

ECOTECH OPTIONS IN INDIAN STEEL REHEATING FURNACES



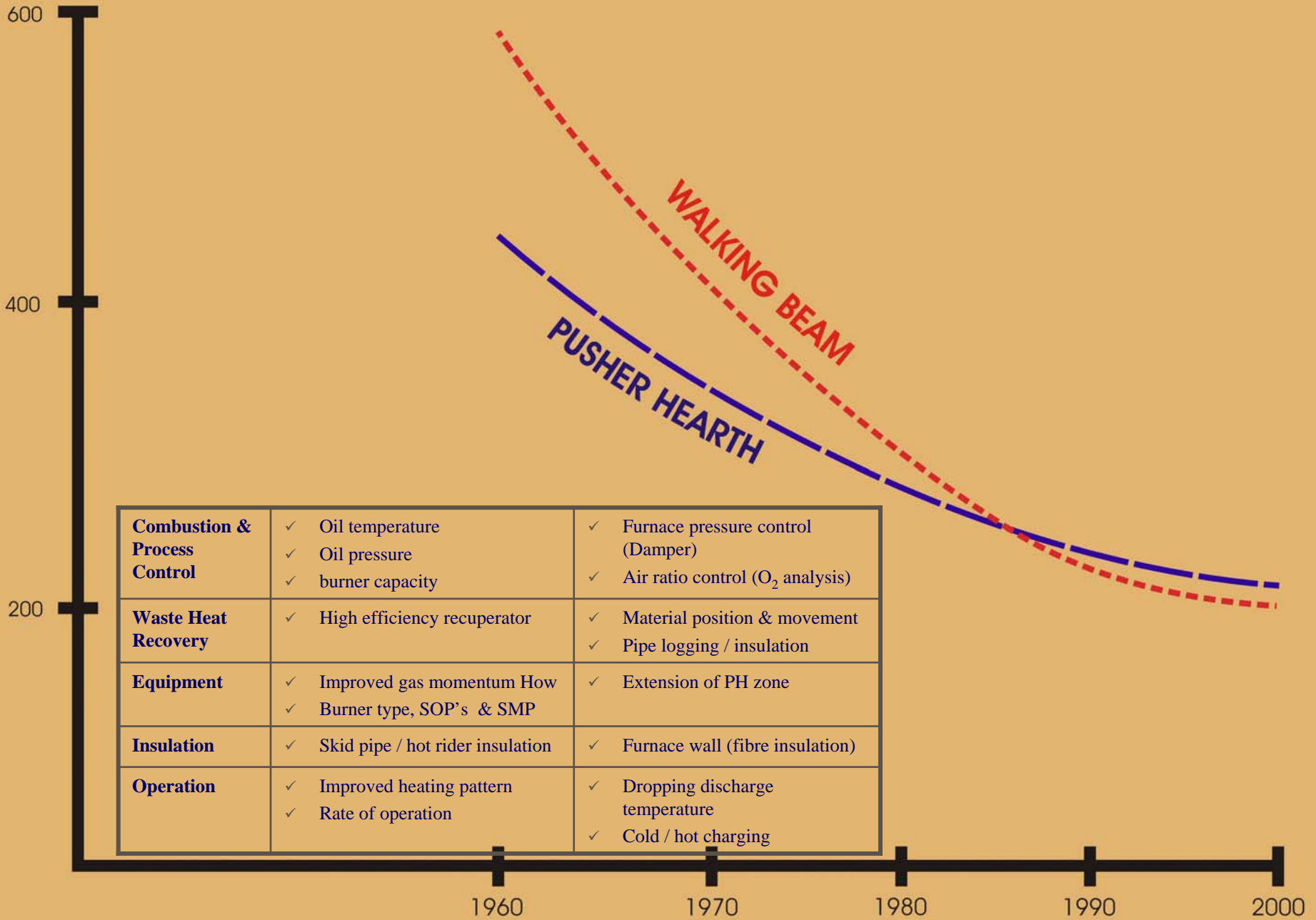
Presented in “Workshop on Continuing Learning Program on
Energy Management System”

NCR Chamber of Commerce & Industry

32nd Milestone Resorts

Gurgaon

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TECHNOLOGY PACKAGES

1

Installation of High Efficiency
Recuperator in conventional
Pusher Hearth Continuous Oil
Fired Furnaces

2

Conversion of Oil fired pusher
hearth furnace to oil fired walking
beam furnaces

3

Conversion of Oil fired pusher
hearth to gas fired walking beam
furnaces with REGEN Burner

4a

Conversion of lump coal fired to
pulverized coal firing with
recuperator

4b

Conversion of lump coal fired to
producer gas fired furnace with
high efficiency recuperator

ECOTECH OPTIONS (Technology Packages)

- ◆ High Efficiency Recuperators
- ◆ Automation & Control
- ◆ Variable Voltage & Variable Frequency Drives
- ◆ Power Factor Correction
- ◆ Energy Efficiency Drives
- ◆ Energy Efficiency Lighting
- ◆ Walking Beam Furnace
- ◆ Regenerator Burners
- ◆ Lump to Pulverized Coal Firing
- ◆ Producer Gas Firing
- ◆ Hot / Warm Charging

CUSTOMIZED PACKAGES (Pre-Requisite)

1 – Combustion (Furnace)

**Installation of High Efficiency Recuperator in
conventional Pusher Hearth Continuous Oil Fired
Furnaces**

2 – Rolling Mill & Electrics

**Conversion of Oil fired pusher hearth furnace
to oil fired walking beam furnaces**

Tailor made as per the units configuration

CUSTOMIZED PACKAGES - OPTIONS

Package-1 Furnace Combustion

OPTIONS

- Improved Refractory Lining
- Ceramic Fiber Veneering
- High Emissivity Coating
- High Velocity-Oil Film Burner



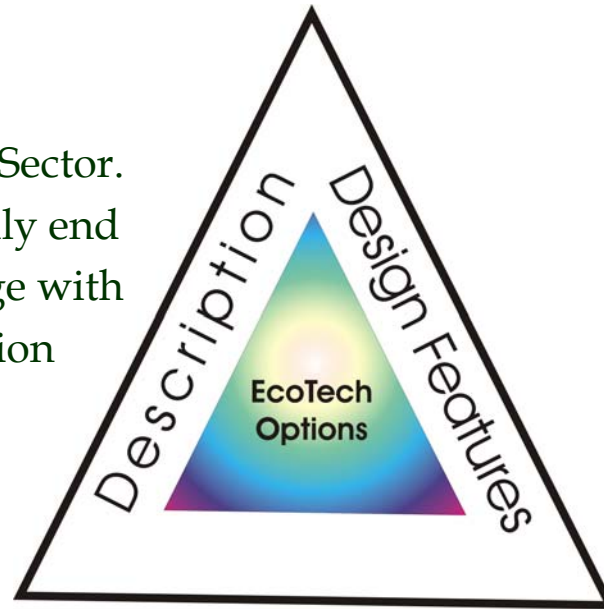
OPTIONS

Package-2 Mill & Electrics

- Crop length Optimization
- Roller entry/ delivery guides (Bar & Rod Rolling)
- Antifriction/ roller Roll Neck Bearing
- Universal Spindle & Coupling
- Tilting Tables
- Y-Tables
- Stationary Wall Tilters
- Oval/ Square Repeaters (Bar & Rod Rolling)

ENERGY EFFICIENT PUSHER HEARTH FURNACE

Most common in SRRM Sector.
Wide variety but normally end charge and side discharge with wide variety of combustion systems

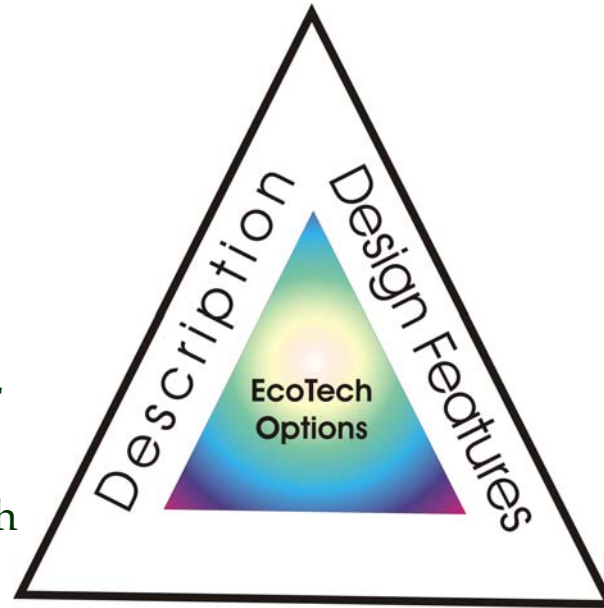


Two-zone top fire having hearth loading upto 350 kg/m²/hr of hearth area, which substantially increase with under firing and more zones. Normally, for stock upto 150 mm thickness 2 zones furnaces adequate. For billets above 150 mm under firing and control zones are required with hot riders

Proposed EcoTech	Special Features	Savings Fuel & Scale	Investment	Payback
Modern Pusher Hearth Furnace	Automatic temperature pressure control High efficiency metallic recuperators Improved refractory lining Heating zone=70-75 % of installed heating capacity Soaking zone-balance 30-25 % heat load	Fuel \simeq 7 - 8 liters Scale \simeq 0.5 – 1.0 %	Approx. 150 lakhs	Less than One year

WALKING BEAM REHEATING FURNACE

- ◆ Stock moves forward with movable water cooled beams
- ◆ Has both top and bottom fired system
- ◆ Overcome disadvantages in PHF
- ◆ Can handle billets of different length, width and thickness



Hearth loading rate

600 – 800 Kg/Hr/m²

Low fuel consumption

275 – 300 Kcal/Kg

Charge uniformly heated

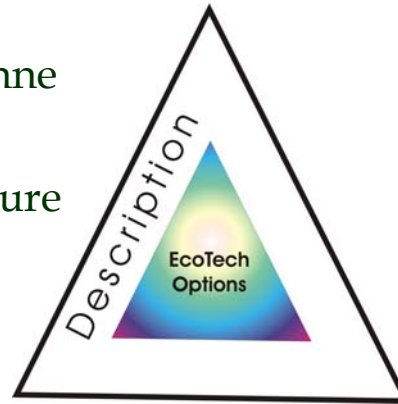
Minimized scale loss

0.6 – 0.8 %

Proposed EcoTech	Special Features	Savings Fuel & Scale	Investment	Payback
Replacement of PH with WB design	<ul style="list-style-type: none"> ● Can be fully emptied ● Heat loss due to accumulation – avoided ● Uniform stock temperature in the range $\pm 20^{\circ}\text{C}$ ● Movement of stock without jerks ● Higher lining life 	Fuel \simeq 10 liters Scale \simeq 1.02 - 1.5 %	Approx. 350 lakhs	Less than One year

REVAMPING / MODERNIZATION OF EXISTING PUSHER FURNACES

- ◆ Most common
- ◆ Fuel oil consumption 40-45 % / tonne
- ◆ Scale loss 2.0-4.5
- ◆ No automatic control of temperature pressure
- ◆ Combustion air preheating temperature 150-160°C



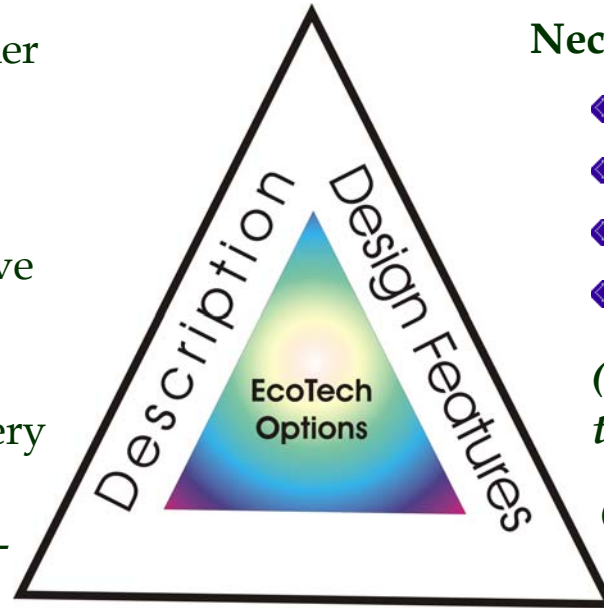
Proposed EcoTech
Replacement of existing PHF
Savings Fuel & Scale
Fuel \simeq 4 - 5 liters, Scale \simeq 0.5 %
Investment
Approx. 50 lakhs
Payback
4-5 months

Special Features

Temperature Control	- through microprocessor based PID controller - efficient burner with automatic control of fuel air ratio
Pressure Control	- Automatic control based on microprocessor PID - Furnace pressure maintained slightly positive (+1mm)
High Efficiency	
Metallic Recuperator	- High efficiency 2 - pass multi tubular recuperator with safety features like dilution air blower, hot air bleeding system
Improved Refractory Lining	
%age oxygen analyzer	- Mounted on flue gas header after recuperator - to monitor oxygen %age - Indicator for excess air in furnace

REGENERATIVE BURNERS

- ◆ Self contained burner with waste heat recovery system
- ◆ Combustion air through regenerative chamber
- ◆ Extremely efficient exhaust heat recovery
- ◆ Air preheat temperature – 1000-1100°C



Necessary Controls

- ◆ Four-way reversing valves
- ◆ Fuel and air control valves
- ◆ Combustion air blower
- ◆ Exhaust blower

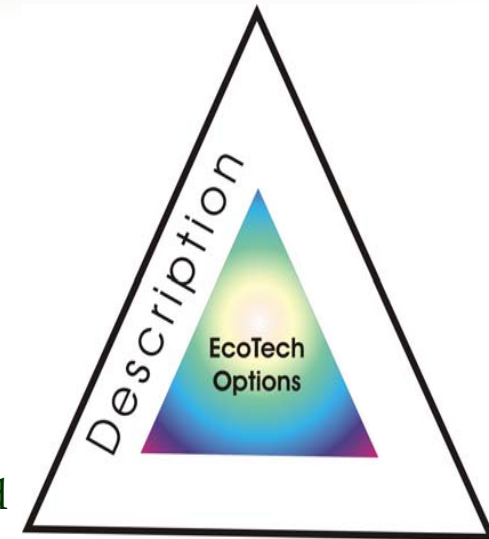
(Refractory Insulation Lining required to accommodate new burners)

(Expensive)

Proposed EcoTech	Special Features	Savings Fuel & Scale	Investment	Payback
Walking Beam Furnace with Regenerative Burners	<ul style="list-style-type: none"> ● Increasingly being used in large capacity furnace in USA, Japan, Korea, etc. ● In India not in use ● Operating in electro steel, kharta (LDO fired) ● High thermal efficiency though pebble bed / honey comb type 	Fuel \approx upto 15 liters Scale \approx less than 2.5 %	Approx. 320 lakhs	One year

COMPLETE CHANGE OF REHEATING LINING

- ◆ High energy loss through ceiling, side walls and hearth due to
 - ◆ Poor lining condition
 - ◆ Improper lining material
- ◆ Insulation replacement – skin temperature exceeds 100-120°C
- ◆ Wall insulation thickness – 450 – 500 mm
- ◆ Wall insulation – 45-60% alumina brick, hot face insulation, cold face insulation and block insulation
- ◆ Ceramic fibre with low thermal conductivity and low density used
- ◆ Furnace hearth – high duty high alumina refractory bricks / chrome / magnesite / aversive bricks
- ◆ Ultra low cement castables

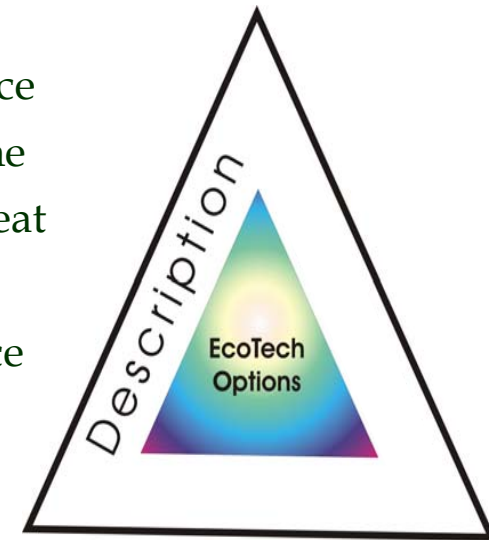


Proposed EcoTech	Special Features	Savings Fuel & Scale	Investment	Payback
Improved Refractory Design with Ceramic Fibre(s)	<ul style="list-style-type: none"> ● Ceramic fibre material reduces heat loss through the walls ● Ceramic fibre has a low thermal mass, heat loss due to daily heating and cooling is reduced 	Fuel \simeq 3 - 4 liters	Approx. 20 lakhs	8 – 10 Months

More than energy saving it results in improvement of ergonomics of the SRRM unit

CERAMIC FIBRE VENEERING

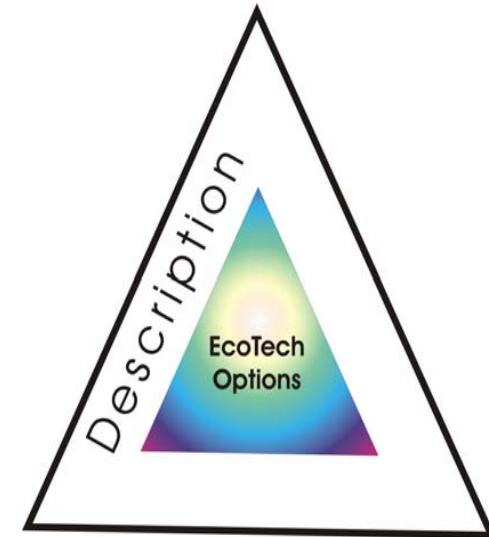
Ceramic fibre veneering modules (50 mm thick) application as hot face insulation except at height of about 160-170 mm of side walls from the hearth in the preheating zone of existing furnaces will reduced the heat losses. Furnaces, which is operated for one or two shifts per day, application of ceramic fibre modules as hot face insulation will reduce the start up time and fuel requirement



Proposed EcoTech	Special Features	Savings Fuel & Scale	Investment	Payback
Application of Ceramic Fibre Veneering	<ul style="list-style-type: none"> • Veneering is done in the furnace zone where the temperature is below 1200°C • When veneering is adopted in the small scale re-heating furnaces of 5-10 t/hr capacity, about 75 % of the area can veneered leaving the areas close to the flame 	Fuel overall (start up + running) \simeq 1 liters	Approx. 2 lakhs @ 2000/- per m ² for 5-10 tph furnace	

MICROPROCESSOR BASED FURNACE ZONE TEMPERATURE, A/F RATIO AND PRESSURE CONTROL SYSTEM

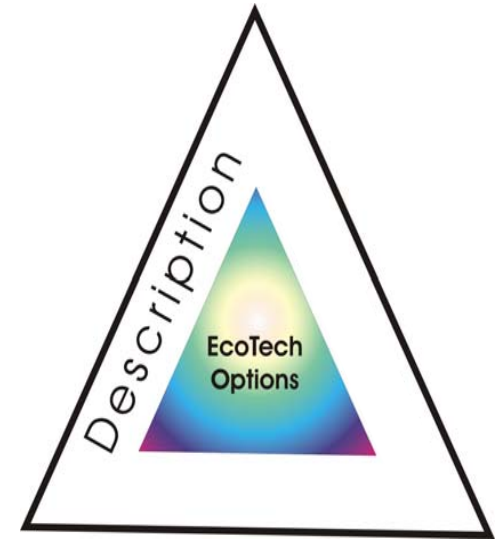
- ◆ The set values of zonal temperatures - automatically controlled by microprocessor PID controllers.
- ◆ The combustion air flow and gas / oil flow measured - by orifice plates complete with flow transmitter.
- ◆ Flow of fuel / air is controlled by a signal received from temperature controller through oil flow valves.
- ◆ Furnaces pressure control maintains positive furnace pressure.
- ◆ Interlocking and sequential control with respect to charging and discharging - done through relay logic in the instrument panel / control desk.
- ◆ Safety for abnormal conditions - provided.
- ◆ Records of various inputs - provide a check on the condition.



Proposed EcoTech	Special Features	Savings Fuel & Scale	Investment	Payback
Mid-sized furnaces with PLC Control	<ul style="list-style-type: none"> ● Control of desired temperature regimes and air-fuel ratio are possible ● Control of furnace pressure will reduce air ingress and in turn control on oxygen inside furnace. ● Operation interaction for control of temperature is lesser. 	Fuel Saving 5-10% depending upon current state of operation	Rs. 20 lakh	4 to 5 months

HIGH EFFICIENCY METALLIC RECUPERATOR

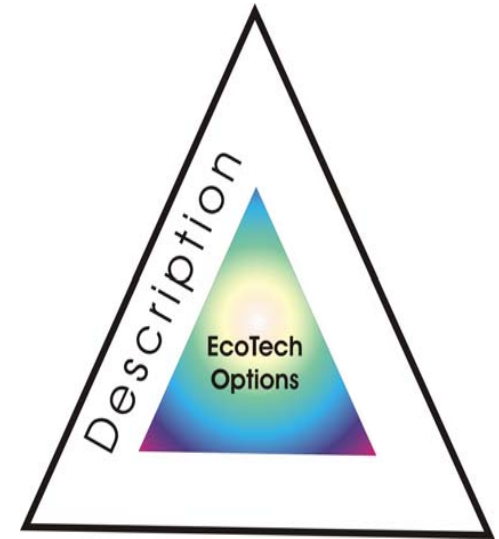
A wide variety of recuperator design are available for use in re-heating furnaces. Metallic recuperator for preheating combustion air up to 300-350°C will be installed in the fuel tunnel (where recuperator does not exist where recuperators preheat air only up to 100 – 200°C. Indigenously available channel type cross counter flow recuperators include 2 completely assembled suspended units. The first bank (hot side) of the recuperator tubes will be made of AISI – 310 / 321 or DIN 1.4720 material depending on the flue inlet temperature and the balance tubes are made of carbon steel to ASTM – 312 OR BOILER QUALITY MATERIAL. The existing re-rolling mill furnaces have long preheat zones and the exhaust flue gas temperature is of the order of 700 – 750°C.



Proposed EcoTech	Special Features	Savings Fuel & Scale	Investment	Payback
High Efficiency Recuperator	<ul style="list-style-type: none"> • Air preheat temperature of up to 550°C can be achieved • Air tube recuperators not suitable for coal fired furnaces • Dilution with atmospheric air required when flue temp. is high 	Saving 5-12 for air preheat at 350-450° depending upon current operation	Rs. 6 -10 lakh	2 to 3 months

Hot charging in composite mills

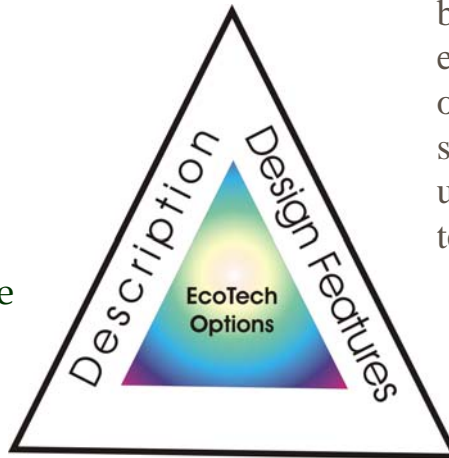
- ◆ A substantial part of energy can be saved if the billets can be charged into the furnace in hot condition. Many a time it is not possible to feed the billets directly from the continuous caster into the furnace due to logistics like interruption in casting or rolling.
- ◆ **Comprehensive designs for hot charging of IF - ingot in PH furnace and CC billets in WB furnace developed by PMC along with furnace and industry experts**
- ◆ The former, being first time in the country and most widely prevalent will be validated first with the industry support.



Proposed EcoTech	Special Features	Savings Fuel & Scale	Investment	Payback
Hot Charging in composite mills	<ul style="list-style-type: none"> ● Automation like temp. controller for accurate control for furnace zones provided ● High order of system integration and engineering required 	25-60 % oil and scale saving is possible depending upon hot charge temp. and %age of hot charging	Rs. 110 lakhs (in case of PH Furnaces)	4 ~ 6 months

VARIABLE VOLTAGE VARIABLE FREQUENCY (VVVF) DRIVES

- ◆ The existing oil fired re-heating furnace combustion air blower motor and the fuel oil pump motor are started with star-delta and DOL starter.
- ◆ The air flow control is through motorized butterfly valve.
- ◆ The fuel oil supply is constant to the ring main system by positive displacement oil pump.
- ◆ Change in change of speed of drive motors of combustion air blower & oil pump is not affected duty conditions of the furnace resulting in loss of electric energy
- ◆ Also high starting current and jerks create stress on the motors.



Variable voltage variable frequency drives are combination of latest microprocessor based digital technology, static inverter equipment as power switching devices with other hardware platform, software & high speed signal processing. These VVVf drives use the following latest state-of-art technology

- Modern Integrated Gate Bipolar transistor (IGBT) technology resulting in low loss operation.
- Integrated Gate Commutative Thyristor (IGCT) for higher drive ratings with direct torque control.
- Vector control, v/f control & servo controls as closed loop controls depending upon application

VARIABLE VOLTAGE VARIABLE FREQUENCY (VVVF) DRIVES....contd.

Proposed EcoTech	Special Features	Savings Fuel & Scale	Investment	Payback
Use of VVVf drives with air blowers and auxiliaries	<ul style="list-style-type: none"> ● Energy loss are quite high in case of AC motors running at fixed speed. Thus for optimum utilization of power (low-output) required output for loads which are of varying nature such as pumps. ● Fast & accurate control of torque and speed of drives under all operating conditions of rolling process. ● The new control system has direct impact on the quality of end products since mill drive motors have high dynamic response high efficiency. ● Reduce spare part inventory. 	Fuel Saving 1.5 – 2 – scale reduction 0.5% Power Reduction 1.2 kWh/t	Rs. 10 lakhs	10-12 months

COMPARISON BETWEEN TOP FIRED PUSHER FURNACE & TOP FIRED WALKING HEARTH FURNACE

	<u>PUSHER</u>	<u>WALKING HEARTH</u>
■ QUALITY OF HEATING	Not satisfactory	Satisfactory
■ SPECIFIC HEARTH LOADING	Low	Moderate
■ FURNACE LENGTH	x	0.7x
■ TEMPERATURE UNIFORMITY	Low	Good
■ SCALE GENERATION	1.5 – 2.5%	0.7 – 0.9%
■ FUEL CONSUMPTION	x	0.8x
■ MECHANICAL SKID MARKS	Very high	No Skids
■ THERMAL SKID MARKS	High	No marks
■ FLEXIBILITY OF OPERATION	Restricted	Good flexibility
■ SELF EMPTYING	Not possible	Standard feature

TOP FIRED PUSHER FURNACE & TOP FIRED WALKING HEARTH FURNACE (Contd..)

	<u>PUSHER</u>	<u>WALKING HEARTH</u>
■ MAINTENANCE OF HEARTH	(once in every year)	(once in three years)
■ CAPITAL REPAIR	(once in two years)	(once in four years)
■ OPERATING TEMPERATURE	Higher	Lower than pusher
■ COMBINATION OF HOT CHARGING	Not possible	Excellent
■ COST COMPARISON	x	1.6x
■		

COMPARISON BETWEEN TOP AND BOTTOM PUSHER FURNACE & TOP AND BOTTOM WALKING BEAM FURNACE

	<u>PUSHER</u>	<u>WALKING BEAM</u>
■ QUALITY OF HEATING	Good	Excellent
■ SPECIFIC HEARTH LOADING	Moderate	Highest
■ FURNACE LENGTH	x	0.6x
■ TEMPERATURE UNIFORMITY	Moderate	Very good
■ SCALE GENERATION	2 –2.5%	0.5 – 0.7 %
■ FUEL CONSUMPTION (Later)	x	0.9x(initially) / 0.7x
■ MECHANICAL SKID MARKS	High	Nil
■ THERMAL SKID MARKS	High	Nil
■ FLEXIBILITY OF OPERATION	Low	Excellent
■ SELF EMPTYING	Not possible	Standard feature

COMPARISON BETWEEN TOP AND BOTTOM PUSHER FURNACE & TOP AND BOTTOM WALKING BEAM FURNACE

	PUSHER	WALKING BEAM
■ MAINTENANCE OF HEARTH	Very high	Nil
■ MECHANICAL SKID MARKS	Very high	Nil
■ THERMAL SKID MARKS	Very high	Nil
■ LIFE OF HEARTH REFRACTORY	One year	No refractory hearth
■ LIFE OF SKID INSULATION	One year	Occasional change at portion after three years
■ WATER CONSUMPTION	High	Moderate
■ COST OF REPAIRING	High	Moderate
■ COST COMPARISON	x	2.5x



Factors that contribute to Loss of Fuel

- Furnace capacity un-matched with rolling capacity
- Improper selection of combustion equipment
- Inefficient recuperators or absent recuperators
- Absent / by-passed automatic air / fuel ratio control system
- Absent automatic temperature control system
- Absent automatic furnace pressure control system
- Improper maintenance and operation of furnace and combustion system



THE EFFICIENCY PROBLEM

- Fuel-fired furnaces suffer from the perennial problem of low efficiency.
- The largest source of heat loss is through the exit flue gases.
- The higher the furnace temperature, the greater the flue loss.



Regenerative Burner Technology

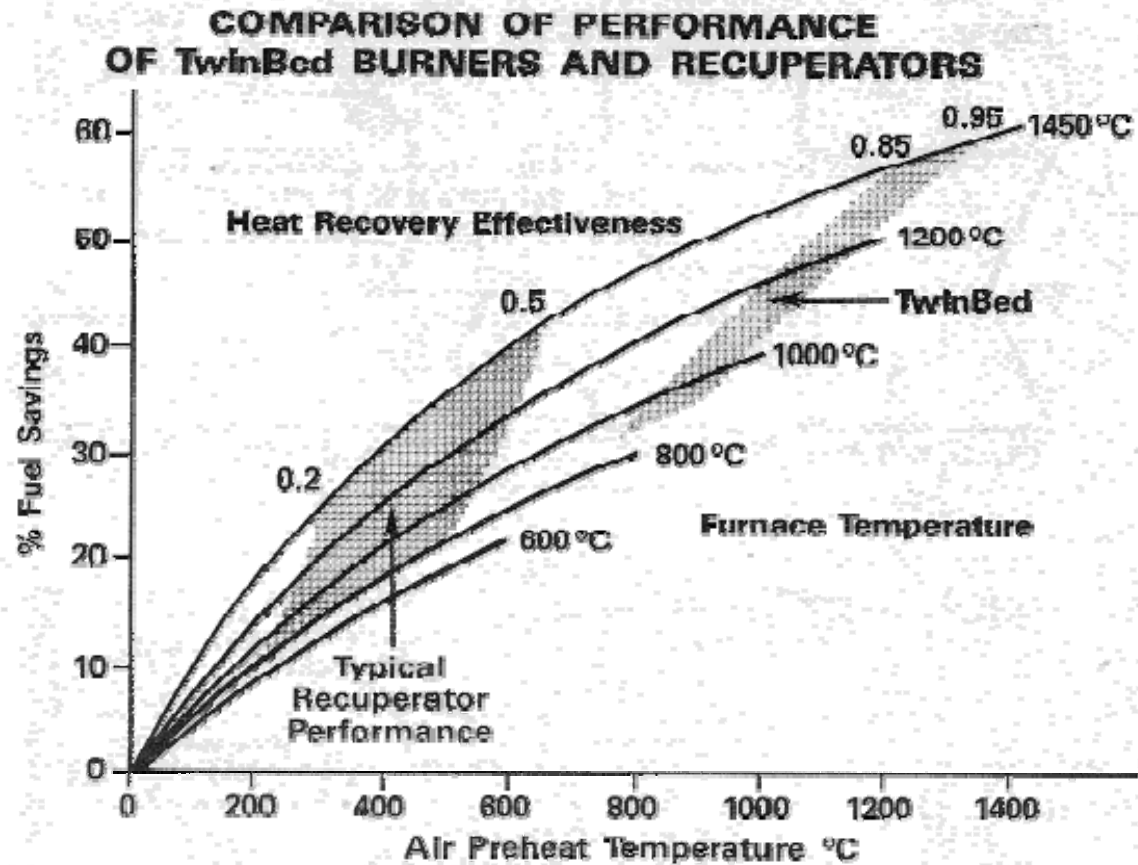
- Revolutionized energy scenario
- Considerably reduced fuel consumption in Industrial Furnaces
- Can effectively work on low CV fuels like coal producer gas, BFG, etc



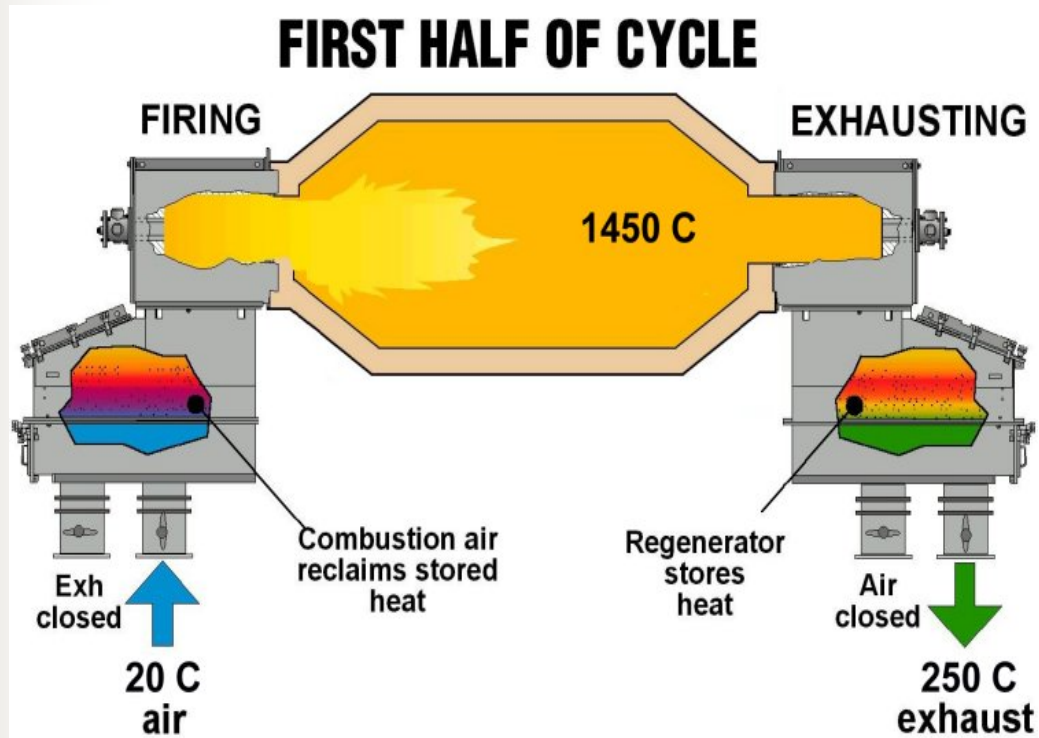
RECUPERATORS Vs REGENERATORS

- Metal recuperators fail at high temperatures and corrode on exposure to flue gases.
- Ceramic recuperators are difficult to fabricate, fail under tension and have sealing problems.
- Regenerators display none of these problems.
- Regenerators are expensive due to their size.
- They can be made smaller by:
 - ▶ Close coupling of the regenerator with the burner
 - ▶ Reduction of cycle time

A Comparison of Regen with Convention Burner



HOW A REGEN SYSTEM WORKS



- One burner fires, and the other acts as a flue port for furnace gases that heat the regenerator bed.
- The cycle is reversed after 20 seconds.

WHY ARE REGENS SO EFFICIENT?



- Ability to preheat combustion air to near furnace temperature.
- Very high flame temperature obtained due to very high combustion air preheat temperature.

Cost Benefit Analysis

■	Capital Cost (Rs. Lacs)		
	Supply of complete Combustion Package		110.00
■	Supply of Steel Structure, Refractory / Insulation, Chimney		40.00
	piping and flue duct, cables for revamping the furnace		10.00
■	Erection and Commissioning	:	
■	Total	:	160.00
■	Assumptions		
■	Production rate after revamping	:	20 MTPH
■	Production rate before revamping	:	12 MTPH
■	Added Capacity	:	8 MTPH
■	No. of hours of operation per day	:	20
■	No of working days in a year	:	300
	Cost of fuel	:	Rs. 22/- per lit.
■	Fuel saving	:	6.5 Litre / MT
■	Reduction in scale*	:	0.25 – 0.35 %

*** REDUCTION OF SCALE LOSS WILL BE OBTAINED BECAUSE OF LESSER RESIDENT TIME OF EACH BILLET**