# INSTALLATION OF ENERGY EFFICIENT IBR BOILERS (NG/Biomass)

(***For Ankleshwar Chemical Cluster***)

## Cluster Brief:

Gujarat is a major contributor in the production of basic chemicals as well as petro-chemicals with 54% and 59% share of the country's production, respectively. Also, chemicals /petro-chemicals and pharmaceutical sectors contribute to about 60% in the entire manufacturing output of Gujarat. About 50% of the total chemical production in Gujarat is contributed by industries in Ankleshwar. Ankleshwar and Panoli industrial areas has more than 1,200 industries, manufacturing diverse range of chemicals, pesticides, pharmaceuticals, bulk drugs, petroleum products, engineering, textiles, plastics, rubber, and packaging. Out of these 1,200 units, more than 600 are MSME units manufacturing various types of chemicals, like dyes, pigments, insecticides, specialty chemicals, petrochemicals, pharmaceuticals, and paints. Varieties of basic chemicals are used as raw materials to manufacture major chemical products. These basic chemicals, used as raw materials, are classified according to a variety of features:

- ✔ Based on their chemical composition (organic and inorganic),
- ✔ Based on their origin (mineral, vegetative, and animal), and
- ✔ Based on their state of aggregation (solid, liquid, and gaseous).

Majority of the industries located in Ankleshwar and Panoli are wet processing units which requires high amounts of thermal energy in the form of steam and thermic-fluid and electrical energy. The sector is unorganized in nature, mostly using old and inefficient technologies. There is a significant potential to make these units energy efficient and cost competitive, through accelerated adoption of energy efficient technologies in the cluster.

## Existing practice:

Majority of the chemical industries uses conventional boilers (Non IBR) for generation of steam, for use in the manufacturing process of chemicals. Non IBR boilers have a higher steam release velocity leading to generation of wet steam when steam demand increases (normal dryness fraction between 0.7 and 0.8). Whereas, IBR boilers respond well to fluctuating loads without affecting steam quality due to lower steam release velocity (dryness fraction - 0.98). Thus, IBR boiler is the better choice if dry steam is important.

Figure: Non-IBR boiler

Most of the boilers used in the cluster are inefficient with operating efficiency ranging from 65 to 77%. These boilers are equipped with conventional pipe burners and do not have any monitoring and control. These boilers are also risky considering the safety point of view.

The operating parameter for a conventional boiler of 1 tph has been tabulated below:

***Table 1: Operating parameter of existing Non IBR boiler***

| Particulars | Units | Value |
|---|---|---|
| Rated Capacity | tph | 1 |
| Steam generation | kg/h | 700 |
| Steam pressure | $kg/cm^2$ | 4 |
| Steam temperature | $^0C$ | 148 |
| Feed water temperature | $^0C$ | 40 |
| GCV of fuel | kcal/SCM | 9,507 |
| Fuel consumption | SCM/h | 67.39 |
| Boiler efficiency | % | 77 |

## Proposed technology:

Energy Efficient IBR boiler is used expressively for generating steam under pressure and includes any mounting or other fitting attached to such vessel which is wholly or partly under pressure when steam is shut off. Major advantages of replacement of conventional Non IBR boiler with IBR Boiler are given below:

- Efficiency improvement
- Fuel saving
- Quality improvements
- Productivity improvements
- Improved working environment
- Resultant GHGs reduction
- Lesser break down
- Safety assurance

**Figure: Energy efficient IBR steam boilers**

The new energy efficient IBR boiler is considered both for **'Natural-Gas'** and **'Biomass/coal'** firing.

By considering all the advantages, it is recommended to install energy efficient IBR Boiler. The proposed technology **"Natural Gas / Biomass / Coal fired Energy efficient IBR boiler"** includes:

**PRESSURE PART ASSEMBLY-**

- One Pressure part assembly consisting of the full fusion welded shell consisting of wet back furnace and two sets of convection smoke tubes, hinged ceramic lined front doors and smoke chamber with soot cleaning door
- Two fusible plugs are provided as an ultimate mechanical safety to prevent the boiler from overheating in case of low water level in boiler

**BURNER WITH AIR REGULATING ASSEMBLY-**

- One Industrial burner with high-low flame control having pilot flame for burner light up. Flame sensor is provided in the burner to detect the flame in auto mode operation
- Damper assembly with step motor & cam linkages. Separate cams are provided for fuel & air. Proper support frame is provided to mount the air regulating assembly.

**FORCED DRAFT COMBUSTION AIR FAN-**

- One backward curved design forced draft (FD) combustion air fan with the motor & flexible duct at the suction & discharge of the fan to prevent other components from any vibration. Arrangement is provided to connect the Air regulating assembly at the suction of the fan

**FEED WATER PUMPS-**

- Two highly efficient centrifugal multi-stage, vertical feed water pumps with motor. Impellers & shaft of the pump are of stainless steel.

**FIELD MOUNTED INSTRUMENTS-**

- One Pressure switch for burner ON/OFF control.
- One Temperature element for flue gas temperature.
- One Pressure switch to sense low combustion air pressure (Applicable in case of gas or oil/gas fired units only)
- One main stream pressure gauge
- Two float operated magnetic water level controller

**HIGH PRESSURE GAS TRAIN (FOR NATURAL GAS FIRING):**

- A gas train consists of Filter, Slam-shut off valve, pressure regulator, safety relief valve & flame arrestor. Filter helps to remove the dust / dirt particles in the gas which may damage the regulator parts. The slam shut off valve normally remains open. In-case the outlet pressure of the regulator exceeds the permissible limits; the slam shut off valve senses it through the impulse line & instantly shuts off the supply to the downstream system.
- The safety relief valve is provided for additional safety. It is to be set at a higher pressure than the slam shut off valve pressure so that the safety relief valve will operate only when slam shut off valve fails to operate. The outlet of the safety relief valve is vented well above the roof.

**AUTOMATED BIOMASS /COAL CHARGING SYSTEM (FOR SOLID FUEL FIRING):**

- An automatic Biomass/coal charging system consisting of hopper and screw based feeding system for controlled charging of fuel to be provided.

## Justification of technology selection:

The proposed technology of installation if energy efficient IBR boiler not only helps to improve product quality but also can save fuel consumption, improves boiler efficiency, improves steam quality and evaporation ratio. The improvement envisaged through the installation of the system has been summarized in the table below:

***Table 3: Performance parameters of boiler (for 1 tph NG fired boiler)***

| Parameter | Current Operation | Existing scenario | Post Implementation of scenario |
|---|---|---|---|
| NG consumption | 67 SCM/h<br>(considering a 1 tph NG fired boiler) | Lesser heat transfer due to generation of wet steam leads to more NG consumption | Installation of IBR boiler reduces fuel consumption and improves specific thermal energy consumption |

| Parameter | Current Operation | Existing scenario | Post Implementation of scenario |
|---|---|---|---|
| Combustion air requirement | Not measured | Lesser boiler efficiency leads to more fuel and more combustion air requirement | Installation of IBR boiler reduces combustion air requirement and proportional power saving in FD fan which improves specific electricity consumption |
| Boiler efficiency | 77 % | Low boiler efficiency will lead heat and fuel loss more | Installation of IBR boiler improves boiler efficiency upto 85-90 % |

## Estimated Energy & monitoring saving:

As mentioned in the earlier segments, the boiler capacity at Ankleshwar chemical units varies from 0.3 to 3 t/h. For calculating the energy and monetary benefits, a representative case of NG fired boiler of 1 t/h has been considered. The benefits envisaged through installation of energy efficient IBR boiler has been summarized in the table below:

***Table 4: Cost benefit analysis for Natural gas fired IBR boiler***

| Particulars | Unit | Baseline | Post Implementation |
|---|---|---|---|
| Rated Boiler Capacity (For like to like comparison) | kg/h | 1,000 | 1,000 |
| Steam Load | kg/h | 700 | 700 |
| Boiler efficiency | % | 77 | 87% |
| Steam temperature | degC | 148 | 148 |
| Steam pressure | kg/cm2 | 4 | 4 |
| Steam enthalpy | kcal/kg | 657 | 657 |
| Feed water enthalpy | kcal/kg | 40 | 40 |
| GCV of fuel | kcal/SCM | 9,507 | 9,507 |
| Natural Gas consumption | SCM/h | 67.39 | 60.00 |
| Natural Gas savings | SCM/h | | 7.39 |
| Natural gas saving annually | SCM/y | | 13,412 |
| Fuel price | Rs./SCM | | 38.6 |
| Annual monetary saving | Rs. Lakh | | 5.18 |
| Cost of equipment | Rs. Lakh | | 11.15 |
| Total Project cost | Rs. Lakh | | 13.95 |
| Simple payback period | years | | 2.7 |

* extracts of calculation provided

The benefits can be summarized as:

- ✔ 10-15% reduction in specific power consumption
- ✔ Improvement in boiler efficiency by 10-15%

## Replication Potential:

Ankleshwar has a large number of chemical processing units forming clusters around common effluent treatment plants (CETPs). The Ankleshwar Industries Association (AIA) is the biggest association operational in the cluster, with close to 600 registered chemical units. To establish the replication potential of the technology in the sector, the following were considered:

- ✔ Technology feasibility and adaptability through energy audits in 8 units.
- ✔ Survey of 100 units
- ✔ Meetings held with associations / stakeholders (including technology suppliers)

The Installation of NG/Coal fired IBR boiler have potential in the cluster, with 41 out of 100 surveyed units so far, showing interest in the technology having gas fired boiler with old or non IBR boilers. The capacity of these boilers are range from 0.5 Ton to 3 t/h .

Out of the technologies identified for the Ankleshwar cluster, energy efficient IBR boiler replacement has a 31% replication potential among all the technologies.

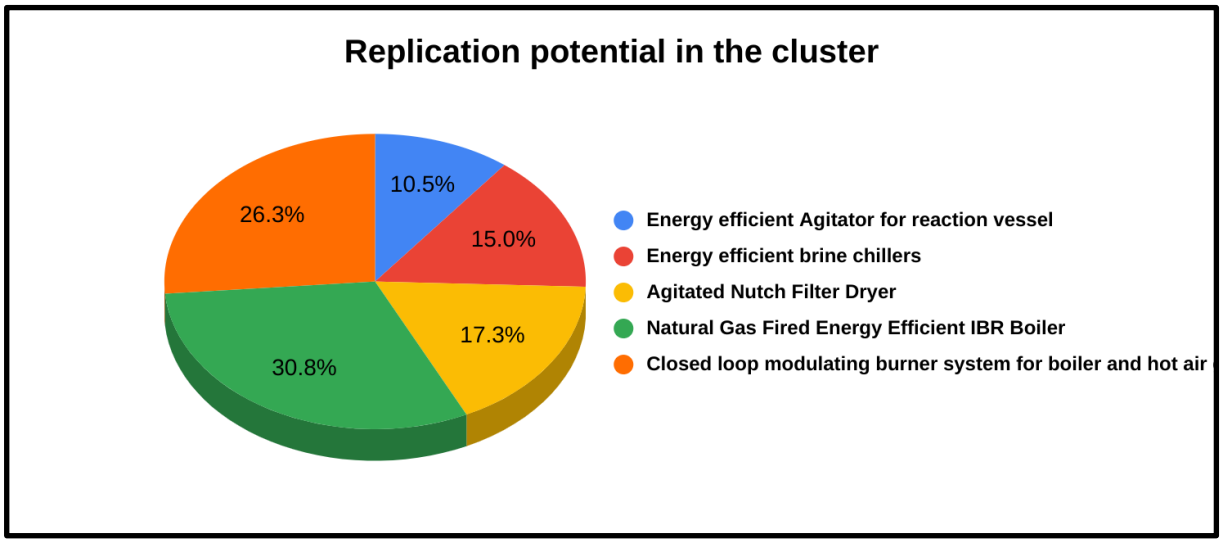


***Figure 1: Summary of survey results***

Considering the survey results and based on further discussion with associations, units, stakeholders and outcome of the energy audits, it is estimated that the technology has a replication potential of 30.8% in the cluster, i.e. 41 units. Based on replication in 41 units, the overall project benefits will be as follows:

***Table 5: Impact of replication of technology***

| Parameter | UoM | Value |
|---|---|---|
| Annual thermal energy saving (one unit) | SCM/y | 13,412 |
| Annual thermal saving (considering 35 units) | SCM/y | 469,407 |
| Annual energy saving (considering 35 units) | MJ/y | 18,680,679 |
| Annual CO2 emission saving (one unit) | tCO2/y | 24.3 |
| Annual CO2 emission saving (considering 35 units) | tCO2/y | 849 |
| Estimated investment in technology (one unit) | Rs Lakh | 13.95 |
| Estimated investment in technology considering 41 units (assuming price down due to demand aggregation) | Rs Lakh | 488 |
| Total Investment | Mn USD | 0.7 |
| Total energy savings (in 10 years) | TJ | 187 |
| Annual CO2 emission saving (in 10 years) | tCO2 | 8,495 |

## Barrier for implementation:

Although the technology has been successfully proven; there has been limited replication of the technology in the cluster. The barriers identified for limited penetration of the technology in the cluster are as follows:

- ✔ **Knowledge barrier:** Based on discussion with units, it has been found that knowledge dissemination related to the technology has been limited. The boiler installation has been limited to temperature and pressure control in the units. Most of the units are unaware of other key parameters (including boiler feed fuel and air control) which are important to optimize the boiler performance.
- ✔ **Lack of after-sales service:** The technology penetration has been limited due to the lack of after sales service. The delay in such services forces the units to bypass the automation system. The annual maintenance contract and warranty, which has been inbuilt in the present model, is expected to take care of the issue.
- ✔ **Lack of skilled manpower:** The technology requires skilled manpower and /or training within the existing manpower to operate the system at optimum level. Such training has been incorporated in the model.
- ✔ **Risk related to implementation:** The units lacks confidence related to performance of the technology. The risk of performance has been covered under the project. **Lack of monitoring instruments:** Not clear about their existing level of operations and efficiency, due to lack of instrumentation & non availability of energy consumption data
- ✔ **Narrow focus on energy:** The units have much interest in production figures and committed for target production
- ✔ **Limited manpower:** implementation of new technology in unit may require skilled man power which is also a barrier

## Availability of technology supplier:

The technology of IBR Boiler has been well established. A large number of reputed technology supplier cum integrators are involved in supply and service of the technology. Most of these technology suppliers have local offices / representative at Surat and nearby. In addition to the established names, a large number of smaller system integrators are also involved in the supply of this technology. Some of the established technology suppliers are:

- ✔ Thermax global
- ✔ Rajdeep Boiler Pvt. Ltd.
- ✔ Utech Projects Pvt. Ltd.
- ✔ Energy Process Equipment
- ✔ Cheema Boilers