PRESENTATION

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# APPROACH TO EFFECTIVE ENERGY SAVING IN FOUNDRIES

By

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# EFECTIVE ENERGY SAVING IN FOUNDRIES

## Agenda for Presentation

- *Major Energy Consuming Areas in Foundries*
- *General Pattern of Energy Consumption in Foundries*
- *Commonly Observed Areas & Potential for Electrical Savings*
- *Energy Saving in Fuel fired Furnaces and Conservation of Fuel Oils*
- *Specific Electrical / Fuel Consumption and Benchmarking*
- *General Practices for Energy Saving in Foundry Areas*
- *Conclusions and Recommendations*

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## 1.0 Major Energy Consuming Areas in Foundries

- Energy requirements in Ferrous and Non-ferrous foundries are huge.
- Foundry is one of the most energy intensive sectors in the country
- With growth in capacities, sizes and up gradation of the level of mechanization and automation in foundries, the energy requirements are continuously growing

***Energy Sources utilized in Foundries -.***

- Electricity
- Coke
- Fuel Oils (Furnace Oil, Light Diesel Oil, High Speed Diesel)

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## 2.0 General Pattern of Energy Consumption in Foundries

### A) Electricity Consumption

| | | |
|---|---|---|
| Melting Furnaces | - | 65 to 70 % |
| Sand Plant | - | 6 to 10 % |
| Fettling & other Areas | - | 6 to 8 % |
| Cranes & Material Handling | - | 6 to 10 % |
| Compressed Air | - | 9 to 10 % |
| Other Areas | - | 12 to 15 % |

### B) Fuel Oils ( LDO / Furnace Oil ) Consumption

| | | |
|---|---|---|
| Core Baking / Drying | - | 80 to 90 % |
| Transportation | - | 5 to 10 % |
| Miscellaneous Heating Applications | - | 5 to 10 % |

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## 3.0 Commonly Observed Areas & Potential for Electrical Savings

### *3.1 Melting Shop and Melting Furnaces*

- Consumption of Melting Shop usually in the range of 65 – 70 % which includes Furnace Auxiliaries, Moulding & Pouring activities
- Mains Frequency Furnaces being used for producing Cast Iron
- Medium Frequency Furnaces used for Steel Manufacture

Hence, In-depth Study of Furnaces essential. The Study includes –

- Furnace Operation
- Furnace Utilization
- Improved Heat Insulation and Furnace Modification for reducing energy consumption
- Replacement of Old furnaces by Energy Efficient Furnaces
- State-of-art Instrumentation & Control

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- Reducing Mechanical Breakdowns
- Impact of Furnace Layout vis-à-vis Moulding

**a) Furnace Operation**

**Tap On of previous Heat cycle to Tap on of the next Heat cycle**

Study of Furnaces revealed following common occurrences / observations in various studies.

- Superheating of Metal
- Non-availability of ready moulds
- Warm hold-ups of metal
- Not operating furnace 'Tap Position Control'
- Low Charge Rate
- 'Mould Rate' not matching 'Melt Rate'.
- Non availability (Breakdown) of or not timely availability of Cranes

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- **Long** Pouring Time.
- Maintaining **low 'heal'** in Furnace
- **Return** of large quantities of molten metal in ladles after 'pouring in moulds' and thereby adding colder metal to furnace
- **Improper** provision / operation of capacitors resulting in unbalanced loading on three phases
- Capacitors **not being checked** and found faulty
- Large Radiation losses due to **not using** of furnace 'LID'
- **Inadequate** ladle pre-heating
- **Use of molten metal** for ladle pre-heating and pouring cold metal back in furnace
- Use of **sandy foundry returns** resulting in high slag formation
- More than one furnace reaching **'pouring stage'** simultaneously resulting in warm 'hold-ups'
- Use of **gunny bags** for charging, thereby causing slag formation

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Suggested Measures for increasing Energy Efficiency in Furnace operation are -

- Maintaining **low** Temperatures of melting(1350 to 1400/1450deg C) for melting commensurate with grade and desired quality of casting. Use optical Pyrometers for correct temperature measurement.
- Do not allow **Superheating** by strict control
- Controlling and Maintaining **'high' Melt Rate** as near Melting rate specified by Manufacturer
- Maintaining **minimum heal** as specified (around 30 %) by manufacturer
- **Alternate charging** of CI borings, MS scrap and foundry returns
- Tapping only **desired** quantity of metal avoiding return of metal after pouring
- Ensuring that **'LID'** provided by manufacturer is actually used and furnace is kept closed except while charging. Lid mechanism can be fabricated if not provided.

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- **Working out** 'Mould Rate' based on moulding provided and 'matching' Melt rate and Mould rate from time to time by proper planning to reduce warm hold-ups. Principle of planning is '**Moulds can wait for Metal; but Metal can not wait for Moulds**'
- Maintaining **high** charge rate(example 0.9 –1.0 T/hr for 3 T furnace)
- Install '**Digital**' display of kWh & kWh/t for each melt near Furnace
- **Tap operation** commensurate with quantity of charge and balancing f currents
- Ensuring **availability** of Crane for carrying material for pouring during Melting
- Composition of charge should be maintained more or less **fixed** .
- Capacitors should be periodically **checked**
- Furnace should **always** be covered by '**LID**' except while charging**.**

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- **Preheating** of ladle should be done by using **'lower'** grade fuels.
- Use **clean foundry returns** to avoid slag formation & excessive electrical consumption

**b) Furnace Utilization**

- Take **optimum** number of Heats**.**
- Reduce **number of days** to achieve better utilization.
- **Timely** Mould preparation
- **Reducing** Pouring Time.

**c) Improvement in Heat Insulation or Modifications in Furnaces for Reduced Energy Consumption**

- Improvement in Heat Insulation and Modifications in Crucible, Electric circuitry, capacitors to reduce heat losses & electrical losses & thereby increasing energy efficiency

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**d) Replacement of Old Furnaces by Energy Efficient Furnaces**

- Replacement of 'old' mains frequency Furnaces by 'Medium frequency' furnaces would substantially reduce electricity consumption and in addition improve Quality, Productivity and Composition of Steel.
- Replacing old 'Fuel Oil' fired furnaces by Induction Furnaces gives large savings.
- Replacing LDO fired Furnaces by Gas operated Furnaces improves energy efficiency and also substantially reduces environmental pollution.

**e) Instrumentation and Control**

- 'Concept' and 'Philosophy' of furnace instrumentation changes with time. Sophisticated instruments & controls are provided on modern Furnaces. These help in efficient operation of furnace. Old furnaces are handicapped on this account. While it may not be possible to totally replace old instruments or fully modernize instrumentation / control on them, higher energy efficiency can be achieved by incorporating

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**f) Reducing Electrical / Mechanical Breakdown of Furnaces**

-Best maintenance practices and regular maintenance will avoid occurrences of electrical & mechanical breakdowns of furnaces resulting in higher consumption of electricity.

**g) Effect of layout of Furnaces and Moulding Area on consumption**

- Layout of Furnaces & Mould preparation area significantly affects metal handling time up to pouring and hence on energy consumption .

Compact and streamlined layout layout reduces travel time, hence allows Furnace temperature to be kept at minimum essential level for moulding and lower holding time for furnace. Both will reduce electricity consumption. Temperature drop from Furnace to mould pouring area is high (about 140 to 150 deg C) noticed. Change in layout recommended. Foundries where drops in temperature of metal from Furnace to mould pouring area is high, even up to 140 –150 deg C, travel time needs to be reduced by change of layout.

# EFECTIVE ENERGY SAVING IN FOUNDRIES

### *3.2 Mould Section / Mould Preparation*

Proper co-ordination between Mould preparation and Melting section would ensure better utilization of Melting furnace & moulding facilities and lower electricity consumption.

### *3.3 Shell Moulding Section*

Following measures of saving need to be explored in Shell Moulding Section / Machines –

- Improving insulation of Shell moulding Machines
- Provision of Temperature Controller

### *3.4 Sand Plant / Sand Section*

Following areas in Sand plant should be studied for electricity saving

- Sand Mixers
- Millers

In above two areas following possibilities shall be explored –

- Controlling time of operation to avoid excess running by Installing ON- OFF Timer

- Various measures for energy saving in Drive motors
- Replacement of 'V Belts' by 'Flat belts'

### *3.5 Core Drying / Baking Section*

For Electric Core baking ovens electrical consumption can be reduced by–

- Improving furnace utilization
- Controlling baking period (Avoiding excessive time)
- Temperature control by installing proper devices and their maintenance
- Proper heat insulation
- Ensuring proper heat distribution
- Energy saving measures for under loaded drives

For Fuel fired furnaces use Furnace oil in stead of HSD or LDO.

Monitor kWh/kg of Cores baked for Electric furnaces and litres/kg for fuel fired furnaces and ensure Optimum level of these ratios for electricity / fuel savings.

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## *3.6 Fettling (Emery) and Averaging Sections*

- Measures of saving for under loaded drives
- Reduction in operation cycle / running time of Shot blasting machine

## *3.7 Sand Drying*

- Sun drying in place of oven drying
- Operating Dryer on FO instead of HSD/LDO.
- Proper Utilization of Dryer capacity
- Ensuring energy efficient operation of furnace
- Use of FO instead of HSD in fuel fired Sand Drying system

## *3.8 Crane Section*

- Reduce ‘unwarranted travel of cranes
- Avoid using larger capacity Cranes for smaller jobs
- Avoid under loading of electric drives
- Improving Crane availability

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***3.9 Centrifugal Casting***

- Control Metal pouring temperature
- Energy saving measures for under loaded drives

***3.10 Conveyors in Mechanized Foundries***

- Speed reduction
- Energy Savers for under loaded drives
- Replacement of old motor by Energy Efficient motor
- Replacement of old motor by smaller kW motor

***3.11 Illumination in Foundries***

Need for good and cost effective Illumination in Industries including Foundries is well understood by all. Following actions suggested -

- ON/OFF Control in areas
- Installation of 'Translucent Sheets' in Roof or Side walls for eliminating reducing use of lighting during 'Day'
- Installation of Energy savers for lighting

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- Replacement of conventional ballasts in FTL & other Discharge lamps by Electronic ballasts
- Replacing existing lamps by EnergyEfficient lamps (36W FTL/28W FTL, HPSV Lamps, CFL lamps, LED Lamps)

***3.12 Electrical Power Distribution System***

Reduction in losses in electrical system by –

- Optimum loading on transformers (50 – 60 %)
- Operating Transformers on proper 'Tap' position
- Proper maintenance of Transformers
- Replacing Old transformers by High Efficiency / Energy Efficient ones
- Proper sizing of feeders/cables
- Maintaining High Power Factor (Near Unity)
- Installation of Automatic Power Factor Improvement Scheme
- Regular checking of Capacitors

# EFECTIVE ENERGY SAVING IN FOUNDRIES

- Reduction in Maximum Demand by various measures like demand monitoring, staggering of loads, PF improvement, DG set operation etc

***3.13 Improving Machine Maintenance / Breakdowns***

- It is known that Foundry equipment/machines are more prone to breakdowns resulting in increased electrical consumption.
- Improve overall machine availability in Foundry areas to about 98-99 %.
- Breakdown time should be limited to 1.0 –1.5 %.

***3.14 Foundry Shop Building***

- Not many Foundry Buildings are well planned, constructed and maintained. Common observations are -
- Low roof height. Inadequate light and ventilation
- Stuffy atmosphere inside due to dust and smoke
- Walls of dark colour. Usually blackened with smoke or dirt
- Shop floor sandy, oily. - Shattered / broken roof.

# EFECTIVE ENERGY SAVING IN FOUNDRIES

Following measures are suggested for better light & ventilation coupled with lower energy consumption

- Increasing Roof height
- Providing North light Roof Truss
- Constructing Roof of Coated G.I. or Aluminium alloy sheets
- Providing Translucent sheets in Roof/Walls
- Installation of Turbo ventilators in roof

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## 4.0 ENERGY SAVING IN FUEL FIRED FURNACES AND CONSERVATION OF FUEL OILS

***a) Light Diesel / Furnace Oil used for -.***

- Core Baking Ovens
- Mould Baking Ovens
- Sand Drying
- Heat Treatment Furnaces

***b) High Speed Diesel used for -.***

- Mould heating
- Transportation (Platform Trucks / Three Wheelers)
- Diesel Generating Sets

Study following areas - Fuel Oil ( a ) Receipt, Storage, Handling and Issue ( b ) Pumping and Distribution ( c ) Consuming Equipment e.g. Furnaces, Ovens and Driers

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## *4.1 Fuel Oil Receipt, Storage Handling and Issue*

Measurement of 'incoming' fuel oil received is usually done. However, the 'issues' within the Plant are seldom measured. Hence, fuel oil consumption figures in various areas are NOT usually available. Elaborate system of measurements and recording is necessary for identifying quantum of fuel savings.

Further, spillage, leakage or wastage of oil shall be should be determined and consciously reduced or stopped.

Installation of Flow meters for oil flow measurement is justifiable if oil consumption is large.

## *4.2 Study of Core Baking Ovens / Mold Baking Ovens*

- Maintaining low temperatures in oven (175-200 deg C) commensurate types and sizes of cores
- Ensuring optimum loading /utilization of oven
- Adjusting and maintaining correct Air-to-fuel ratio by using Ratiotrol valve
- Periodic Flue gas temperature Measurement and Analysis

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- Reducing cycle time
- Proper Tray Design (Cores)
- Proper record of Foundry production and fuel consumption and monitoring fuel consumption per kg of core / mould weight
- Closing gaps / open spaces in oven body
- Checking insulation of the furnace
- Providing Air curtain for Furnace / Oven in the shop
- Explore possibility of using light weight trolleys

***4.3 Sand Dryers***

- Time cycle reduction
- Optimum Fuel to Air ratio
- Maintaining proper Sand Temperature while drying

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## *4.4 Oil Fired Furnaces*

- Checking of Burners for proper combustion. If, operation is not satisfactory adjustment is necessary.
- If Burner is found to be inefficient, replace it with new efficient one.
- Ratiotrol valve should be used to control ratio of fuel and air.
- Replace use of HSD or LDS by Furnace oil.

## *4.5 Heat Treatment Furnaces*

Explore following possibilities of saving in Heat Treatment furnaces -

- Maintaining specified Temperature / Avoiding excess temperatures.
- Periodic Measurement and Analysis of Flue Gas Temperatures
- Maximum loading of furnaces
- Reduction in cycle
- Ensuring No Leakages
- Providing 'Good Heat insulation

# EFECTIVE ENERGY SAVING IN FOUNDRIES

***4.6 Moulding***

- Study Moulding operations for saving
- Study 'Drying' of moulds

***4.7 Ladle Heating***

- Avoid use of Hot metal for ladle heating

***4.8 Energy Saving by Process Improvements***

- Controlling Molten Metal Temperature and avoiding excess heating by accurate Temperature Monitors
- Avoiding melting 'excess' quantity of metal than mould requirements by calculating weight of casting before pouring.
- Synchronizing Moulding with Pouring metal from furnaces in to ladles
- Display of Furnace & Pouring Temperatures
- Use of 'good quality' scrap to improve quality (not corroded /inferior)

# EFECTIVE ENERGY SAVING IN FOUNDRIES

- Improving Shot blasting machine by installing High quality / Energy efficient machines
- More precise Temperature control by installing PID Controllers on Core Baking ovens
- Revamping of Furnace Insulation
- Use of Heat Retardant Coating in Heat Treatment Furnaces

***4.9 Transportation***

Saving in HSD / Petrol achieved by –

- Keeping proper record of fuel used, number of trips made and distance traveled. Work out & monitor km / litres of oil
- Improved maintenance of vehicles / engines

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## *4.10 Diesel Generating Sets*

Improving efficiency of Diesel Generating Sets by -

- Keeping record of HSD Consumption and kWh generated and Monitoring kWh generated per Litre of fuel consumed. This figure shall not be less than 3.0 kWh/Litre
- Optimum loading on DG Sets
- Flexibility of adjusting load on electrical system to allow higher utilization of DG Sets

## *4.11 Cranes & Material Handling*

- Provide two or three smaller capacity Cranes instead of One Big Crane
- Introduce ‘Remote’ operation of EOT Cranes / Hoists

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## 5.0 Specific Electrical / Fuel Consumption & Benchmarking

Every Foundry should work out 'Specific Electrical / Fuel Consumption values on 'Day to Day' basis or 'Shift to Shift' basis and take steps if the actual values exceed the following figures

### *5.1 Electrical Consumption.*

(i) Cast Iron Castings

| | | |
|---|---|---|
| Small size / weight castings | : | **600 - 700** kWh / Ton melting |
| Medium size / weight castings | : | **550 - 600** kWh / Ton melting |
| Large size / weight castings | : | **525 - 550** kWh / Ton melting |
| (ii) Grey Iron Castings | : | **750 – 800** kWh / Ton Melting |
| (iii) Steel | : | **750 – 1000** kWh / Ton Melting |
| (iv) Foundry Auxiliaries | : | **100 – 200** kWh / Ton Melting |
| (v) Compressed Air | : | **50 – 100** kWh / Ton Melting |

# EFECTIVE ENERGY SAVING IN FOUNDRIES

For calculating corresponding consumption figures with respect to 'Good casting' use prevalent yield ratios (normally around 60-65 %)

Above Specific Electrical Consumption figures depend on ratings / sizes of furnaces, size of foundry, sizes / weights of jobs (castings), grade of castings etc. Hence these values to be taken as 'INDICATIVE' values only.

## *5.2 Fuel Consumption*

(i) Core Baking : 2**00 - 250** litres / Ton

(ii) Diesel Generation : **0.25 to 0.30** litres / Ton

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## *5.3 Comparison with National Best and International Best Energy Consumption Figures.*

| S No. | Parameter | International Best | National Best | Achieved in India by a Foundry |
|---|---|---|---|---|
| 1. | C.I Medium kWh/t | 540 | 650 | 610 |
| 2. | C.I. Heavy kWh/T | 540 | 650 | 680 |
| 3. | Alloy Cast Steel kWh/T | 600 | 750 | 715 |
| 4. | Non-ferrous kWh/T | NA | NA | 585 |
| 5. | Yield | 75% | 65% | 72% |
| 6. | Rejection | 2& | 8% | 2% |
| 7. | CA Leakage | NA | 6-10% | 9% |

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## *5.4 Benchmarking*

Following Benchmarks shall be established in Foundries –

Total Electricity Consumption - kWh/Ton of Melting

Total Electricity Consumption - kWh/Ton of Gross Casting

Foundry Fuel Consumption - Litres/kg of Casting

Compressed Air Electricity Consumption - kWh/Ton of Melting

Core Drying Electricity Consumption - kWh/Ton of Melting

Core Baking Fuel Consumption - Litres/Ton

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## 6.0 General Practices for Energy Saving in Foundry Areas

- Record and Report ‘Daily’ energy consumption.
- Display Furnace ‘Electricity / Fuel’ consumption on SHOP FLOOR
- Daily analysis of ‘Actual vs Target’ electricity consumption of Melting
- Review of ‘Specific Energy Consumption’ every Month

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## 7.0 Conclusions & Recommendations

### *7.1 Emphasis on Energy Saving in Foundry Operations*

- Since the proportion of costs of Fuel and Electricity in Foundry to production cost is quite high, energy conservation assumes importance.

  No Foundry can afford to ignore Energy Saving.
- Rather, most of Foundries would lay large emphasis on energy saving.

  Large investments have been made by many by many Foundries on 'Energy Initiatives'.
- Energy Saving potential in Foundries can be as high as 20-25 % with most of it achievable through fairly low expenditure.

### *7.2 Need for Energy Audit & Effective Implementation*

- Systematic & Comprehensive Energy Audit, speedy Implementation and rigorous Monitoring of savings is found to be very cost effective.

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## *7.3 Energy Management System*

Installation of Energy Management System has helped some Foundries in Effective Monitoring of Electricity and Fuel consumption and achieving energy & cost saving. Large Foundries should seriously consider this measure

## *7.4 Need for Training*

Following specific Training Programs would be useful -

- Energy Saving in Melting Process
- Metal & Material Handling
- Energy Efficient Furnaces
- Hot Blast & Divided Blast Cupola Furnace
- Furnace Insulation
- Effective Maintenance of Material handling equipment & Breakdown
- Yield Improvement

# EFECTIVE ENERGY SAVING IN FOUNDRIES

## *7.5 Conclusions*

Measures for saving in Electricity and Fuel in different areas in Foundry have been presented based on the experience of the author and data of ENCON in Foundries. However, Foundry Managers and working personnel may be in a position to identify and ADD many more opportunities due to their long experience of Foundry operations .

# EFECTIVE ENERGY SAVING IN FOUNDRIES

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