

# Presentation

On

**UTILIZING LOW GRADE WASTE HEAT IN ENERGY  
INTENSIVE INDIAN INDUSTRIES**

By

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# SECTORS COVERED

- Sponge Iron (Iron & Steel)
- Pulp & Paper
- Glass
- Fertilizer & Petrochemicals

# WASTE HEAT SOURCES

- Exhaust gases from Kilns
  - Eg. : Sponge Iron Sector
- Exhaust gases from Furnaces
  - Eg. : Glass Industry – After Regenerator, Recuperator
- Hot process fluids, Condensate and steam from waste heat streams
  - Eg. : Fertilisers & Pulp & Paper

# WASTE HEAT RECOVERY OPTIONS

- Heat to Heat :-
  - Preheating of the Charge .
  - Preheating Combustion / Process air as per requirement
  - Reduction of Surface Heat Loss.
  - Utilization of the thermal energy available in the hot process / waste stream
    - Eg. : Customized Steam Generation / Flash Steam

# WASTE HEAT RECOVERY OPTIONS

- Heat to Power :-
  - Installation of Waste Heat Recovery Boiler and TG set for power generation by utilizing thermal energy available.
  - Organic Rankine Cycle Technology for Power Generation.
  - Screw Expander for Power Generation

# TECHNOLOGIES FOR UTILISING LOW GRADE HEAT (Heat to Power)

- **Organic Rankine Cycle:-**

- Organic fluids allow Rankine cycle heat recovery from lower temperature sources such as industrial waste heat, geothermal heat, biomass combustion, solar ponds etc.
- The low-temperature heat is converted into useful work, that can itself be converted into electricity.
- Eg. : A 8000 TPD Capacity Cement Plant consisting 4 kilns has installed an ORC plant of 4 MW capacity.

# TECHNOLOGIES FOR UTILISING LOW GRADE HEAT (Heat to Power)

- **Screw Expander Technology :-**

- Screw expander has applications for electricity generation using saturated / wet steam as the working medium for temperatures up to 225 deg C. They can also work with hot water. The expanders typically range from 60 to 500 kWe. The sets can be installed as multiple installations for higher powers.
- The units are designed to operate with a maximum inlet pressure of 25 Bar and  $\Delta P$  of up to 20 bar.

# TECHNOLOGIES FOR UTILISING LOW GRADE HEAT (Heat to Power)

- **Steamster (Micro Steam Energy Generator)**
  - The generators effectively utilize steam having a small flow, low pressure and varying volume. By utilizing such steam, which is prevalent in industries, the screw generators save energy and reduce CO<sub>2</sub> emission.
  - Supply Pressure – 2 to 9 Kg/cm<sup>2</sup>, 1 to 5 TPH of steam, 8 to 132 KW of power output.





# **SPONGE IRON SECTOR**

# APPLICABLE WHR TECHNOLOGIES

- Power Generation :-

- ❑ Heat Available in Hot Exit Flue gases for Installation of Waste Heat Recovery Boiler for Power Generation

- Preheating :-

- ❑ The heat available in the above case can also be utilized for the preheating of the charge (Iron Ore + dolomite) at the feeding end to 300 °C from ambient temp (For plant less than 200 TPD Capacity).
- ❑ The heat available at discharge end can be utilized for heating the primary air.

# CURRENT STATUS OF WHR POTENTIAL

- Almost all the large capacity plants have adopted Power Generation by installing the WHR boiler.
- Installation of WHR boiler for power generation is not economically feasible for small capacity plants
- Preheating of Charge by Hot Flue Gases & Heating the Primary Air at discharge end by Hot DRI can be best implemented at the design stage itself.



# Pulp & Paper Sector

# APPLICABLE WHR TECHNOLOGIES

- **Flash Steam Generation** from high pressure Condensate in Paper Machines
  - ❑ To be used in low pressure section of the paper machine.
  - ❑ For feed water heating, up to 75 °C
  - ❑ Utilized in the thermo - compressor - The resulting steam can be used in the process again
- **Digester Blow Heat Recovery** - Flash Steam Generation & Utilization in the Heat Recovery System
- **Screw Expander** : Steam is used at the pressure of 8-10 Kg/cm<sup>2</sup> in the digester and 2-4 Kg/cm<sup>2</sup> in paper machine . However the steam is produced in the boiler at higher pressure i.e at 15-20 Kg/cm<sup>2</sup>. The Screw Expander can be installed in place of PRDS for power generation wherever co-generation is not available

# Case Study

## Paper Plant in Pune

### Salient points of the plant

- The Paper Mill has two machines of 40 TPD each and two machines of 50 TPD each ( Total 180 TPD Capacity)
- The plant has installed a co-generation plant with the following details  
600 – 700 TPD boiler capacity, Coal based boiler, 25 Kg/cm<sup>2</sup>, 250°C
- The boiler generates steam at 21 Kg/cm<sup>2</sup> (Around 600 Tonnes per day). About 250 tonnes of steam per day is passed through PRDS for lowering the pressure from 21 Kg/cm<sup>2</sup> to 14 Kg/cm<sup>2</sup>. The balance steam is expanded thorough backpressure turbine ( 4.5 Kg /cm<sup>2</sup> back pressure )

## LOW TEMPERATURE WASTE HEAT RECOVERY

- The PRDS installed can be replaced with the screw expander for power generation.
- The flash steam at the final condensate tank is let off to atmosphere. The same can be used for hot water generation which can be used in the process.
- Considering the 10 tonnes of steam passed through the PRDS for reducing pressure from 21 Kg/cm<sup>2</sup> to 14 Kg/cm<sup>2</sup>. Installing a Screw Expander in place of the PRDS will generate power of 219 KW.

# Paper Mill, Ambernath

The salient points of the plant are indicated below:

- The plant is manufacturing packing paper, The plant has installed Single M/c of 100 to 130 tonnes per day production capacity
- The boiler details installed in the plant are as follows  
12 TPH Capacity , Coal based – FBC boiler, 11 Kg/cm<sup>2</sup>, 225°C ,  
flue gas temp = 140°C on full load (before chimney )
- Condensate recovery: Flash steam used in thermo compressor
- The boiler is generating steam at 11 Kg/cm<sup>2</sup> (Around 12 Tonnes per hour). The 9 tonnes per hour of the steam is passed through PRDS for lowering the pressure from 8 Kg/cm<sup>2</sup> to 4 Kg/cm<sup>2</sup> for process use



# LOW TEMPERATURE WASTE HEAT RECOVERY

- The PRDS installed can be replaced with the screw expander for power generation.
- Considering the 9 tonnes of steam passed through the PRDS for reducing pressure from 8 Kg/cm<sup>2</sup> to 4 Kg/cm<sup>2</sup>. Installing the a Screw Expander in place of the PRDS will generate power of 113 KW.



# Glass Sector

# APPLICABLE WHR TECHNOLOGIES

- For Plants having Regenerators – The final flue gas temperature is 450 °C.
- For the Plants having Recuperators – The final flue gas temperature is 600 °C.
- For both the cases above, there is possibility of Installing Screw Expander for Power Generation

# Case Study

## 1. GLASS PLANT - 1:

- This unit is involved in manufacturing glass bottles as per the customer requirement. The plant has installed two glass melting furnace having capacity of 300 TPD and 350 TPD.
- LSHS is the main fuel used in the glass melting furnace. The average fuel firing rate is 1310 LPH. The fuel is preheated up to 115 to 120°C
- The final flue gas temperature after the regenerator is about 540°C. The average flue gas temperature will vary from 450 to 540°C which is released to atmosphere.

## 2. GLASS PLANT - 2:

- The plant has installed two glass melting furnace having capacity of 450 TPD.
- Furnace oil and pet coke are the main fuels used in the glass melting furnace. About 98% pet coke and 2% furnace oil is used.
- The final flue gas temperature after the regenerator is also around 540°C.

# LOW TEMPERATURE WASTE HEAT RECOVERY:

- The flue gas temperature after regenerator which is sent to chimney is above 450°C.
- The waste heat available can be used to generate steam and running steam turbine.
- The waste heat can be also used to heat thermic fluid and then supplying heating requirement at lehr.
- The waste heat can be used to preheat atmospheric air and the hot air can be circulated to lehr and shrink tunnel.
- Based on the quantity and temperature of the flue gases available for utilizing the heat available, the power generation potential of the following capacity can be achieved by installing a Screw Expander. The steam is to be produced by utilizing the thermal energy available in the flue gases and expanding the steam in the Screw Expander.

# LOW TEMPERATURE WASTE HEAT RECOVERY:

## POWER GENERATION POTENTIAL

- Plant – 1: 445 KW
- Plant – 2 : 735 KW



# Fertilizer & Petrochemicals Sector

# APPLICABLE WHR TECHNOLOGIES

- Most of the Fertilizer units have captive power generation & co-generation facilities.
- The Natural Gas is used as fuel in Reformer & Boiler at less than 10 Kg/cm<sup>2</sup> pressure . The Gas is being supplied at 40 Kg/cm<sup>2</sup> pressure . By installing the Gas Expander for the Gas Quantity being used as fuel in Reformer and Boiler, power can be generated.
- In Fertilizer Plants, maintaining a steam balance at different pressures is always a challenge and there is a tendency of surplus in low pressure steam. This can be utilised for power production in Screw Expander System.
- Installing a Screw Expander in place of steam PRDS in the existing system



# Case Study

## A Fertilizer & Petrochemicals Complex

- **Scheme 1 : Power recovery from steam let-down**
  - Presently about 10 TPH of steam at 41 Kg/cm<sup>2</sup> is being let-down to a pressure of 17 Kg/cm<sup>2</sup> through a PRDS. The potential energy in the steam is wasted in this case. Installing a steam expander to recover this energy for generating power was therefore considered.
  - The above arrangement provides scope for additional power generation of 80 KW
  - It may however be mentioned here that fertiliser plants have surplus steam at low pressures i.e., 3.5 Kg/cm<sup>2</sup> which again can be traced back to a source at higher pressure. To increase the potential for power recovery from the expander, there is a need for detailed investigation on the steam pressure drops within the plant to arrive at the quantity of steam that is being effectively let down to 3.5 Kg/cm<sup>2</sup>.

- **Scheme 2 : Power recovery from Natural gas let-down**

- Presently about 7000 NM<sup>3</sup>/hr of Natural gas is being let down from 25 Kg/cm<sup>2</sup> to 8 Kg/cm<sup>2</sup> for use as fuel in the plant. Installing a gas expander instead of the let-down valve to recover the potential energy in the gas for power generation will lead to additional power generation of 140 KW.



# Refinery Sector

# APPLICABLE WHR TECHNOLOGIES

- The steam is required at various pressure levels for process. In order to meet the steam demand the steam is generated at 1 or 2 nominal pressures and the demand at other pressures is met by reducing the pressure through PRDS and through steam turbine extraction/exhaust.
- The potential energy in the steam is wasted in these cases. Installing a steam expander to recover this energy can be considered..

# Case Study

## A Refinery in the Western Region

- The total steam requirement of the plant is about 250 TPH. The steam is required at various pressures i.e. at 41 kg/cm<sup>2</sup>, 14 kg/cm<sup>2</sup>, 10 kg/cm<sup>2</sup> and 2.6 kg/cm<sup>2</sup>. In order to meet the steam demand the steam is generated at two different pressures i.e. 41 kg/cm<sup>2</sup> and 14 kg/cm<sup>2</sup> and the demand at other pressures is met by reducing the pressure through PRDS.
- On the basis of inlet and outlet pressure conditions and the steam flow the total power generation potential works out to about 3700 KW.



**Thank You**