COGENERATION OPPORTUNITIES IN INDIAN SMALL SCALE INDUSTRIES

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ABSTRACT

To increase the efficiency of industries, cogeneration is advocated as most beneficial technology. Cogeneration or combined heat and power (CHP) is the simultaneous production of electrical power and heat for useful purpose. It is an environment friendly and economically sensible way to produce power simultaneously saving significant amount of cost as well as reducing green house gas emissions. Also, it makes an industry self reliant in terms of captive electrical power rather depends on the state grid. Small scale sector occupies a prominent position in the Indian economy and has potential to adopt cogeneration concept very efficiently.

KEYWORDS: Cogeneration , Environment , Green House Emissions , Power.

Escalating cost of power, unreliable quality ; growing demand resulting in continued shortages, dependency on Central and State grids and frequently changing policies.

These are the grim realities of the current power scenario in India. This makes it difficult, for the industry & commercial establishments to become globally cost competitive. One of the fastest developing countries in the world today, with economy in transition, India consumes 12.18 quadrillion Btu (Quads) of power, with over 8 to 10 % growth per annum. It is of utmost importance for business and industry, to have adequate, economical, reliable power supply of high quality.

Cogeneration of electricity and thermal energy, wherever feasible, is an effective solution to the problem.

Cogeneration , also known as combined heat and power or CHP, is simultaneous production of electricity, heating and/or cooling, from a single fuel input, with an overall efficiency normally exceeding 70%.

The small-scale sector occupies a position of prominence in the Indian economy, contributing to more than 50% of the industrial production in value addition terms. In India’s present liberalized economy, the survival and growth of small-scale industry (SSI) largely depends on its ability to innovate, improve operational efficiency and increase productivity.

The following Areas/Actions are critical for obtaining best results from cogeneration :

1. Improving technical and operating efficiency of the existing plant.
2. Replacing inefficient machinery with new energy efficient equipment.
3. Adopting various means of energy conservation.
4. Optimal design and effective implemetation of cogeneration projects.

Potential Cogenerators

Many sectors of industry have very good potential for cogeneration. Industrial units in following sectors can take advantage :

- Sugar
- Paper
- Oil Extraction
- Rice Milling
- Chemical Fertilizers
- Textiles-Cotton & Synthetic
- Food Processing
- Rubber Industries
- Metallurgical Industries
- Urban Waste Treatment
- Pharmaceuticals
- Hotels
- Distilleries

Principle of Cogeneration

Cogeneration or Combined Heat and Power (CHP) is defined as the sequential generation of two different forms of useful energy from a single primary energy source, typically mechanical energy and thermal energy. Mechanical energy may be used either to drive an alternator for producing electricity, or rotating equipment such as motor, compressor, pump or fan for delivering various services. Thermal energy can be used either for direct process applications or for indirectly producing steam, hot water, hot air for dryer or chilled water for process cooling.

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Cogeneration makes sense from both macro and micro perspectives. At the macro level, it allows a part of the financial burden of the national power utility to be shared by the private sector; in addition, indigenious energy sources are conserved. At micro level, the overall energy bill of the users can be reduced, particularly when there is a simultaneous need for both power and heat at the site, and a rational energy tariff is practised in the country.

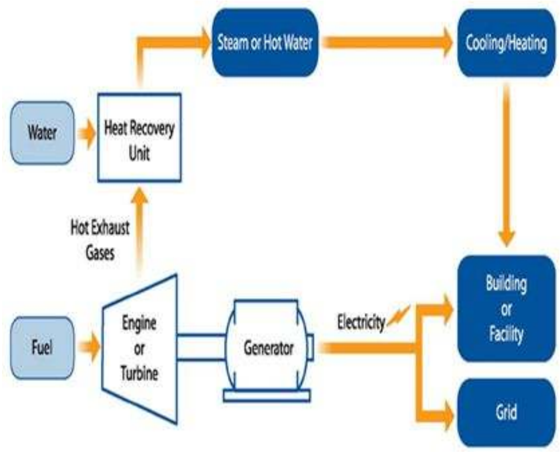

Figure 1: Gas Turbine or Engine with Heat Recovery Unit

Cogeneration Technology

Following are some cogeneration system configurations which are selected very carefully according to need-

1. Steam turbine based cogeneration systems.
2. Gas turbines based cogeneration systems.
3. Combined steam/gas turbine based cogeneration system.
4. Reciprocating engine based cogeneration system.

Most widely used cogeneration systems in the chemical process industrial plants are based on steam turbine, gas turbine or combined steam/gas turbine configurations with installations based on reciprocating engine configuration in moderate number. These configurations are widely accepted by the industries due to their proven track record and easy commericial availability of required equipment.

Variant	Advantages	Disadvantages
Back Pressure Steam Turbine and Fuel firing in Conventional Boiler	- High fuel efficiency rating - Very simple Plant - Well suited to all types of fuels of high or low quality - Good part load efficiency - Moderate relative specific capital cost	- Little flexibility in design and operation - More impact on environment in case of use of low quality fuel - Higher civil construction cost due to complicated foundations
Extraction-cum-Condensing Steam Turbine and fuel firing in Conventional Boiler	- High flexibility in design and operation - Well suited to all types of fuels, high quality or low quality - Good part load efficiency - More suitable for varying steam demand	- More specific capital cost - Low fuel efficiency rating, in case of more condensing - More impact on environment in case of use of low quality fuel - Higher civil construction cost due to complicated foundations - High cooling water demand for condensing steam turbine
Gas Turbine with Waste Heat Recovery Boiler	- High fuel efficiency at full load operation - Very simple plant - Low specific capital cost - Lowest delivery period, hence low gestation period - Less impact on environment (with use of clean fuels) - Least maintenance option - Quick start and stop - Still better efficiency with supplementary firing in Waste heat recovery boiler Least cooling water requirement	- Moderate part load efficiency - Limited suitability for low quality fuels - Not economical, if constant steam load a problem
Combined Gas and Steam Turbine with Waste Heat Boiler	- Optimum fuel efficiency rating - Relatively low specific capital cost - Least gestation period - Less impact on environment - High operational flexibility - Quick start and stop	- Average to moderate part load efficiency - Limited suitability for low quality fuels
Reciprocating Engine and Waste Heat Recovery Boiler with Heat Exchanger	- Low civil construction cost due to block type foundations and least nos. of auxiliaries - High electrical power efficiency - Better suitability as emergency standby plant - Least specific capital cost - Low cooling water demand	- Low overall plant efficiency in cogeneration mode - Suitability for low quality fuels with high cleaning cost - High maintenance cost - More impact on environment with low quality fuel - Least potential for waste heat recovery

Advantages of cogeneration technology

Following advantages are derived by making application of cogeneration technology to meet the energy requirements of industries:

1. Industrial cogeneration plants gives advantage to the efforts of the state electricity boards to bridge the gap between supply and demand of power by very efficient power generation in house.
2. Impact on environment is very low as compared to large size power plants due to less consumption of fuel and efficient operation.
3. Electricity from a cogeneration system is generally not required to be transmitted over long distances.
4. Reliable and quality energy supply.
5. Energy saving & cost reduction.
6. Cogeneration makes an industry self reliant in terms of captive electrical power rather depends on state grid.
7. Sustainable energy for future.
8. If cogeneration systems are implemented in sugar mills or rice mills, waste fuel such as bagasse or rice

husk can be used to fire the boiler to generate steam. This would save our fossil fuel.

Cogeneration is likely to be most attractive under the following circumstances:

(a) The demand for both steam and power is Balanced I.e. consistent with the range of steam: power output ratios that can be obtained from a suitable cogeneration plant.

(b) A single plant or group of plants has sufficient demand for steam and power to permit economies of scale to be achieved.

(c) Peaks and troughs in demand can be managed or, in case of electricity, adequate backup supplies can be obtained from utility company.

Factors for selection of cogeneration system

Following factors should be given a due consideration in selecting the most appropriate cogeneration system for particular industry.

1. Normal as well as maximum/minimum power load in the plant, and duration for which the process can tolerate without these utilities, I.e. criticality and essentially of inputs.
2. What is more critical - whether power or steam, to decide about emergency back-up availability of power or steam.
3. Anticipated fluctuations in power and steam load and pattern of fluctuation, sudden rise and fall in demand with their time duration and response time required to meet the same.
4. Type of fuel available - whether clean fuel like natural gas, naphtha or high speed diesel or high ash bearing fuels like furnace oil, LSHS, etc or fuels like coal, lignite, etc., long term availability of fuels and fuel pricing.
5. Commercial availability of various system alternatives, life span of various systems and corresponding outlay for maintenance.
6. Influence exerted by local conditions at plant site, I.e.space available, soil conditions, raw water availability, infrastructure and environment.
7. Project completion time.
8. Project cost and long term benefits.

Cogeneration in a pharmaceutical industry, India

Normally, bulk drug manufacturers have a boiler in their plant to generate low-pressure steam for drying the powders. The boiler used to be very small, as the steam required, ranged from 3 to 1 bar. The problem which kept this industry continuous power, to prevent outages, which would lead to wastage of costly material. Then a large pressure-boiler was selected and utilised the reduction in steam pressure from 43 to 3 bar to generate power for the plant in a straight back-pressure turbine, which at the same time provided the required steam for the various processes. This can saves the diesel costs, the diesel generator being relegated to standby for additional or emergency power in the event of turbine loss.

Textile Industry

It is currently one of the largest and most important sectors.

India is 2nd in global textile manufacturing and also 2nd in silk and cotton production.

Cogeneration has a wide opportunities in this industry.

In this way cogeneration technology can be applied in other industries also.

Below is an example which shows cogeneration is more efficient with less cost. Also it makes an industry in self reliant in power rather entirely depending on state grids.

Example

Gas Turbine based co-generation system

1. Gas Turbine Based Co-generation

Gas turbine Parameters-

Capacity of a gas turbine generator = 4000kW

Plant operating hours per annum = 8000hrs.

Plant load factor =90%

Heat rate as per standard given by gas turbine supplier = 3049.77 kCal/kWh

Waste heat boiler parameters - unfired steam output = 10 TPH

Steam temperature = 200 ^{0}C

Steam pressure = 8.5 kg/cm^2

Steam enthalpy = 676.44 kCal/kg

Fuel used = Natural gas

Calorific value - LCV = 9500 Kcal/sm3

Price of gas = Rs. 3000/1000 sm^3

Capital investment for total co-generation plant = Rs. 1300 Lakhs

Cost Estimation of Power & Steam From Cogeneration Plant

1. Estimated power generation from Cogeneration plant at 90% Plant Load Factor(PLF)

= PLF x Plant Capacity x no.of operation hours

= (90/100) x 4000 x 8000

= 288 x 10^5 kWh per annum

2. Heat input to generate above units =

Units(kWh) x heat rate

=288 x 10^5 x 3049.77

=878333.76 x 10^5 kCal

3. Natural gas quantity required per annum =

Heat input/calorific value(LCV) of natural gas

= 878333.76 x 10^5 /9500

= 92.46 x 10^5 sm^3

4. Cost of fuel per annum

= 92.46 x 10^5 x Rs.3000/1000sm^3

= Rs. 277.37 lakhs

5. Cost of capital & operation charges/annum = Rs.298.63 lakhs

6. Overall cost of power from cogeneration plant = Rs. 576 lakhs per annum

7. Cost of Power = Rs.2kWh

2. Electric Power from State Grid & Steam from Natural Gas Fired Boiler

Boiler Installed in Plant:

Cost of electric power from state grid-average electricity cost with demand & energy charges = 3.00 Rs./kWh

Capital investment for 10 TPH, 8.5 kg/sq.cm 200^0C Natural gas fired fire tube boiler & all auxiliaries = Rs.80.00 lakh

Estimation of cost for electric power from grid & steam from direct conventional fired boiler :

1. Cost of Power from state grid for 288 lakh = Rs.864.00 lakh per annum

2. Fuel cost for steam by separate bolier

(i) Heat output in form of 10 TPH steam per annum = steam quantity x enthalpy x Operations/annum

= 10 x 1000 x 676.44 x 8000

=541152 x 10^5 kCals

(ii) Heat Input requiredto generate 10 TPH steam per annum @ 90% efficiency = Heat output/boiler efficiency

= 541152 x 10^5/0.90

Heat input = 601280 x 10^5 kCal per annum

(iii) Natural Gas Quantity = Heat input / calorific value (LCV) of natural gas

= 601280 x 10^5/9500

=63.29 x 10^5 sm^3 per annum

(iv) Cost of fuel per annum = Annual gas consumption x price

= 63.29 x 10^5 x 3000/1000 sm^3

=Rs. 189.88 lakh per annum

(v) Total cost = Cost of grid power + fuel cost for steam

= Rs.864+Rs.189.88

=Rs. 1053.88 lakh per annum

Total Cost for 1 = Rs. 576.00 lakh

Total Cost for 2= Rs.1053.88 lakh

Difference = 477.88 lakh

CONCLUSION

Co-generation is well proven technology, recognized world wide as a cleaner alternative to traditional centralized power and it is highly energy efficient whereas trigeneration is upcoming technology having higher efficiency than typical cogeneration system delivering a number of positive financial and environmental benefits in the small scale industry.

Co-generation is a cost effective way to conserve depleting fossil fuels and contributing to sustainable development of the entire world, Climate change and carbon emission reduction is an increasingly dominant factor in co-generation's future.

This will help to any organization individually and nation as a whole.

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