DEMONSTRATION OF ENERGY EFFICIENCY PROJECTS (DEEP)

PROGRAM OBJECTIVE

Bureau of Energy Efficiency (BEE) has partnered with EESL to support Designated Consumers in PAT sector by creating an ecosystem, which shall provide support in meeting allocated Specific Energy Consumption (SEC) reduction targets to DCs under the PAT scheme, as also support market transformation for innovative technologies to enable substantial carbon emissions reduction for the environmental benefit.

Under the DEEP program, EESL shall demonstrate 8 innovative technologies in about 27 Designated Consumers (DCs) that have not yet been commercialized on a large scale but have good potential for energy efficiency improvement. Subsequently, EESL shall aggregate the demand for such EE technologies with an objective to reach out to maximum number of Designated Consumers for large-scale deployment of these and similar EE technologies in PAT sector to achieve the market transformation.

FIRST SET of APPROVED TECHNOLOGIES

- Micro- Turbine
- Turbo Blower
- VFD enabled Screw Compressor
- Low Grade Waste Heat Recovery (LGWHR)

*Balance four technologies will be finalized shortly.

SECOND SET of APPROVED TECHNOLOGIES

The following are the next set of technologies approved.

- High-Grade waste heat recovery system
  - Scrap Preheating with Electric Arc furnace Exhaust
  - Regenerative Burners for Reheating Furnaces
  - Recuperator
- Cooling solutions from Low-Grade Waste heat recovery (Vapour Absorption Machine) system
- Industrial Automation
  - Online Coal GCV Analyser
  - Automatic Blowdown-Control System
  - Intelligent Flow Controller (IFC) for Compressed Air Network
- IE4 motors with VFD
- Inlet air cooling

DESIGNATED CONSUMER SELECTION CRITERIA FOR PILOT STUDY

S. No.	Criteria	Sub Criteria	Qualifying Criteria	Weightage for selection
1.	Percentage Upfront contribution by DC	% of estimated project cost*	Min. 30%	50%
2	Overall contribution	Total contribution (In INR)	INR	50%
If the sum of score of 1 and 2 is same, following marking will adopted for the selection of beneficiary units.				
I	Specific energy saving	Cost basis (toe/Lakh Rs.)	Energy saved per INR lakh of investment	50%
II	Specific emission saving	Cost basis (tCO2/ Lakh Rs.)	GHG mitigated per INR lakh of investment	50%

*Estimated project cost includes the cost of equipment and associated accessories, freight, and insurance, unloading, installation and commissioning, etc.

PROGRAM ENGAGEMENT METHODOLOGY

ABOUT EESL

Energy Efficiency Services Limited (EESL), a Joint Venture of four Public Sector Undertakings (PSUs) of Ministry of Power (MoP), Government of India, was established in 2009 as the implementation arm of MoP and Bureau of Energy Efficiency (BEE), Govt. of India. The four central PSU promoters of EESL are National Thermal Power Corporation Limited (NTPC), Power Grid Corporation of India Limited (PGCIL), Power Finance Corporation Limited (PFC) and Rural Electrification Corporation (REC). The objective of the EESL is to lead the market transformation initiatives of Govt, of India under the National Mission for Enhanced Energy Efficiency (NMEEE) as well as to create and sustain markets for energy efficiency.

Since its inception in 2009, EESL has been spearheading implementation of various large-scale energy efficiency programs in the country in domestic, municipality, agriculture, building and industrial sector.

TECHNOLOGY INFORMATION

Technical details of approved innovative energy-efficient technologies are given below:

High-Grade waste heat recovery system

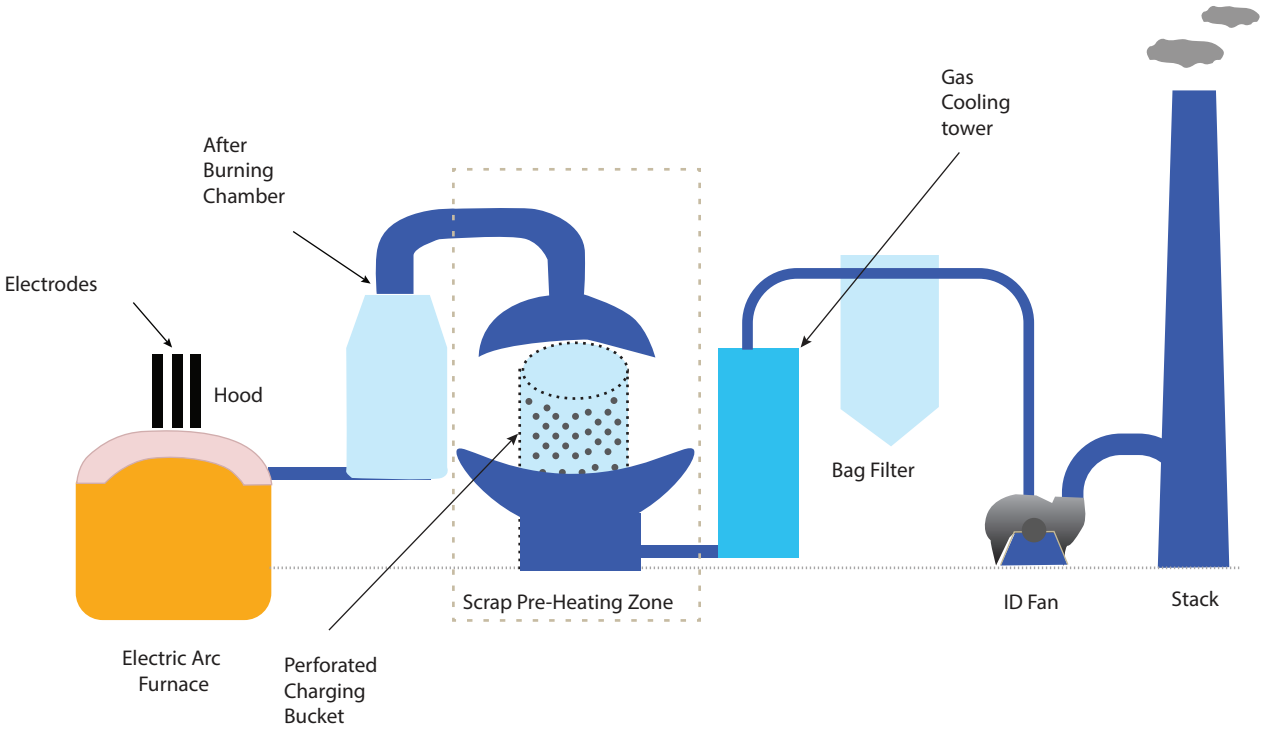
Scrap Preheating with Electric Arc furnace Exhaust

Electric arc furnace involves a high-temperature melting operation. The average temperature of the melt inside the furnace is about 1650 °C. The waste gases or off-gases from the furnace leave at about 900-1200 °C, which is quite high, wasting significant energy. About 20% of the input energy is carried away by the off-gases. This waste heat available in off-gases can be effectively recovered and reused which would help in reducing the overall energy consumption of the furnace. One of the major options for WHR is preheating input scrap. The exact energy savings depend on the type of scrap, size, the temperature of off-gases and residence time.

The most established scrap preheating technologies applicable for EAFs are:

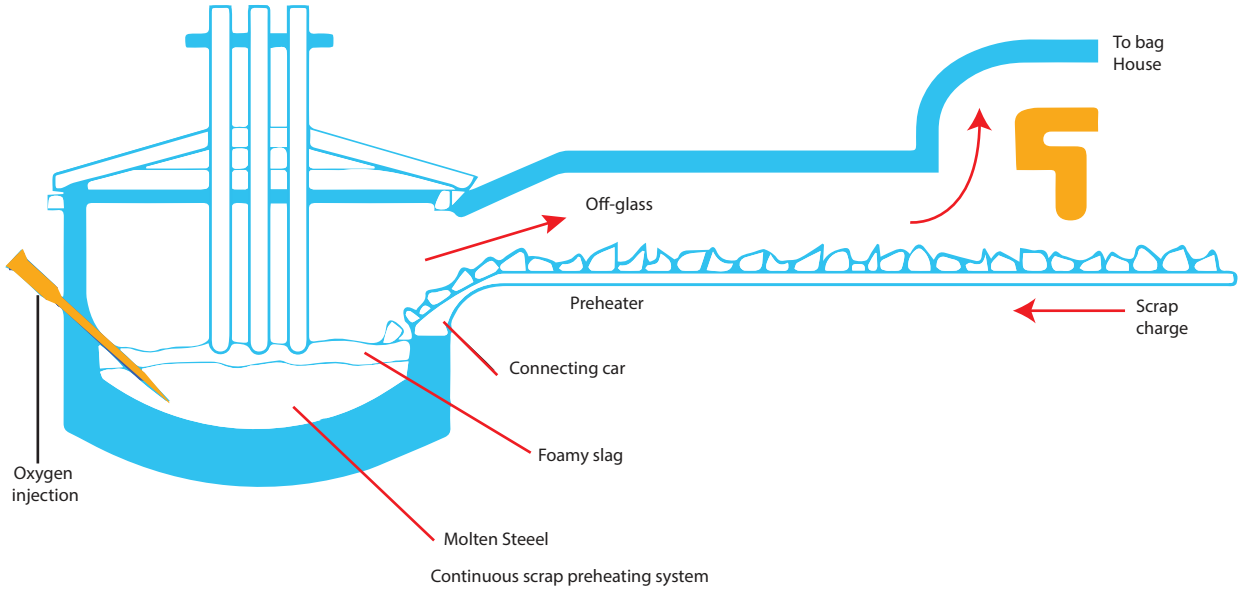
- **Bucket preheating system**

  In this type of preheating, hot off-gases from the furnace are directed into the scrap charging bucket with a piping and special hood arrangement. The off-gases enter the bucket at about 800 °C, and leave at around 200 °C, after imparting sensible heat to the scrap. The scrap can be preheated to about 400 °C.



- **Continuous scrap preheating system.**

  Considering application in the Iron & Steel industry, the use of an EAF, already uses approximately 30 to 40 % less energy than the primary route (blast furnace, DRI kilns). Partial scrap preheating generally saves about 60 kWh/ton, while total scrap preheating saves up to 100 kWh/t of liquid steel (IPPC, 2001). Since lower electricity use leads to lower CO2 emissions the technology supports environmental protection.



Continuous scrap preheating system

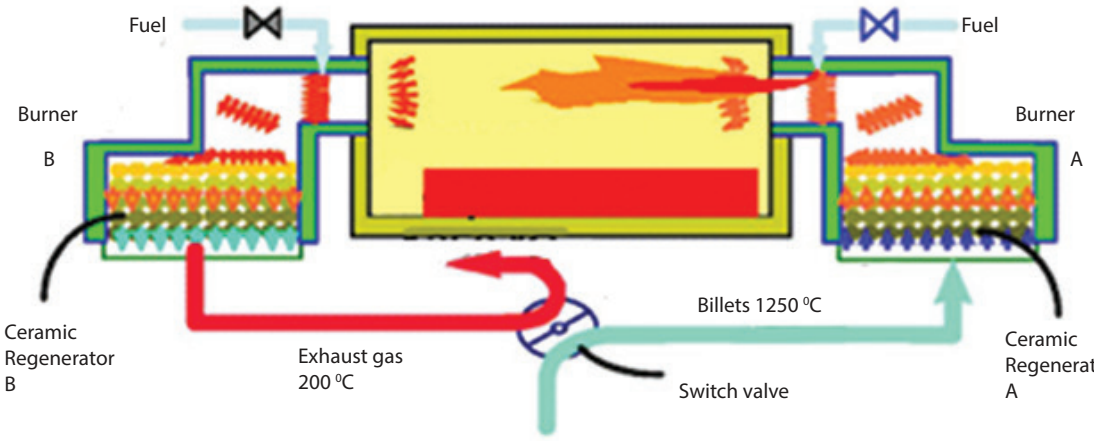
Regenerative Burners for Reheating Furnaces

The regenerative burners fire alternately to recover the sensible heat from waste gas for the preheating of combustion air. The systems are capable of obtaining high-temperature preheated air exceeding 1,000 in a short timeframe, by repeated heat accumulation and combustion. They recover between 85 -90 % of the heat from the furnace waste gases; therefore, the incoming combustion air can be preheated to very high temperatures of up to 10° -150 °C below the furnace operating temperature. Application temperatures range from 800oC up to 1500 °C. Fuel consumption can be reduced by up to 60 %.

This burner can be used with various gaseous and liquid fuels like

• Gaseous Fuels: LPG, Natural Gas, Producer/ SynGas, Coke Oven Gas, Blast Furnace Gas, etc

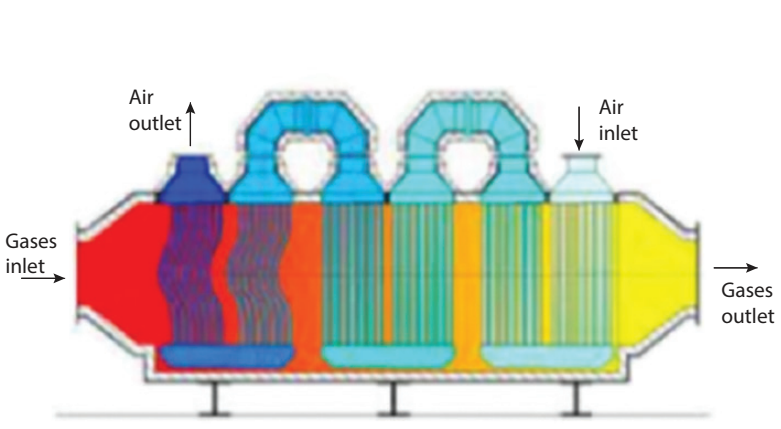
• Liquid Fuel: Diesel, LDO, HFO, FO, pyrolysis oil, etc.



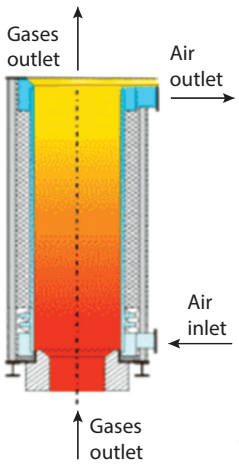
Source: APP, 2010

Recuperator

In a recuperator, heat exchange takes place between the flue gasses and the air through metallic or ceramic walls. Ducts or tubes carry the air for combustion to be preheated, the other side contains the waste heat stream. Recuperators are classified based on the principle of heat transfer by radiation, convection, or combinations. Recuperators are constructed out of either metallic or ceramic materials. Metallic recuperators are used in applications with temperatures below 1050 °C, while heat recovery at higher temperatures is better suited to ceramic tube recuperators which can operate with hot side temperatures as high as 1500 °C and cold side temperatures of around 950 °C. For maximum effectiveness of heat transfer, hybrid recuperators are used. These are combinations of radiation and convective designs, with a high-temperature radiation section followed by a convective section.

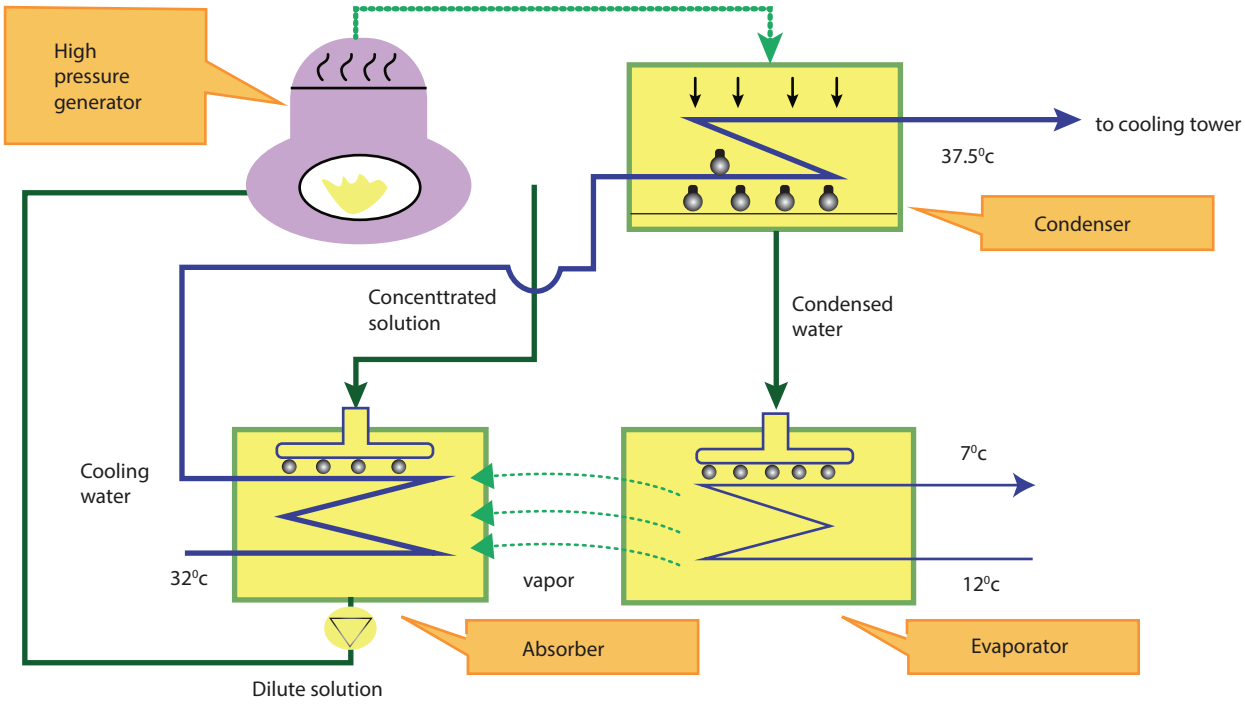


Convective Recuperator



Cooling solutions from Low Grade Waste heat recovery (Vapour Absorption Machine)

A vapour absorption chiller (VAM[1]) is a machine to produce chilled water using heat sources such as steam, hot water, and gas. A fluid pair of lithium bromide and water are used in commercial VAM. The refrigerant used is actually water, as that is the working medium that experiences a phase change and causes the cooling effect. The second fluid that drives the process is salt, generally lithium bromide. Heat is used to separate the two fluids, when they are mixed in a near vacuum environment. For low-temperature applications, ammonia-based absorption machines are used that utilize ammonia as a refrigerant and water as an absorbent. These machines use only a small fraction of electricity as compared to the conventional vapour compression chillers. Vapour absorption systems work with non-CFC environmentally friendly refrigerants such as water or ammonia.



Industrial Automation

Plant Performance Management

Plant Performance Management (PPM) software module enables power plant operators to understand plant performance. The software breaks down the causes of Heat Rate deviation into Operating conditions (load, cooling water temp, etc) and Equipment Degradation (turbines, condensers, heater).

The software uses state-of-the-art AI tools like neural networks and advanced thermodynamic models and segregates the cause of Heat Rate deviation into two buckets viz. equipment degradation and operating condition deviation. It analyses the boiler, turbine, condenser, heater, and pumps according to ASME/PTC equations and displays the heat rate deviation online and offline. It takes data from plant DCS through OPC for calculation.

Heat Rate impact due to Operating condition deviation can never be avoided. But the same can be minimised by grouping them into non-controllable deviation (load, CW temperature, etc.) and controllable deviation (MS and RH temperature/pressure, spray and blowdown). Once the controllable deviation is baselined, it can be optimised either manually or using an advanced optimization package, implemented separately.

[1] https://pdhonline.com/courses/m130/m130content.pdf

Process Optimisation

Industry 4.0, has embraced automation, data exchange and manufacturing technologies. At the core of this new industrial revolution bringing in unlimited possibilities are digital twins. In complex industries such as Thermal Power, Oil and Gas, Chemicals, etc, assets are working round the clock with each other to achieve a combined goal. They operate in extreme and varying conditions (like input change, weather, and demand change) which cause suboptimality. The Digital Twin of an entire process helps model the relationships between multiple assets and learn the optimal configuration for any desired output. This helps plant personnel to operate assets and processes at the peak possible performance, always.

Online Coal GCV Analyser

Description of the Technology:

The online Coal GCV Analyser provides real-time data that can then immediately drive decisions at the power plant. This analysis method uses a radioisotope that has a low energy level, can be used for a long time without requiring replacement, has low radiation and is safe and reliable. This analyser finds extensive use in Coal Mining, Coal Washeries, Coal Blending Plants, Coal-fired Power Plants, Coking Plants, steel plants, etc. It is especially suitable for online coal ash analysis on the entire belt conveyor during the coal transportation process.

Installation of the machine has given the advantage of feeding close-to-design GCV coal in the Boiler for optimizing combustion. Unscheduled loss of generation on account of coal quality can be avoided. Additionally, it also provides online information on the Slagging index of the coal, so that Boiler slagging & hence long outages can be prevented.

Benefits:

- Helps in real-time analysis of coal GCV
- Helps in feeding close-to-design GCV coal to boiler
- Helps in optimised combustion of coal
- Reduction in loss of generation due to poor coal quality

Automatic Blowdown-Control System

Description of the Technology:

Boilers generate steam used for heating or manufacturing processes. When steam leaves the boiler, impurities (TDS – total dissolved solids) are left behind to accumulate in the boiler. Accumulation of TDS beyond their solubility limit results in the formation of scale.

Blowdown is the process of removing water with high concentrations of TDS and replacing it with fresh makeup water with lower levels of TDS, thereby lowering the overall TDS in the boiler.

Manual Blowdown

- Involves manually opening a blowdown valve at various times throughout the day; used in conjunction with a hand-held conductivity meter to keep some degree of control over TDS levels.
- Results in high and low conductivity spikes due to boiler load variances.
- Conductivity levels above the target maximum lead to the formation of scale. Conductivity levels below the target maximum result in excess water and chemical usage.
- At best, manual systems err on the safe side and keep TDS too low.

Automated Blowdown

- Uses an automated controller and valves to continuously or intermittently sample the boiler water and then blowdown as needed.
- Types of Automated Blowdown

  a. Continuous Sampling – Used when steam blowdown requirements exceed 2000 kg/hr. A sample of water is continuously sent across the conductivity probe to drain. When conductivity levels exceed the target maximum, a larger blowdown valve opens and sends more water to drain until the set point is satisfied.

  b. Timed Sampling (most common) – Used when steam blowdown requirements are less than 2000 kg/hr. A sample of water is intermittently sent across the probe for a predetermined amount of time (interval and duration are adjustable), and the blowdown valve is held open until the conductivity set point is satisfied.

Boilers without a blowdown heat recovery system and with high blowdown rates offer the greatest energy-savings potential. The optimum blowdown rate is determined by a number of factors, including boiler type, operating pressure, water treatment, and makeup-water quality. Savings also depend upon the quantity of condensate returned to the boiler.

Benefits

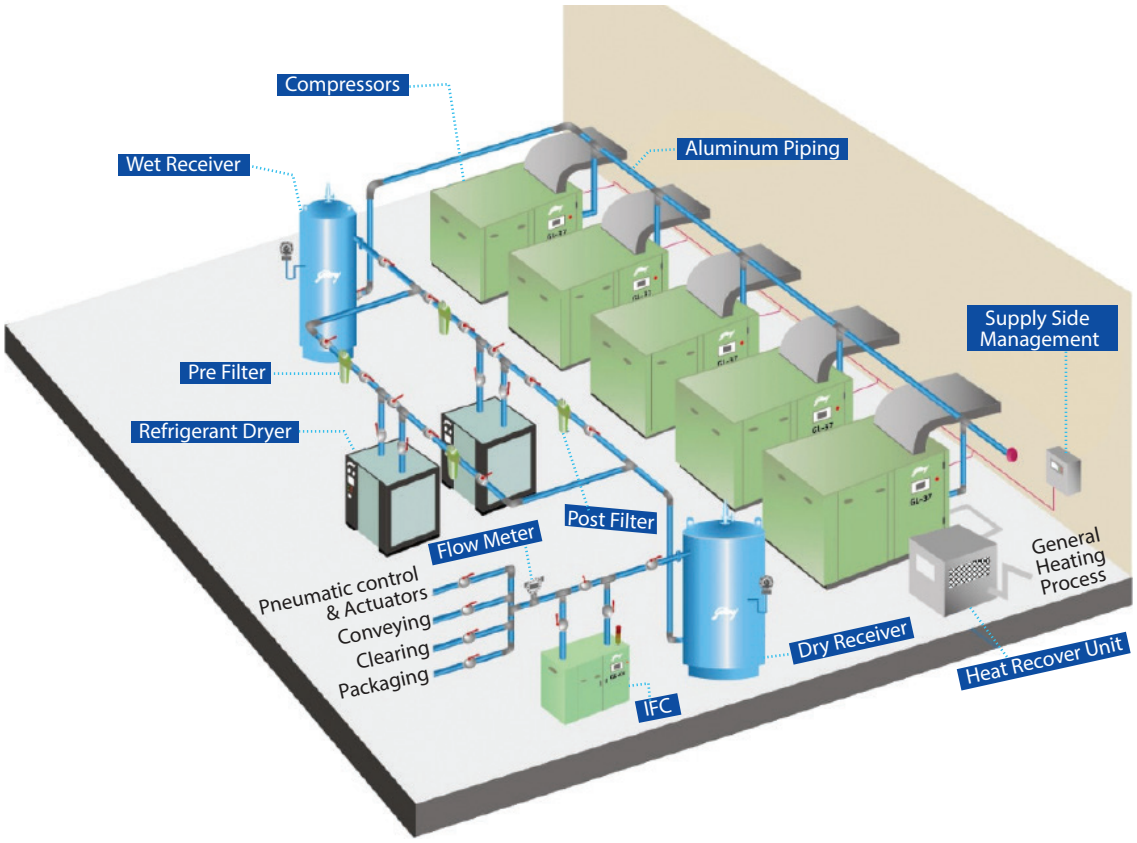
- With automatic blowdown, one can avoid high and low conductivity spikes due to boiler load variance.
- Can avoid keeping the TDS too low than what is required
- Reduced operating costs (less feed water consumption, chemical treatment and higher heating efficiency)
- Reduced maintenance and repair costs (minimised carry over and deposits)
- Cleaner and more efficient steam
- Minimise energy loss from boiler blowdown

Intelligent Flow Controller (IFC) for Compressed Air Network

The fluctuating air pressure is the major problem faced by industries caused due to intermittent use of several pneumatic equipment. It begins with the sudden air demand pulling down the pressure at the point of use.

An intelligent Flow Controller (IFC) controls the airflow and pressure being delivered to the plant. It operates at the intermediate point of the compressed air system, i.e. on downstream of Dryers/Receivers and upstream of the main piping distribution system.

IFC creates useful storage, which isolates compressors from the demand side peak and trough to provide a stable air supply at optimum pressure. It monitors the demand side rate of change of pressure and releases only the required amount of storage air to satisfy the peak demand instead of starting additional compressors. Thus reduction in the mass of air and a reduction in the load period of compressors leads to energy savings.



Benefits

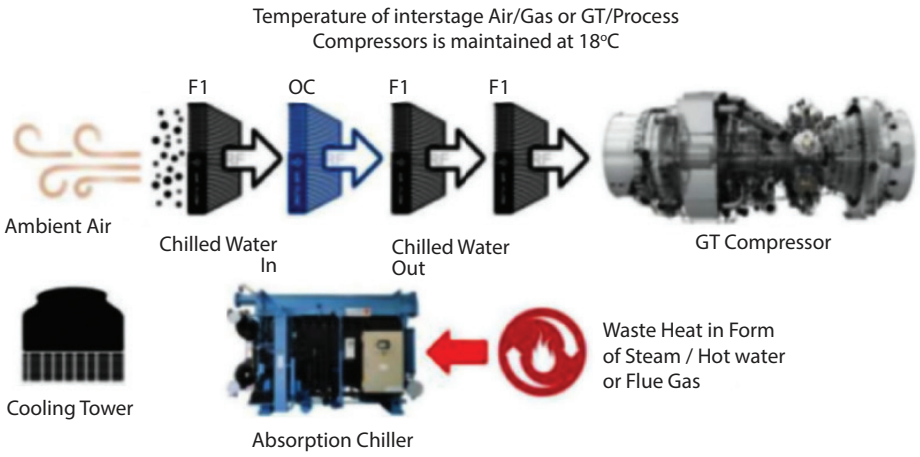
- Energy saving from 7% to 20%
- Simple payback period within 1 to 2 years
- Creates useful storage in the compressed air system
- Increases the response time of the system to meet instantaneous demand
- Constant air pressure to pneumatic tools; Reduction in artificial demand
- Reduction in compressed air leaks
- Reduction in compressor's operation & maintenance cost.

Inlet Air Cooling

Gas turbines and bigger size process air compressors take in filtered ambient air and compress it in the compressor stage. The performance of a gas turbine, its efficiency (heat rate) and generated power output strongly depend on the climate conditions, which may decrease the output power ratings by around 20-25%. In Gas turbine, after mixing with the fuel in the combustion chamber, compressed air is ignited, leading to high temperature and high pressure flow of exhaust gases entering the turbine. As the gas turbine is a constant volume machine, air volume introduced in the combustion chamber after compression stage is fixed for a given shaft speed (rpm). Thus the air mass flow is directly related to the density of air, and the introduced volume. $m = \rho V$ Where m is the mass, ρ is the density and V is the volume of the gas. As the volume V is fixed, only density ρ of the air can be modified to vary air mass. The density of the air depends on the relative humidity, altitude and temperature. To operate the turbine at ISO conditions and recover performance, inlet air cooling systems are the best.

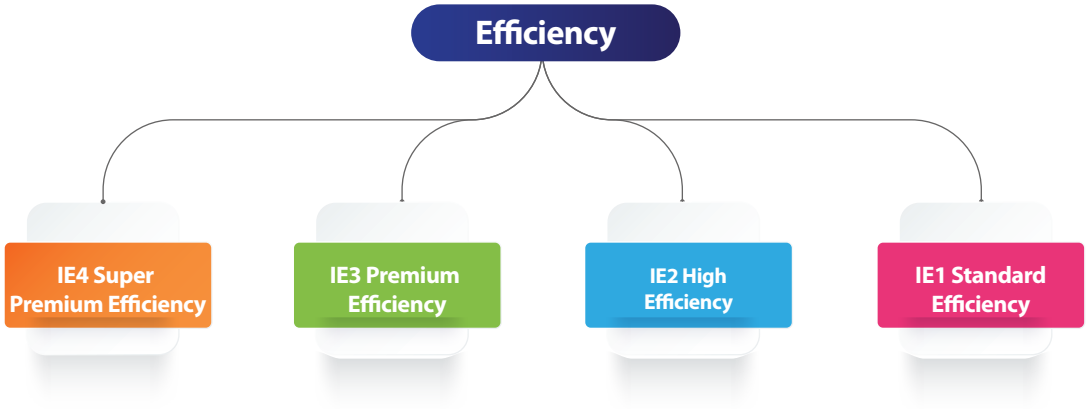
Benefits:

- Heat rate can be improved by 6-8% as per the performance curve of the turbine
- With inlet air cooling the air temperature can be maintained at 15 Deg C and as a result the throughput of the turbine/compressor can achieve ISO condition
- Reduction in repair and maintenance cost



IE4 Motors with VFD

The super-premium efficiency (IE4) motors come in the size range of 0.37 kW to 375 kW. The load factor of the IE4 motor should be greater than 65% so that the advantage of energy savings can be achieved. The benefits of using IE4 motors are maximum in continuous duty applications such as compressors, pumps, fans, blowers, etc.



IE4 motors are also equipped for frequency converter (VFD) duty. By using IE4 motors together with a premium VFD there can be several benefits including better process control, energy savings and a reduced starting current. It can further reduce stress on mechanical equipment and the electrical supply network.

The internal efficiency loss caused by heat generation and friction can be as high as 20% in small motors and 4-5% in motors upward of 160 kW. IE4 motors operate with significantly less heating and, as a result, with much lower losses. Lower working temperatures mean less thermal stress on the motor, the motor bearings and terminals. Motor service life is significantly extended as a result.

Benefits:

- High efficiency
- Less maintenance
- Lower operating temperatures
- Less thermal stress on the motor, the motor bearings and terminals.
- Enhanced motor life
- Low operating cost

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