Heat Recovery Steam Generator by Using Cogeneration

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ABSTRACT:

A heat recovery steam generator or HRSG is an energy recovery heat exchanger that recovers heat from a hot gas stream. It produces steam that can be used in a process (cogeneration) or used to drive a steam turbine (combined cycle). It has been working with open and closed cycle. Both of cycles are used to increase the performance and also power on the cogeneration plant. If we are using closed cycle technology, we can recycle the waste heat from the turbine. in cogeneration plant, mostly they are using open cycle technology. additional, by using closed cycle technology, we can use the waste heat that converts into useful amount of work. In this paper, the exhaust gas will be sent by using proper outlet from cogen unit, we are using only waste heat that produce from turbine.

Keywords—cogeneration,BackpressureTechnology, Extraction Condensing Technology, Gas Turbine Heat Recovery Boiler Technology, Combined Cycle Technology, etc….

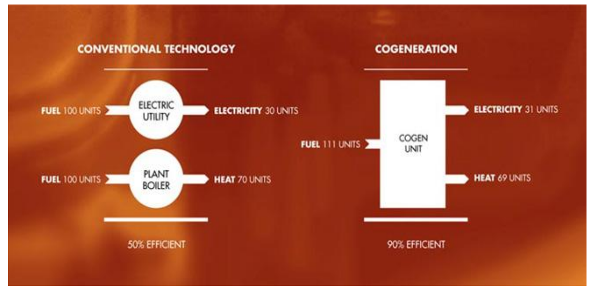
INTRODUCTION:

Environmentally progressive companies and those looking to make cost savings by producing heat or power by recovering energy from waste heat or renewable energy sources will benefit with the implementation of HRSGs. Some companies take it further and use HRSGs as part of a long term goal to meet carbon emission targets. Currently, in the United States and Canada, there are increasingly stringent emission regulations and the need for HRSGs is expected to increase.

COGENERATION OR COMBINED HEAT AND POWER (CHP)

What is Cogeneration

"Cogeneration is the process whereby a single fuel source, such as natural gas, is used to produce both electrical and thermal energy". By definition, an onsite cogeneration system is more efficient than a utility operated central power plant since thermal energy that would otherwise be wasted is captured for use at the facility.



Principle of Cogeneration OR Combined heat and power (CHP).

a very basic principle:"Generating electricity produces heat; cogeneration equipment captures that heat and uses it to supply hot water, steam, space heating - even cooling. Thus, an otherwise by product of electricity generation becomes a highly useful commodity".

The principle behind cogeneration is simple. Conventional power generation, on average, is only 35% efficient – up to 65% of the energy potential is released as waste heat. More recent combined cycle generation can improve this to 55%, excluding losses for the transmission and distribution of electricity. Cogeneration reduces this loss by using the heat for industry, commerce and home heating/cooling.

"In conventional electricity generation, further losses of around 5-10% are associated with the transmission and distribution of electricity from relatively remote power stations via the electricity grid. These losses are greatest when electricity is delivered to the smallest consumers".

Through the utilization of the heat, the efficiency of cogeneration plant can reach 90% or more. In addition, the electricity generated by the cogeneration plant is normally used locally, and then transmission and distribution losses will be negligible. Cogeneration therefore offers energy savings ranging between 15-40% when compared against the supply of electricity and heat from conventional power stations and boilers.

"Because transporting electricity over long distances is easier and cheaper than transporting heat, cogeneration installations are usually sited as near as possible to the place where the heat is consumed and, ideally, are built to a size to meet the heat demand". Otherwise an additional boiler will be necessary, and the environmental advantages will be partly hindered. This is the central and most fundamental principle cogeneration.

When less electricity is generated than needed, it will be necessary to buy extra. However, when the scheme is sized according to the heat demand, normally more electricity than needed is generated. The surplus electricity can be sold to the grid or supplied to another customer via the distribution system (wheeling).

Main Parts Cogeneration OR Combined heat and power (CHP) with Combined open and closed Cycles.

CC—Combustion Chamber

C—Compressor

T—Turbine

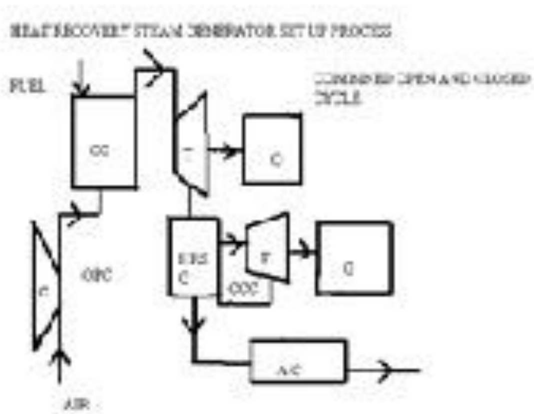
HRSG—Heat recovery steam generator(boiler)

CCC—combined closed cycle

OPC— open cycle

G—generator

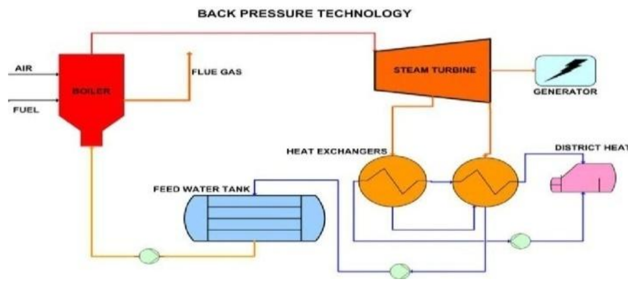
AC—absorption chill(cooling purpose)



Various Technology in cogeneration or combined heat and power:

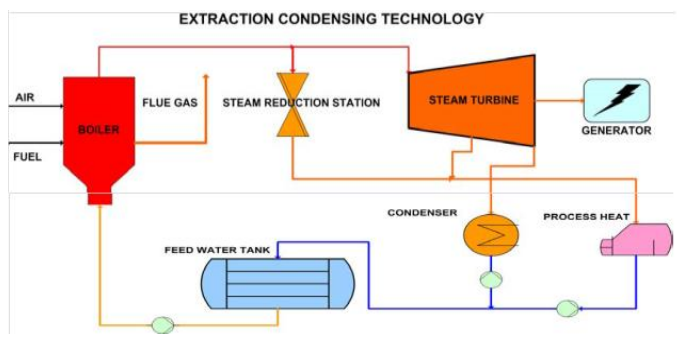
Backpressure Technology:

The first type of technology in cogeneration available was the Backpressure, where combined heat and power (CHP) is generated in a steam turbine. The Fig shows the process flow of backpressure type cogeneration (CHP).



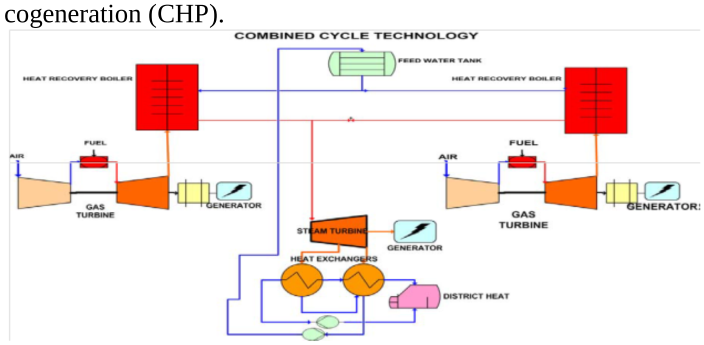
Extraction Condensing Technology:

The second type of technology in cogeneration available was the Extraction Condensing. A condensing power plant is generating only electricity whereas in an extraction condensing power plant some part of the steam is extracted from the turbine to generate also heat. The Fig shows the process flow of Extraction Condensing type cogeneration (CHP).
Extraction of technology in cogeneration available was Gas Turbine Heat Recovery Boiler. In gas turbine heat recovery boiler power plants heat is generated with hot flue gases of the turbine. The fuel used in most cases is natural gas, oil, or a combination of these. Gas turbines can even be fired with gasified solid or liquid fuels.



Combined Cycle Technology:

The forth type of technology in cogeneration available was Combined cycle. A combined cycle power plant consists of one or more gas turbines connected to one or more steam turbines. The Fig shows the process flow of Combined Cycle cogeneration (CHP).



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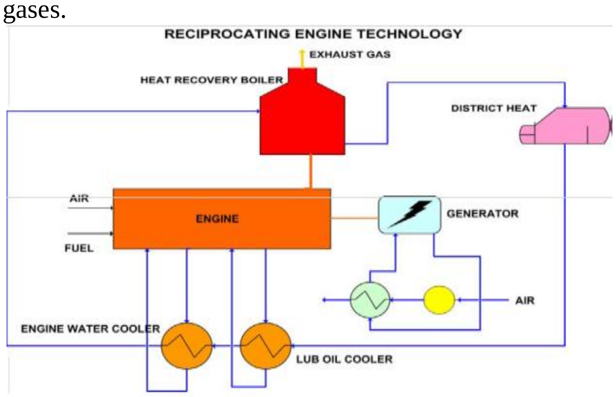
Reciprocating Engine Technology:

The fifth type of technology in cogeneration available was Reciprocating Engine. Instead of a gas turbine, a reciprocating engine, such as a diesel engine, can be combined with a heat recovery boiler, which in some applications supplies steam to a steam turbine to generate both electricity and heat. In a reciprocating engine power plant heat can be recovered from lubrication oil and engine cooling water as well as from exhaust gases.



Micro-turbines:

This new type cogeneration technology to be commercialized. Micro-turbines are smaller are smaller than conventional reciprocating engines, and capital and maintenance costs are lower. There are environmental advantages, including low NOx emissions of 10-25 ppm (02 – 15% equivalent) or lower.

Micro-turbines can be used as a distributed generation resource for power producers and consumers, including industrial, commercial and, in the future, even residential users of electricity.

Significant opportunities exist in five key applications:

Traditional cogeneration,
Generation using waste and bio-fuels,
Backup power,
Remote Power for those with “Black Start” capability,
Peak Shaving.

Fuel cells:

Fuel cells convert the chemical energy of hydrogen and oxygen directly into electricity without combustion and mechanical work such as in turbines or engines. In fuel cells, the fuel and oxidant (air) are continuously fed to the cell. All fuel cells are based on the oxidation of hydrogen. The hydrogen used as fuel can be derived from a variety of sources, including natural gas, propane, coal and renewable such as biomass, or, through electrolysis, wind and solar energy.

A typical single cell delivers up to 1 volt. In order to get sufficient power; a fuel cell stack is made of several single cells connected in series. Even if fuelled with natural gas as a source of hydrogen, the emissions are negligible: 0.045 ppm NOx, 2 ppm CO, 4 ppm HC. A number of different types of fuel cells are being developed. The characteristics of each type are very different: operating temperature, available heat, tolerance to thermal cycling, power density, tolerance to fuel impurities etc. They are also in very different stage of development and some of them have not emerged from the laboratory. Some are approaching commercial breakthrough. This will be covered by other briefings from COGEN Europe.

Stirling engines:

The Stirling engine is an external combustion device and therefore differs substantially from conventional combustion plant where the fuel burns inside the machine. Heat is supplied to the Stirling engine by an external source, such as burning gas, and this makes a working fluid, e.g. helium, expand and cause one of the two pistons to move inside a cylinder. This is known as the working piston. A second piston, known as a displacer, then transfers the gas to a cool zone where it is recompressed by the working piston. The displacer then transfers the compressed gas or air to the hot region and the cycle continues. The Stirling engine has fewer moving parts than conventional engines, and no valves, tappets, fuel injectors or spark ignition systems. It is therefore quieter than normal engines, a feature also resulting from the continuous, rather than pulsed, combustion of the fuel.

There are some low capacity Stirling engines in development or in the market. The electrical efficiency is still not very high and in the range of 10% (350 We engine); 12.5% (800 We engine) up to 25% (3,000 We engine), but it should be possible to design then with at least 25% electrical efficiency and total efficiency of 90%.

The Need for Cogeneration:

- When it makes economic sense to the industry.
- The cost of power supplied by the utility is more than the cost of generation by the cogeneration power plant.
- The utility is not being able to provide reliable enough or good quality power causing inconvenience/loss to the industry.
- Driven by efficiency considerations.

Sustainable:

- With equivalent CO_2 emissions, a combined cycle power plant can produce 50% more electricity than a conventional thermal power plant.
- Renewable power supply such as wind and solar implies high power grid fluctuations and conventional power plants have to compensate. Thanks to their flexibility, gas-steam combined cycle power plants are, therefore, the perfect alternative to renewable.

Benefits :

- Improves versatility – works with existing and planned technologies for various applications in industrial, commercial, and residential sectors
- Saves energy and resources– simultaneous production of useful thermal and electrical energy leads to increased fuel efficiency and lower emissions
- Increases efficiency – localized energy generation avoids grid transmission and distribution losses associated with decentralized power stations .

Costs:

From the facility owner's perspective, the initial cost of a cogeneration system is substantially higher than for a conventional heating system. However, the facility's overall operating costs are likely to drop enough to pay off this investment. The economic attractiveness of cogeneration is a function of the relative prices of electricity and natural gas: the best case is when electricity prices are high and natural gas prices are low.

POLLUTION CONTROL METHOD:

Emissions controls may also be located in the HRSG. Some may contain a Selective Catalytic Reduction system to reduce nitrogen oxides (a large contributor to the formation of smog and acid rain) and/or a catalyst to remove carbon monoxide. The inclusion of an SCR dramatically affects the layout of the HRSG. NOx catalyst performs best in temperatures between 650 °F (340 °C) and 750 °F (400 °C). This usually means that the evaporator section of the HRSG will have to be split and the SCR placed in between the two sections. Some low temperature NOx catalysts have recently come to market that allows for the SCR to be placed between the Evaporator and Economizer sections (350 °F - 500 °F (175 °C - 260 °C)).

CHP Applications

CHP technology exists in a wide variety of energy-intensive facility types and sizes nationwide, including:

- Pharmaceuticals & fine chemicals
- Paper and board manufacture
- Brewing, distilling & malting
- Ceramics
- Brick
- Cement
- Food processing
- Textile processing
- Minerals processing
- Oil Refineries
- Iron and Steel

SIMULATION RESULT:

1. To reduce power and other energy costs.
2. To improve productivity and reduce costs of production through reliable uninterrupted availability of quality power from Cogeneration plant.
3. Cogeneration system helps to locate manufacturing facility in remote low cost areas.
4. The system collects carbon credits which can be traded to earn revenue.
5. Due to uninterrupted power supply it improves working conditions of employees raising their motivation. This indirectly benefits in higher and better quality production.
6. Cogeneration System saves water consumption & water costs.
7. Improves brand image and social standing.
8. Cogeneration is the most efficient way of generating electricity, heat and cooling from a given amount of fuel. It saves between 15-40% of energy when compared with the separate production of electricity and heat.
9. Cogeneration helps reduce CO2 emissions significantly. It also reduces investments into electricity transmission capacity, avoids transmission losses, and ensures security of high quality power supply.
10. A number of different fuels and proven, reliable technologies can be used.

Conclusion

Amongst all the countries, next to China, India has to sustain the largest population of over 960 million. It is unfortunate that the per capita electricity available for consumption in India is 315 Kwh only, which is one of the lowest in the World. Therefore, until and unless electricity generation is increased 7 to 8% annually, the requisite growth in the national economy at the annual rate 7% cannot be sustained.

Electricity generation in India has to depend primarily on coal since India has very low reserve of other fossil fuels and natural gas. Therefore, serious effort has to be made to use well proven and reliable technology i.e. Cogeneration Combined Heat and Power (CHP).

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