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Co-generation in Textile Industries

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----------**ABSTRACT**----------
This paper pertains to a textile industry engaged in manufacture of fabrics and yarn in which co-generation play vital role for cost effective process. In this article we optimised flue gases from gas engine and low pressure steam from turbine.

The main objective of this article on Co-Generation, combined heat and power brings about the need of the co-generation to meet the present demand of electricity and reduce costing to prepare high quality fabric and yarn. It also bridges the gap between supply and ever increasing demand of electrical energy and becoming self reliant in terms of captive electrical power rather depends on the state grids. It also talks about the co-generation technology, benefits, applications and Potential beneficiaries for the amateurs who are keen to implement this technology to meet their needs and serves nation as a whole by reducing the load on grids and reduction of CO2 emissions to protect the environment.

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I. INTRODUCTION:-

The high cost of power coupled with the cost for generation of steam of desired temperature was eating into the bottom line of the products in the highly competitive market. A cost effect analysis pointed to power cost as the main target to work upon. Captive generation of power as a standalone project either using conventional or new generation fuels was calculated to be not that cost effective.

Cogeneration first appeared in late 1880s in Europe and in U.S.A. during the early parts of the 20th century, when most industrial plants generated their own electricity using coal-fired boilers and steam-turbine generators. Many of the plants used the exhaust steam for industrial processes. In textile industries low pressure (3-4 kg/cm^2) steam is used in many processes such as washing, bleaching, sizing, de-sizing, dyeing and printing.

We consider a typical example of a power plant engaged with a textile industry. As we know textile industries require very high capital cost, power and steam so we consider below equipment for the utility section.

In textile unit we must require steam so if we put back pressure turbine along with boiler we can reduce the cost near about 70% because the fuel consumption of boiler is near about same when it operate no load or full load so we consider below utilities.

1. Back pressure steam turbine 12TPH and 40 kg/cm^2.
2. DG set of 250*2 KVA for peak load time.
3. Grid power connection of 1MW.

So above these utilities we get reliable and effective power and steam and calculate the saving after co-generation/Trigeneration.

II. SCENARIO BEFORE INSTALLATION OF CO-GENERATION PLANT:-

The above requirement is fulfilled by state electricity, 12 Ton steam boiler and DG set. We calculate the approx. Costing of different utilities separately without using CHP technology.

Formula for evaluation of boiler efficiency by direct method

$$\text{Boiler Efficiency} = \frac{Q \times (H-h) \times 100}{q \times GCV}$$

Q = Steam flow rate in kg/hr

h = Enthalpy of fed water kcal/kg

H = Steam enthalpy in kcal/kg

q = fuel firing rate kg/hr

GCV = Gross calorific value of fuel, kcal/kg

So by the above formula we can calculate boiler efficiency and fuel consumption.

For grid power we can calculate

1. Contract demand of grid power 1000 KVA
2. Maximum demand of plant 1000 KVA
3. CD charges per month 1.875 Lacs
4. Cost of unit power (kWh) (Average) 5.5 Rs

Table 1.1. Total power bill (in Rs) for a year of different utilities

Equipment	Fuel/Electricity consumption(per hour)	Unit Cost(Rs.)	Cost Per Hour(Rs.)	Total cost per 8000 hrs of year(Rs. Lacs)
Grid Power Boiler DG Set	1000 KWh 3200 Kg/Hr. 60 L/h	5.5 35(per Kg.) 54(per Ltr.)	5500 112000 3240	9659.2

III. SCENARIO AFTER INSTALLATION OF CO-GENERATION PLANT:-

We add 1 MW reciprocating Gas engine operated by PNG in above utilities and used CHP to improve the efficiency of the entire unit.

Two types of steam turbine most widely used are the back pressure and extraction condensing types. The choice between back pressure turbine and extraction-condensing turbine depends mainly on the quantities on the quantities of power and heat, quality of heat and economic factors. The extraction points of steam from the turbine could be more than one, depending on the temperature levels of heat required by the processes.

1. Back pressure steam turbine is more efficient than Extraction condensing turbine because we required large amount of steam in process house for processing the fabric and yarn. Generally we require 3-4 kg/cm^2 pressure steam having temperature of 120-150 degree.

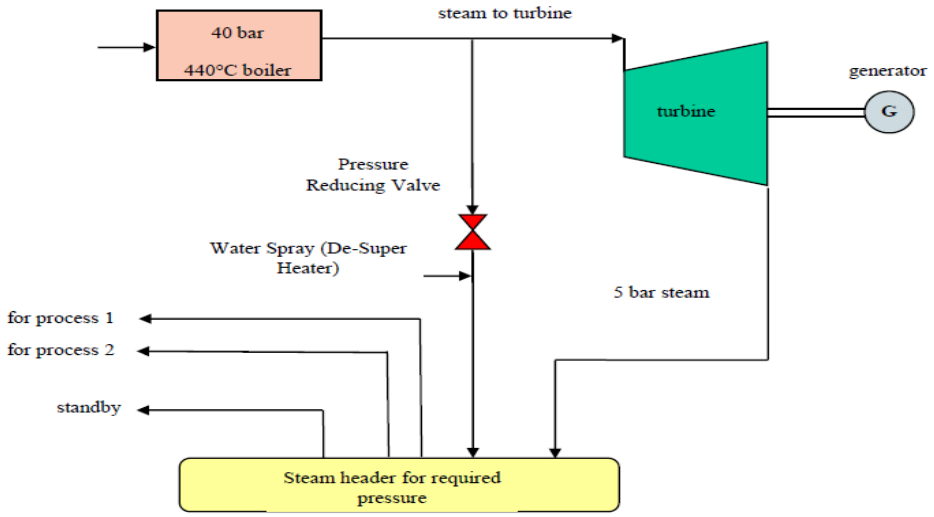

Fig.1.1. Cogeneration with Back-pressure steam

The specific advantage of using steam turbines in comparison with the other prime movers is option for using a wide variety of conventional fuels as well as alternative fuels such as natural gas, fuel oil and biomass.

2. Gas engine and DG set exhaust are connected by a single stack so that we can improve the efficiency by reducing waste heat. We consider the height of stack is 30 meter. We can use coil type heat exchanger for fabrication of the stack and in upper portion of the stack we can use damper to control the flow of the flue gases. The temperature of exhaust gases are near about 350 degree Celsius so we can utilise this temperature by specified design of stack as given below.

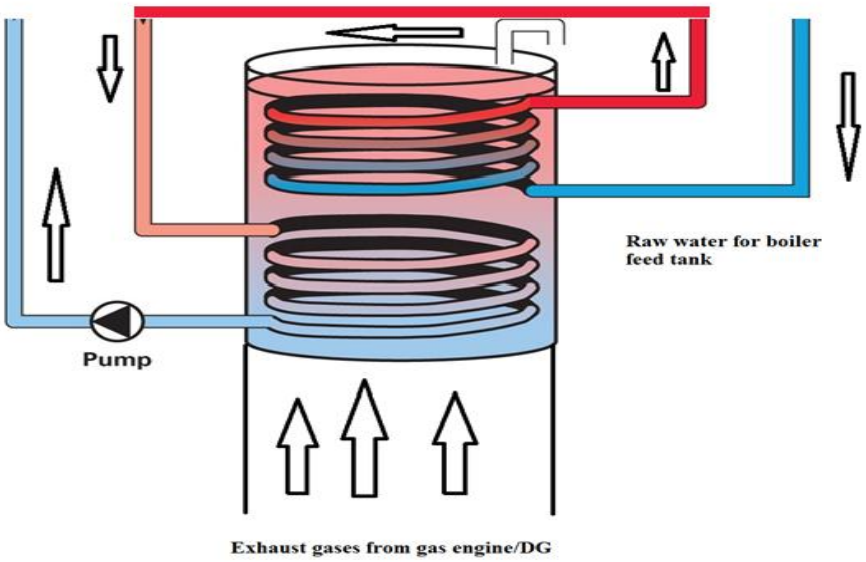

Fig.1.2. Flue gases stack made by coil type heat exchanger for Gas engine/DG

If we increase the raw water temperature feed to boiler we can definitely reduce the operating cost of the boiler, fuel and environment too. As per calculation

Quantity of water to make 10 kg steam is 10 litres of water. 1 Tph = 1000 kg or litres or 1.0 m3/hr. To heat 1 kg of water from 0 C(37 F) to 100 C(212 F) 100 kcal are needed.
1 Kcal is the quantity of heat needed to rise the temp of 1 kg of water by 1 C.
0.7 to 0.8 of kcal is the quantity of heat needed to rise the temp of 1 kg of wet compost by 1 C.

1 kcal = 3.968 BTU
1 BTU = 0.252 kcal

to convert 1 kg of boiling water to steam about 540 kcal are needed.
so >
1 kg of steam = 100 kcal + 540 Kcal = 640 kcal

and the steam will supply upon condensation 540 kcal + 1 kg of 100C water(100 Kcal)

Calorific value wood 3500 Kcal(ranges 3000 Kcal ~ 3900 Kcal) So 10 kg steam x 640/3500= 1.8 >2.0 kg wood or 1 Tph = 1000 kg/hr x 640/3500 = 183.0 kg/hr. Depending on your boiler efficiency and calorific value/moisture content % which you have not mentioned It will average between 200~250 kg/hr with feed water 100C.

So above calculation we can save near about 200 kg of wood/coal for producing every 1TPH steam. We can save 60-70% of boiler fuel by applying cogeneration. We run DG when Gas engine are maintenance mode.
By using co-generation technique in a textile unit we can save below amount

Table 1.2. Total power bill (in Rs) for a year of different utilities

Equipment	Fuel/Electricity consumption(per hour)	Unit Cost(Rs.)	Cost Per Hour(Rs.)	Total cost per 8000 hrs of year(Rs. Lacs)
Grid power	550 KWh	5.5	3025	
Boiler	1400 Kg/h	35 (per Kg)	49000	
Gas Engine	160 Nm^3/h	44 (per Nm^3)	7040	4725.2
DG Set	-	-	-	

Important Notes:

1. net saving per year Rs.4934 lacs

2. Net savings are calculated by assuming 8000 hrs of operation per year.

Net savings = Cost difference between grid and captive electricity +Reduction in contract demand charges +Elimination of costly HSD fuel through stopping of DG set.

IV. ADVANTAGES RECIPROCATING ENGINE:-

- High power efficiency achievable over a wide range
- Relatively low cost per kWh electrical power output
- Wide range of unit sizes from 3 kWh and upward
- Part load operations from 30% to 100% with high efficiency
- Fast start-up time of 15 second to full load (gas turbine needs 0.5 – 2hrs)
- Real multi fuel capability, it can also use FO as fuel
- Can overhaul in site with normal operators
- Can be operated remotely

V. BENEFITS ACHIEVED SINCE INCEPTION OF PROJECT:-

- Monetary. Rs 4934 Lacs has been saved and it has helped to improve the bottom line of the company. Self reliance in terms of captive electric power achieved and it has helped to improve the productivity as there is no breakdown of the plant due to power outages.
- Reduction of CO2 emissions. Total quantity of 1326 Tons of CO2 emissions reduced.
- CDM Benefits. Reduction of CO2 emission could be traded with World Bank as per Kyoto protocol. These benefits will be exploited soon by submitting a detailed project for our all initiatives in this regard.
- SH&E policy. Helped to stick and work towards our SH&E policy for greener environment.
- Serving nation. By reduction of 1 MW load on the state grid, helped

VI. CONCLUSION:-

Co-generation is well proven technology, recognized worldwide as a cleaner alternative to traditional centralized power centralization and it is highly energy efficient whereas tri-generation applied in our case is upcoming technology having higher efficiency than typical cogeneration system delivering a number of positive financial and environmental benefits in the textile industry.
This will help to any organization individually and nation as a whole.

From this article we have seen, it was evident that the cogeneration and tri-generation system would substantially reduce the operating cost of industries. The rate of return for this tri-generation project is very attractive and payback period would fall in between 1 to 2 years.

Further in today's the growing concern towards global warming and cleaner development mechanisms, most of the CO2 emissions stem from the burning of fossil fuels for the purpose of electricity generation. Coal accounts for 94 percent of the emissions from the electric utility industry. Going for Co-generation and tri-generation will substantially reduce CO2 emissions when it compare with traditional heat and power generating stations.

Thus, apart from monetary savings, 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.

By seeing the above mentioned success and advantages with cogeneration plant, it is strongly recommended the aspirers to go for the implementation of this system and get benefited in terms of monetary and environmentally.