175	170	165	164	165	163
AOP Target	175	199	182	173	170	169	166	167	166	167	167	167

Fig.2

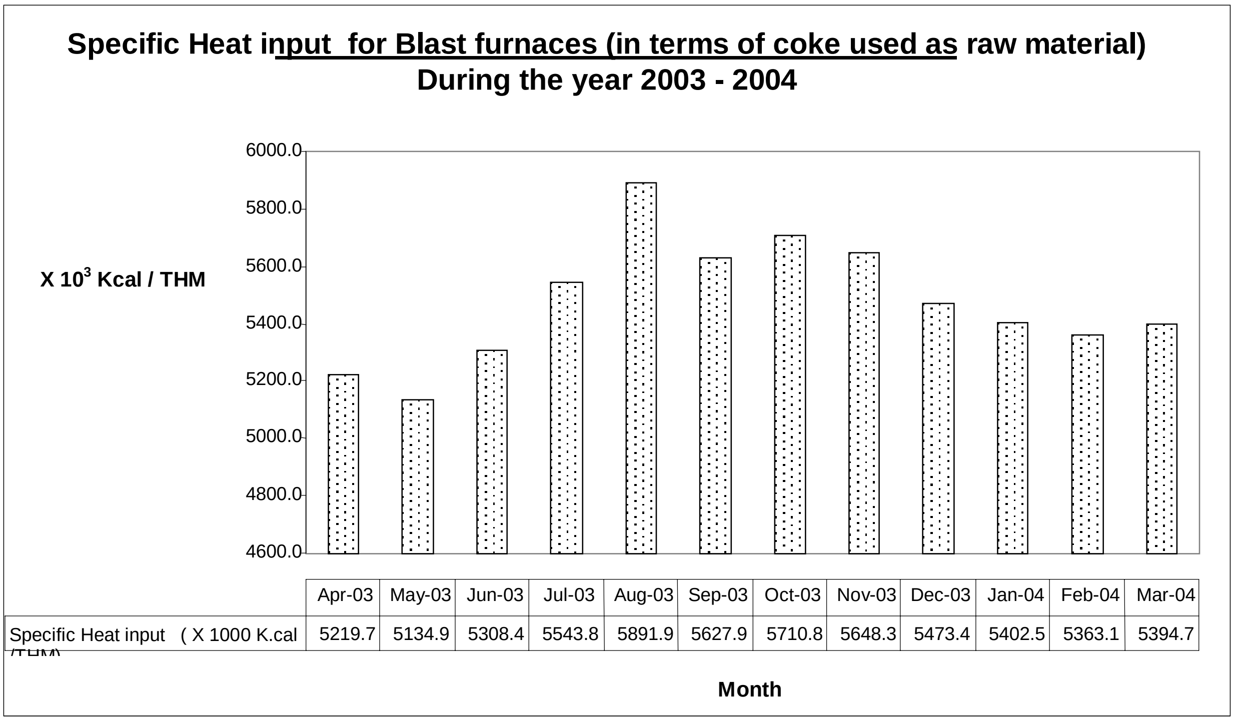
(Note: Variation in consumption in the month of July'03 and Aug'03 is because of MBF2 relining shutdown.)



	01 - 02	02 - 03	03 - 04
Specific Electrical Energy Consumption	176.21	175.25	176.33

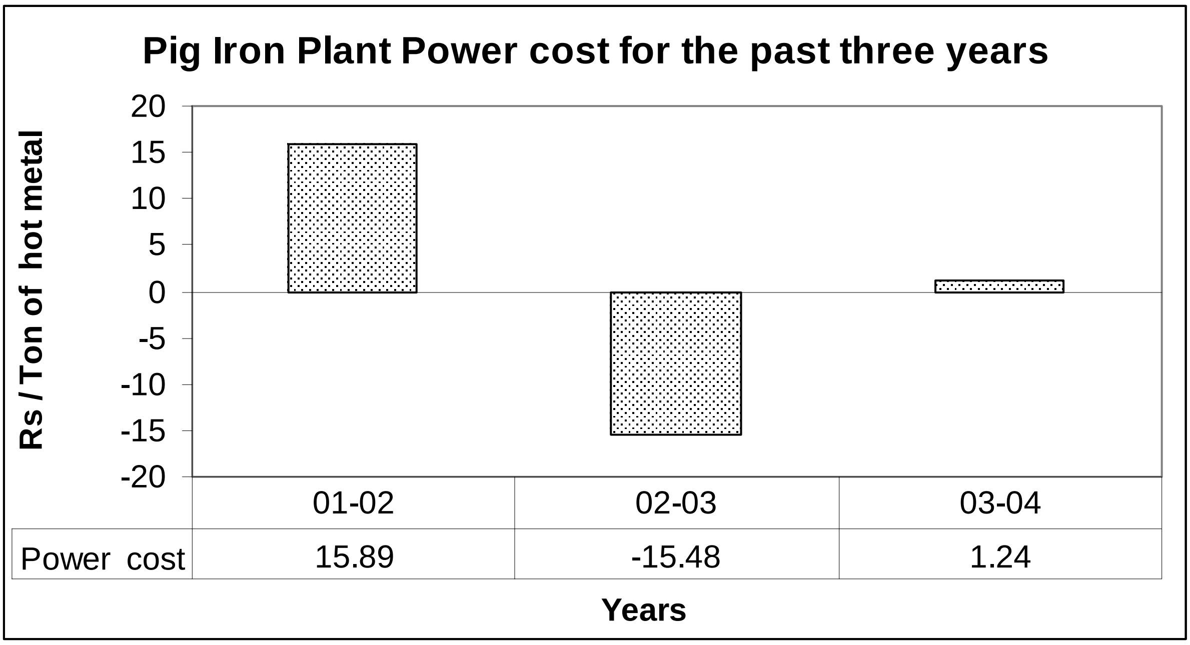
Fig.3

(Note: In the year 01-02 and 03-04 MBF relining shutdown was taken, because of which the consumption was high)



	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04
Specific Heat input (X 1000 K.cal /THM)	5219.7	5134.9	5308.4	5543.8	5891.9	5627.9	5710.8	5648.3	5473.4	5402.5	5363.1	5394.7

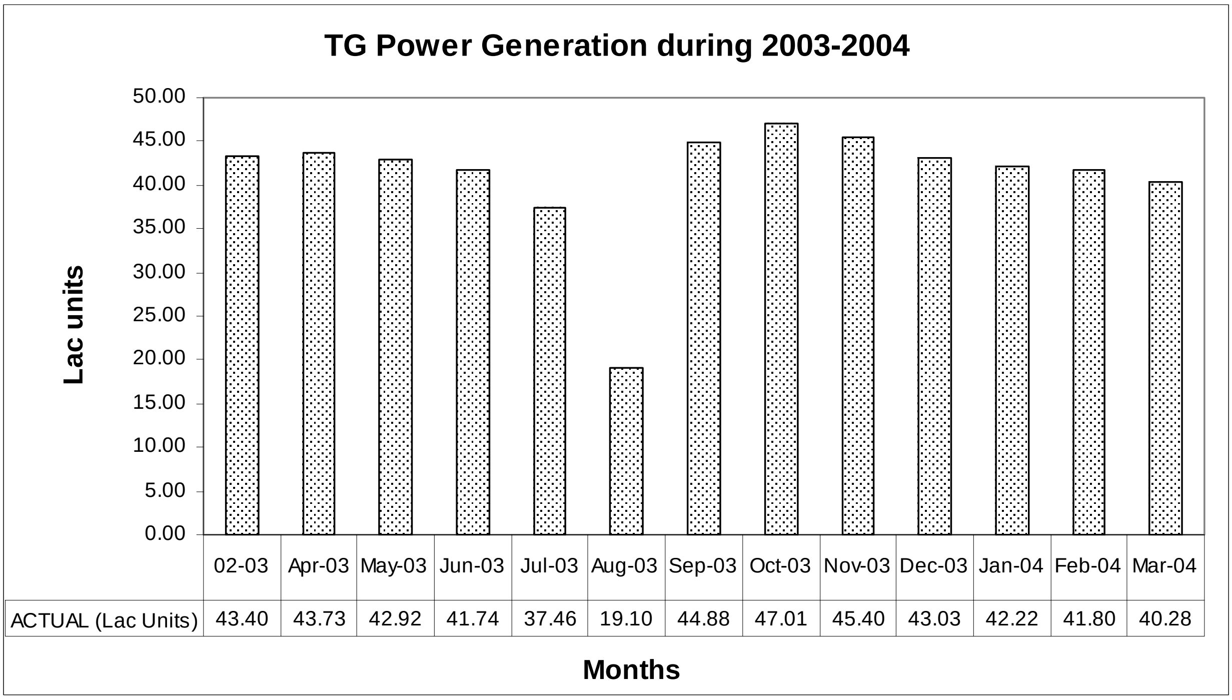
Fig. 4



	01-02	02-03	03-04
Power cost	15.89	-15.48	1.24

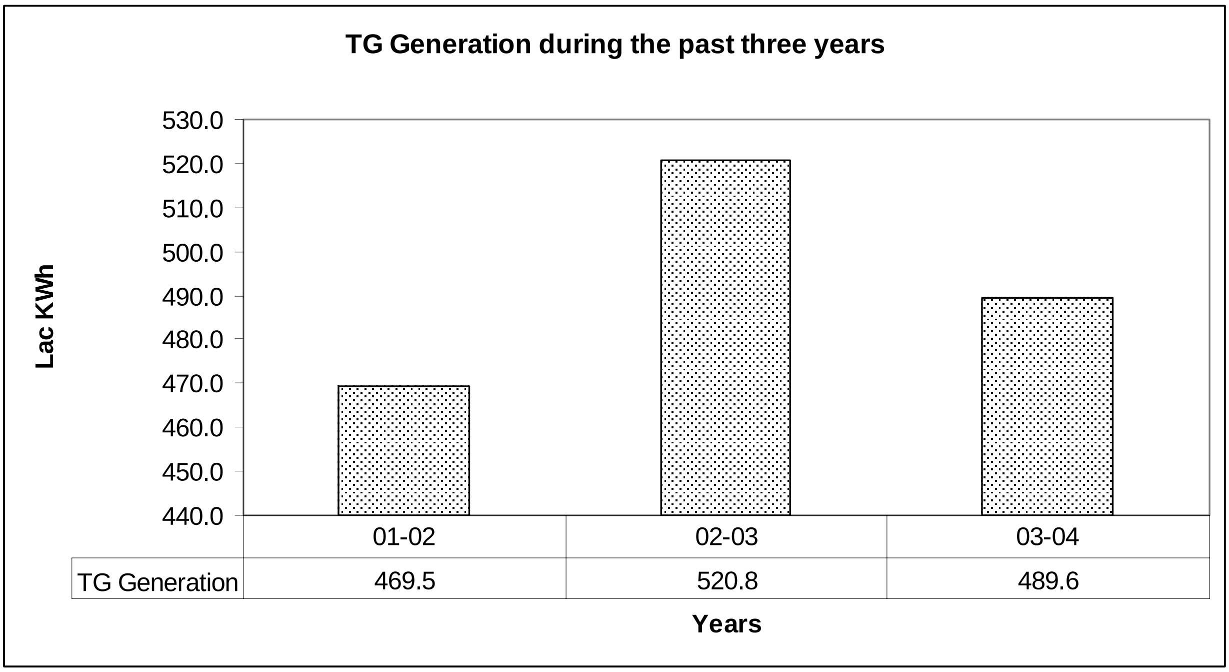
Fig. 5

(Note: Power cost was high during 01-02 and 03-04 as MBF shutdown was taken for relining)



	02-03	Apr-03	May-03	Jun-03	Jul-03	Aug-03	Sep-03	Oct-03	Nov-03	Dec-03	Jan-04	Feb-04	Mar-04
ACTUAL (Lac Units)	43.40	43.73	42.92	41.74	37.46	19.10	44.88	47.01	45.40	43.03	42.22	41.80	40.28

Fig. 6
(Note: Generation was low during July and August as MBF relining shutdown was taken)



	01-02	02-03	03-04
TG Generation	469.5	520.8	489.6

Fig. 7
(Note: Generation is low in 01-02 and 03-04 as MBF shutdown was taken)

A brief write up of the activities that were carried out in 2003-2004 for energy conservation is explained below.

I. Installation of Modified venturis at MBF2:

Brief description of the activity:
The Flue Gas generated by the Blast furnace is rich in Carbon monoxide and can be used as fuel for heating purposes. This gas, in it's impure form is passed through gas cleaning process, where the gas is cleaned and reused for preheating the blast air in Metallic Blast preheater (MBP). This clean gas is also used in power plant's boiler for power generation.

As shown in fig.8, the gas cleaning plant consists of (in sequential order, according to flow of gas);

a) a dust catcher, to trap heavy dust,
b) a saturator, to clean the gas by spraying water in counter flow direction,
c) two venturis to regulate the flow of gas and to determine the cleaning efficiency of gas cleaning plant and
d) Finally a mist eliminator to trap all the residue moisture after the cleaning process.

The venturis play an important role in achieving the desired parameters of the Blast furnace gas. (viz., Dust content of less than 25 mg / Nm^3 and moisture of less than 4% in the gas).

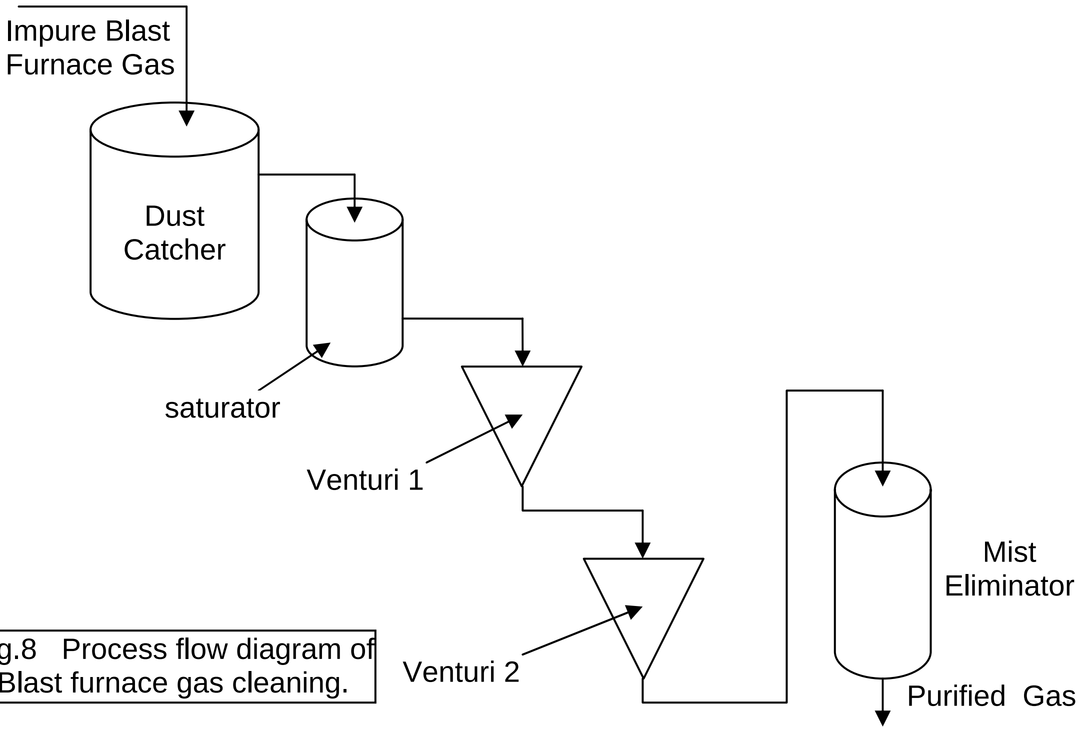


Fig.8 Process flow diagram of Blast furnace gas cleaning.

Problem:
The venturi, originally supplied by Kirloskar AAF ltd, was not performing well to give the desired clean gas. This partially cleaned gas was creating many operational problems, like, inefficient operation of MBP (Metallic blast preheater) leading to higher consumption of Main fuel (Coke) in blast furnace. Similarly, this impure gas deposited thick layers of dust on boiler tubes, reducing the operational efficiency of boiler, thus forcing frequent shutdowns for cleaning boiler tubes.

Corrective action implemented:
The venturis were replaced with modified venturis of Thermax make, during Aug-03. The improvement in performance was apparently seen in terms of clean gas. The table below will show the difference or rather the improvement achieved after this.

Gas parameters		
	Before replacing venturis	After replacing venturis
Dust (in mg / Nm^3)	66 - 112	8.26 – 29.12
Moisture (in %)	24 - 51	1.04 – 3.37

Benefits:

1. The efficient operation of MBP (metallic blast preheater) has lead to the increase of Bustle main temperature (which is the output of MBP). The graph in Fig. 9 clearly shows that there has been an increase of bustle main temperature by atleast 40^{o}C, after the venturi was installed.

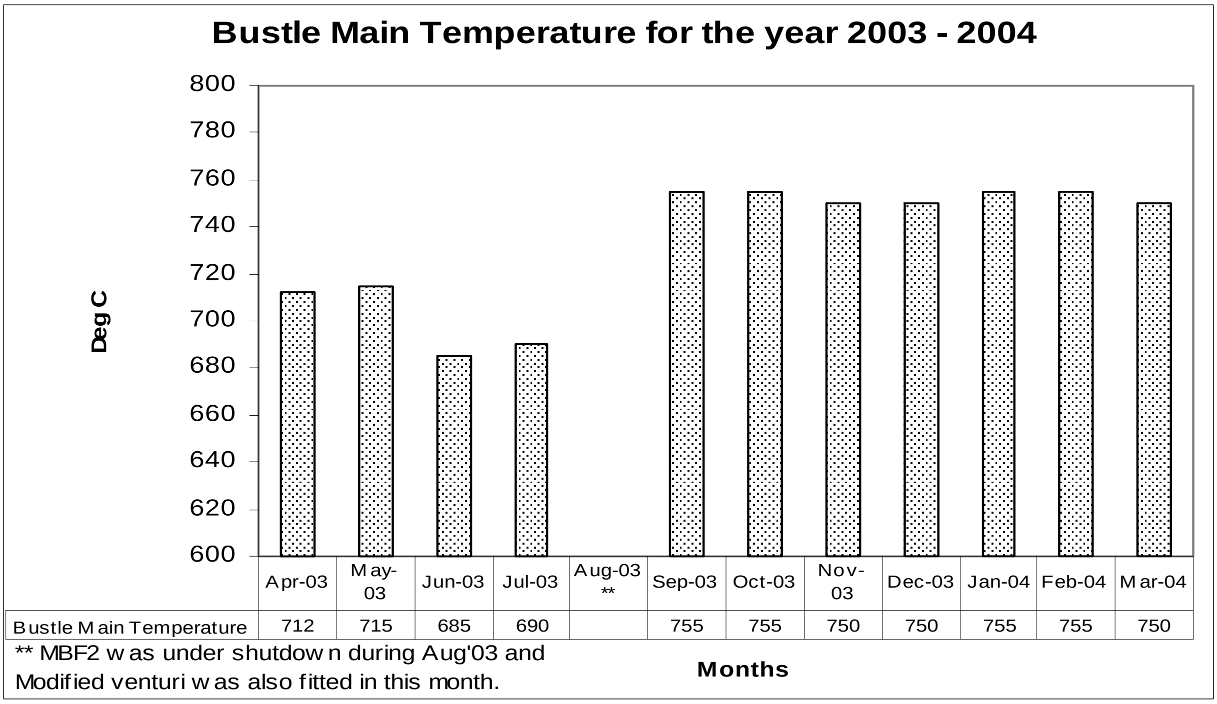


Fig. 9

2. The consumption of Main fuel (Coke) in blast furnace has also come down which is shown in Fig. 10 below.

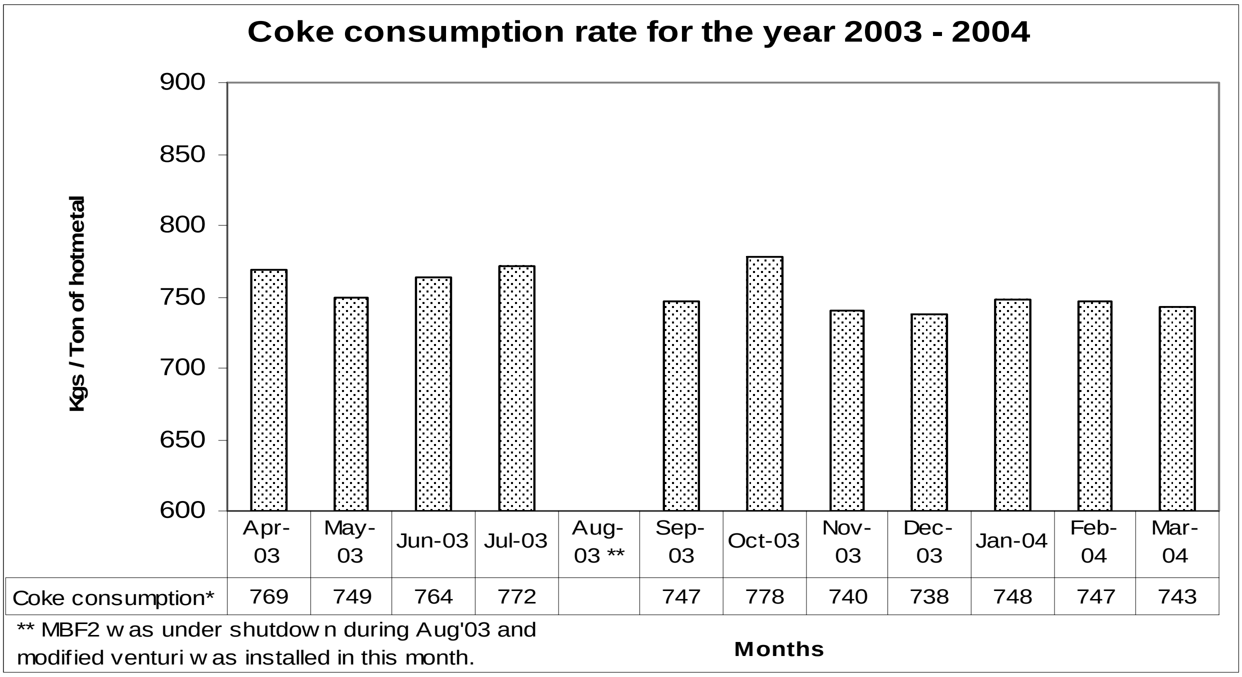


Fig. 10

3. The shutdown hours of Power plant has come down drastically.

II. Replacement of pump used for Pig casting machine water spray (at MBF1)

Brief description of the activity:
The pig iron casting process is carried out on pig casting machine. In this process moulds are fitted on a chain drive and hot metal (liquid metal) is poured on this moulds. These moulds while traveling from one end of the chain to the other end is cooled and solidified by spraying water. One pump is used for the water spraying activity.

Problem:
In the old system a pump of 50 meters head with a capacity of 200 m^3 / Hr was being used. This was driven by a 45 KW electric motor. Most of the power used was wasted in building unnecessary pressure. The system did not demand such a huge capacity pump.

Corrective action implemented:
The pump set was replaced with a lower capacity pump, whose head was 30 meters and capacity was 100 m^3 /Hr. This pump was driven by a 15 KW electric motor. The reduction in power is as tabulated below;

	Before replacing pump	**After replacing pump**
Current (in Amps)	58	16.5
Voltage (in Volts)	430	430
Power (in KW)	**37.58**	**10.69**
Electrical Energy Consumption per day (Pump used for 11 hours per day)	**415 Kwh**	**118 Kwh**

Benefits:
There has been a reduction of energy consumption by 71%, for this particular application, which is quite substantial.

III. Auto ignition of Flare stack

Brief description of the activity:
The gas generated by the blast furnace process is mostly used in preheating or power generation, even after this some excess gas is let out of a stack, to the atmosphere. This excess gas, when being released to atmosphere, is flared by means of a pilot LPG flame.

Problem:
In the existing system the pilot LPG flame is kept on continuously, even if gas is not let out. This leads to wastage of LPG. The daily consumption of LPG is about 3 cylinders per day, which is 57 Kgs of LPG per day.

Corrective action planned:
The existing LPG system will be replaced with an electric ignitor. This electrical ignitor will switch on whenever the flame goes off and will switch off when the flame is on

Benefits:
At present the LPG used per day is costing us Rs. 2,025/- (Rupees two thousand twenty five only). But with Electrical ignitor we will be spending Rs. 650 /- per day (Rupees six hundred and fifty only). This will help in eliminating wastage of LPG. On the other hand we will be using electrical energy which is more efficient than the thermal energy of LPG.

IV. Use of one FD fan at MBP

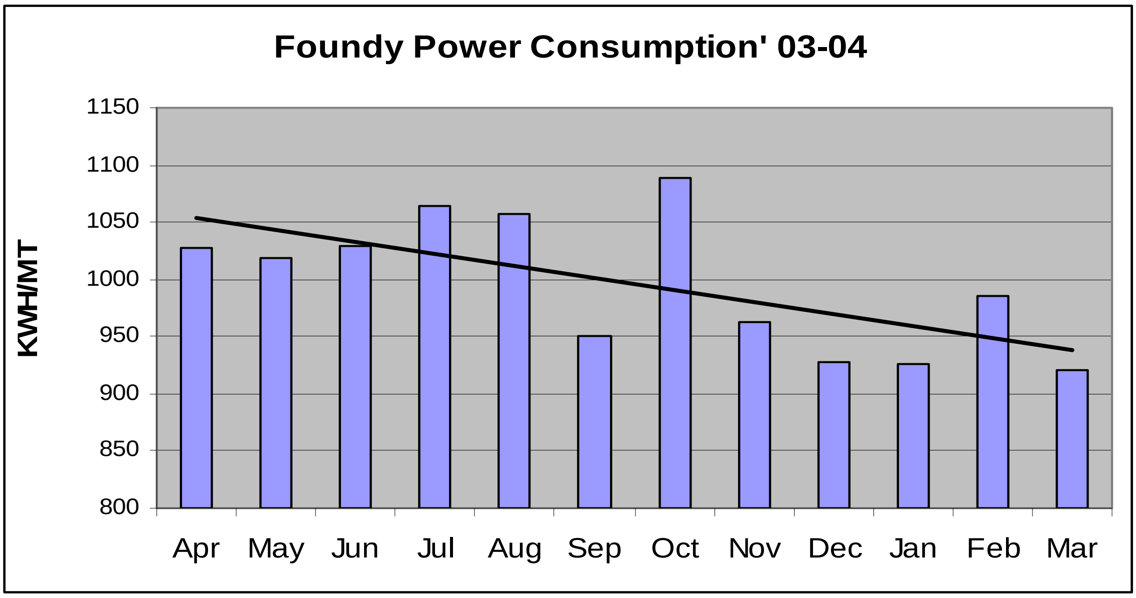
Brief description of the activity:
The metallic blast preheater consists of two chambers. Each chamber is operated with one FD fan, one ID fan and burner system. The FD fan supplies combustion air to the burner system. Each FD fan is capable of delivering about 8000 m^3 /Hr of air to the burner system.

Problem:
Presently the FD fans are run at 70% of it’s capacity. Rest 30% capacity is left unused.

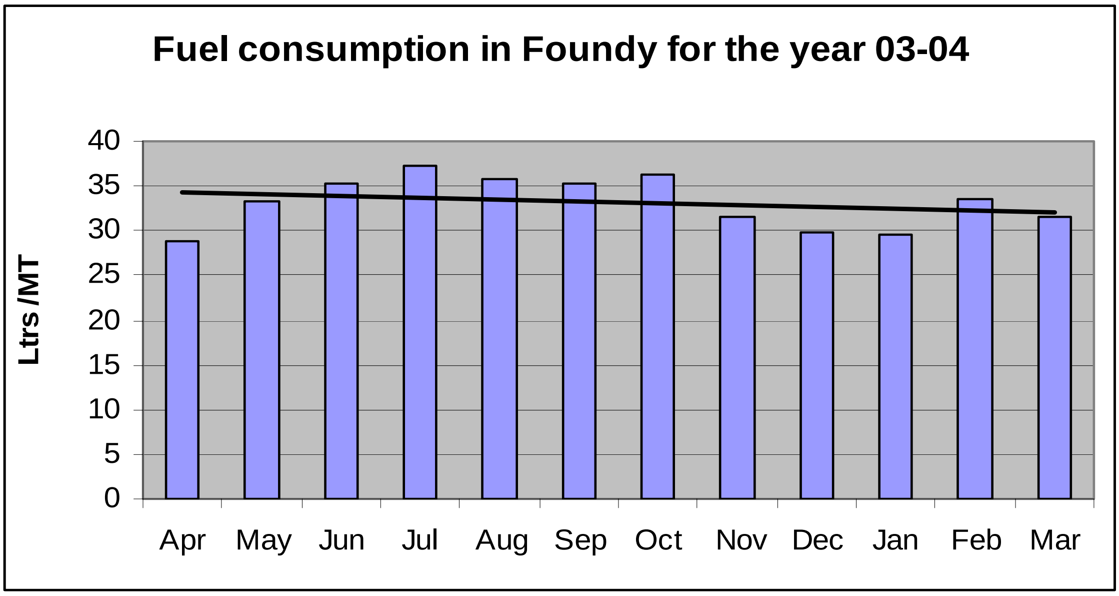
Corrective action planned:
We planned to run both MBPs with only one FD fan, by slightly changing the fuel to air ratio. This will help us in maintaining the burner system of both MBPs with only one FD fan, leading to saving of power. Trials in this respect were taken, but the results were not encouraging. We used one FD fan and were able to get about 9000 m^3 / Hr of air. When the trials were started the process was stable and the combustion air supplied by the fan was sufficient to maintain a Blast temperature of 720^oC. But when the process was unstable, the burner system was not capable of maintaining the required temperature (between 720^oC to 750^oC) and additional combustion air of 4000 m^3/Hr was required. This forced us to start the second FD fan and meet the combustion air requirement. However this has been mooted for further study. We have also contacted the fan supplier to look for retrofitting of this fan for the required output of at least 14000 m^3/Hr, with electrical power input remaining almost same as previous (i.e. 30 KW)

REVIEW OF ENERGY CONSUMPTION AT FOUNDRY:

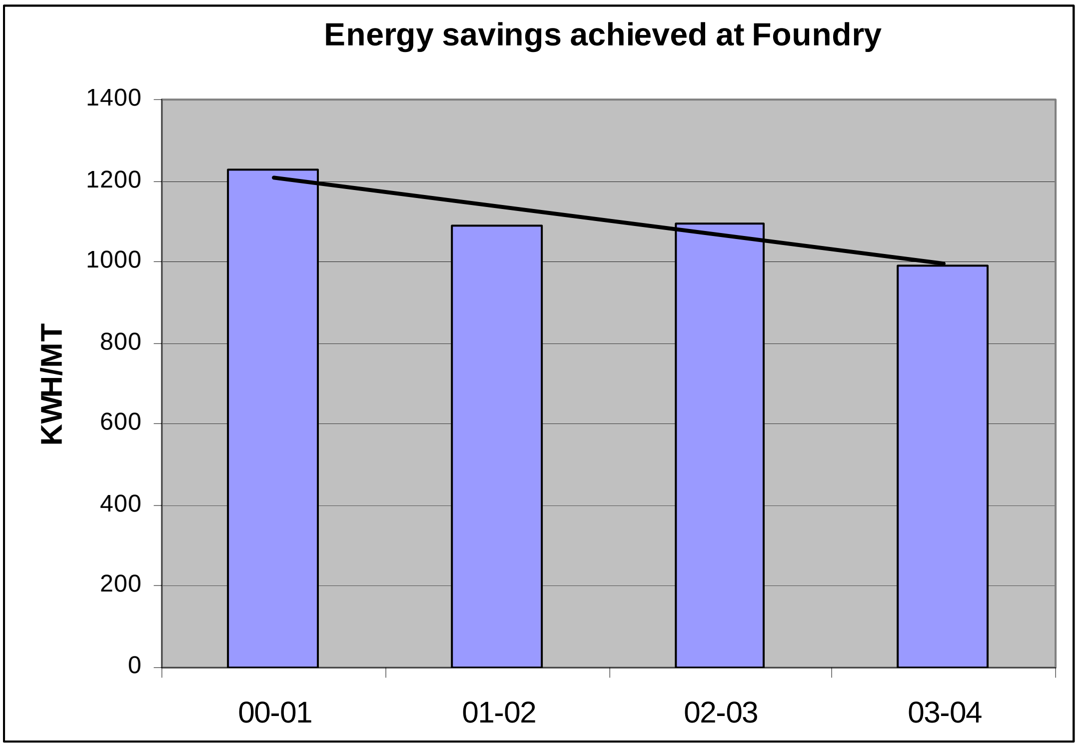
SPECIFIC ELECTRICAL ENERGY CONSUMPTION IN FOUNDRY.



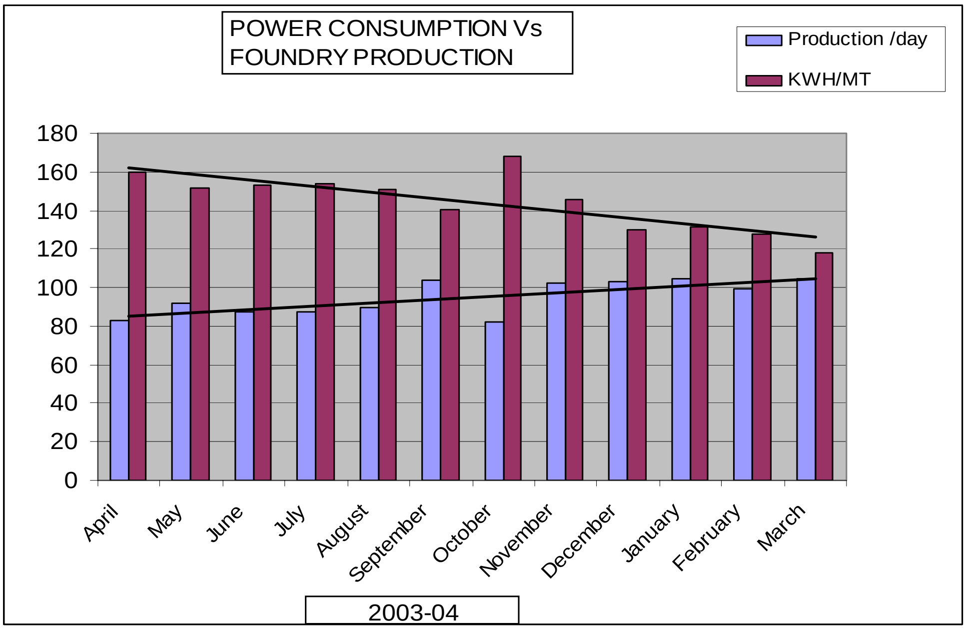
FUEL OIL (HSD & LDO) CONSUMED BY FOUNDRY



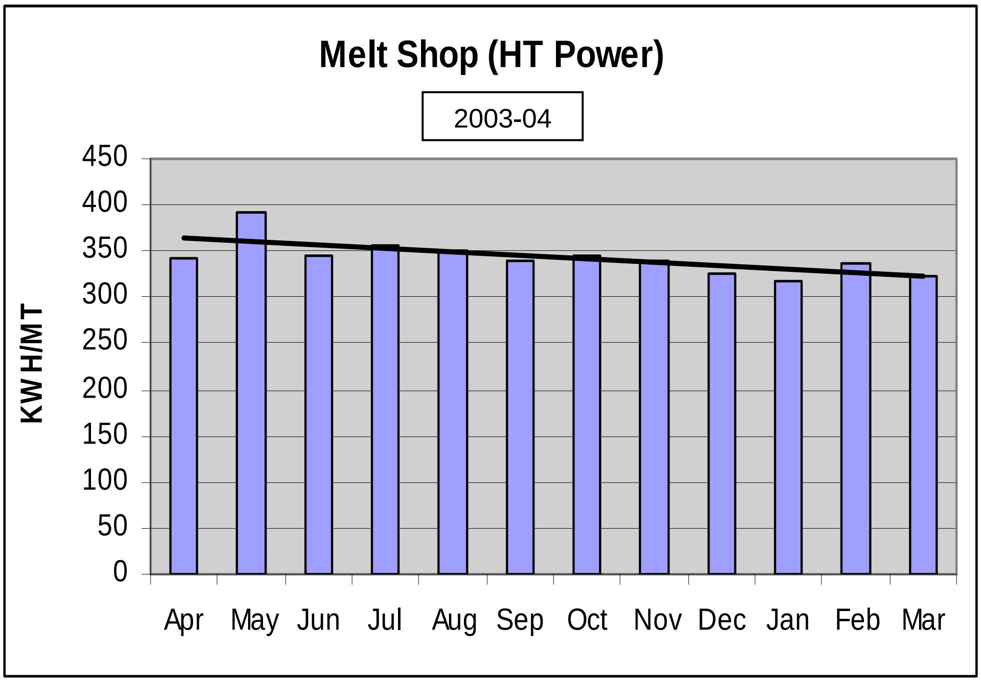
Review of Earlier / Performance



Area wise Energy Consumption Analysis
Compressor House



Melt Shop Electrical energy consumption for melting

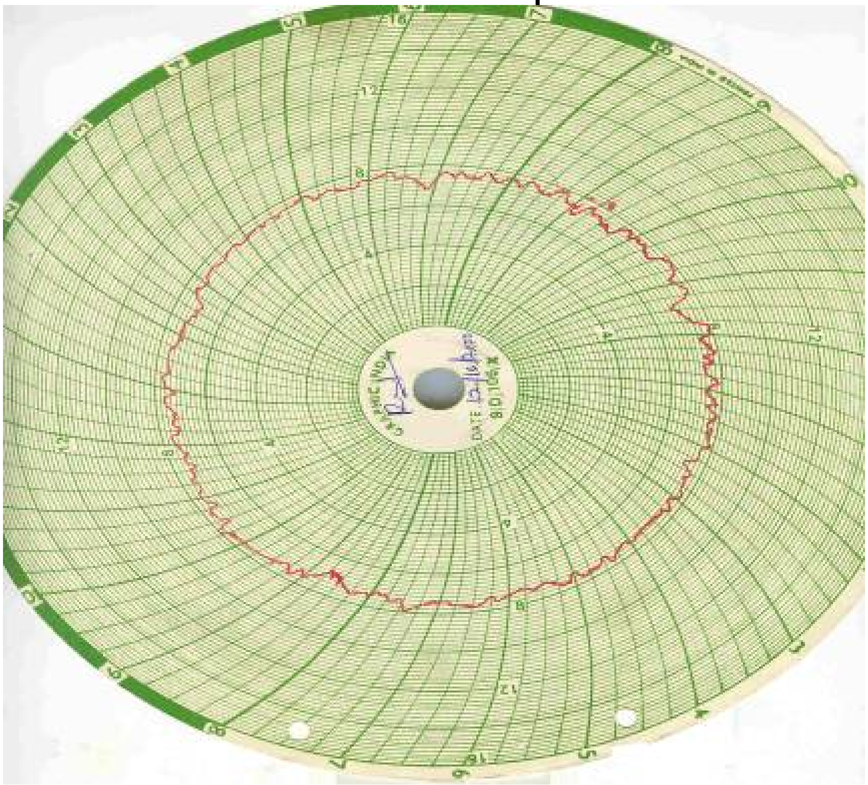


Options considered for Energy saving:

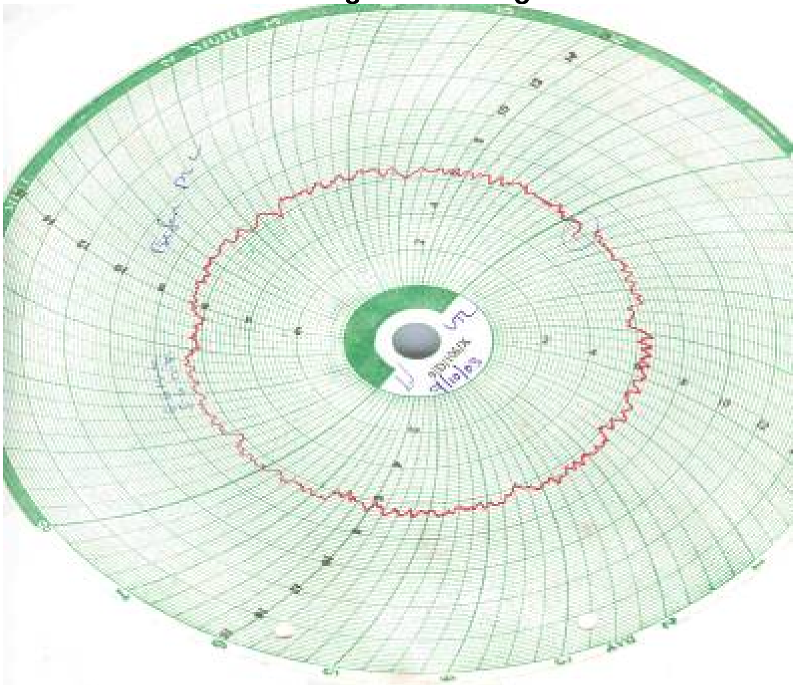
1. Reduction in compressed air pressure from 8Kg./Cm^2 to 6.2 Kg/Cm^2 after studying the plant requirement.
2. Improvement in compressor loading and unloading system through digital pressure sensor controlled by PLC system.
3. Rationalizing of Air receivers.
4. Continuous compressed air leakage identifying and arresting.
5. Unwanted air points plugging.
6. Creating awareness of compressed air through dialogues with individuals.

ROUND THE CLOCK PRESSURE MONITORING CIRCULAR GRAPH

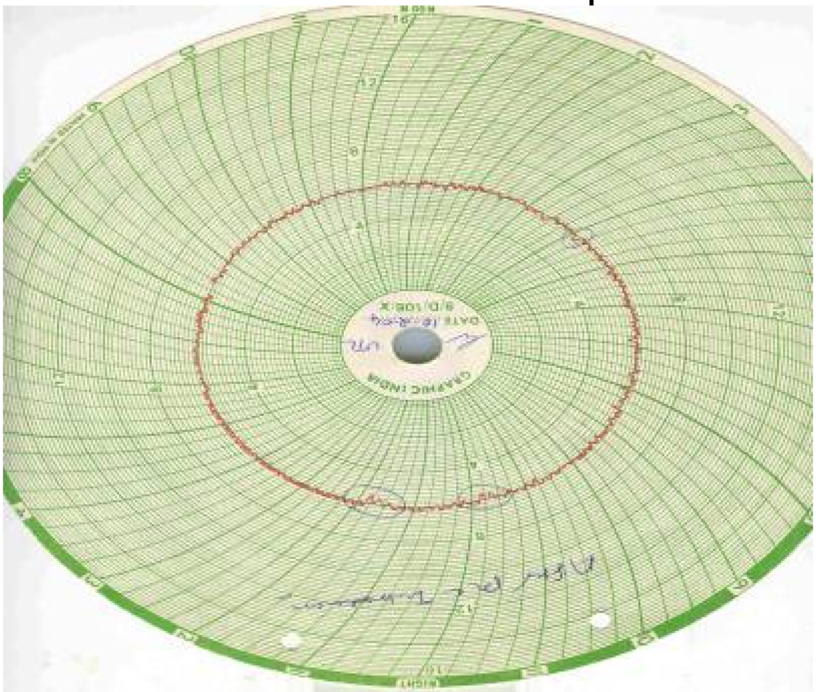
Fluctuations before PLC implementation



Maintaining Max. 6.5 Kg/Cm^2



Reduction in Fluctuations after PLC implementation



Savings Achieved during current / Past years.

Year	Actuals (KWH /MT)	Target (KWH/MT)	Net savings (KWH/MT)
00-01	1229	-	-
01-02	1091	-	-
02-03	1095	978	-
03-04	991	999.72	8.72

Savings achieved in compressor House

Year	Avg. KWH/MT of Foundry production	Savings KWH/MT
02-03	177	-
03-04	142	35

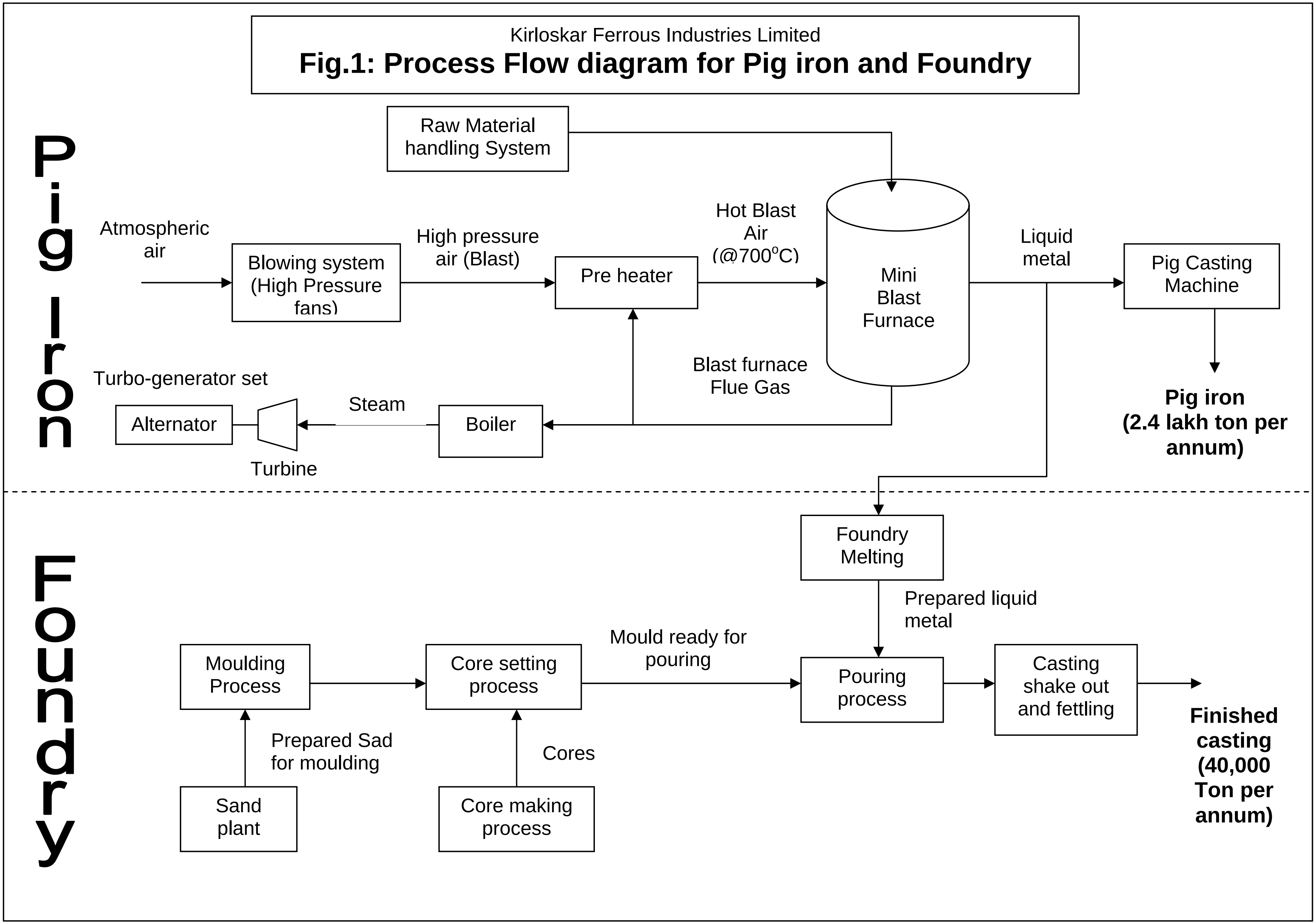
Display boards used to bring awareness:

New Equipment and Devices:

- **Modification in impeller of ID fan**:
  - Retrofit devices were planned for installation during the year 2003-2004. As per our plan we installed one retrofit impeller for ID fan of MBP at MBF2 to increase the flow from existing 28000 m^3/Hr to 32000 m^3/Hr. The trials for this retrofit impeller is on, the results are awaited.

- **Raw-material handling system (Coke)**:
  - In our Raw material handling system there was multiple handling of coke leading to wastage in the form of fines and handling losses. In order to avoid this, a conveyor belt was laid directly from the coke unloading point to the feeding point. Earlier, in this process coke was dumped on ground, picked up, transported and dumped on to the feeding hopper. Installation of this belt has eliminated that process.

- **Direct feeding of raw materials**:
  - We have now implemented direct feeding of raw materials on to the feeding point, which reduced the handling losses of raw materials. This has brought us significant advantage in terms of reduction in handling losses by about 0.5 - 2% and wastage in the form of fines by about 2 - 4% in our Raw material handling system.


Kirloskar Ferrous Industries Limited
Fig.1: Process Flow diagram for Pig iron and Foundry
Pig Iron
Raw Material handling System
Atmospheric air
Blowing system (High Pressure fans)
High pressure air (Blast)
Pre heater
Hot Blast Air (@700°C)
Mini Blast Furnace
Liquid metal
Pig Casting Machine
Pig iron (2.4 lakh ton per annum)
Blast furnace Flue Gas
Turbo-generator set
Alternator
Steam
Boiler
Turbine
Foundry
Foundry Melting
Prepared liquid metal
Mould ready for pouring
Moulding Process
Core setting process
Pouring process
Casting shake out and fettling
Finished casting (40,000 Ton per annum)
Prepared Sad for moulding
Cores
Sand plant
Core making process