DG SET COMBINED HEAT & POWER (CHP) GENERATION - A SUCCESSFUL CASE STUDY OF A COLD STORAGE

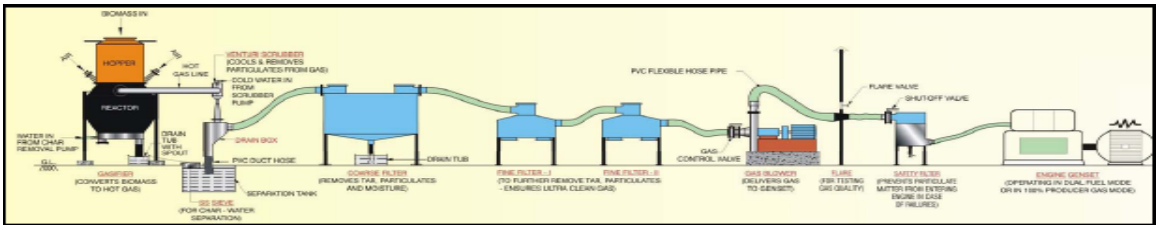
G.Subramanyam
Sr.Dy.Director (Energy Management)
National Productivity Council
10th Floor, Gagan Vihar
M.J.Road, Hyderabad – 500001
Ph: 040-24733473 (O), 040-24075323®
Fax:040-24606981
Email: g.subramanyam@npcindia.org

The following is a successful case study of Cold Storage unit situated at outskirts of Hyderabad. The Unit started its operations way back in 1987. The company is one of the first and commercial De-Humidification Cold Storage unit in the state of Andhra Pradesh, exclusively designed for high value hybrid seeds, tamarind , chillies etc. The company has state-of-art pre-cooling facility for export of quick perishables like fruits, vegetables and eggs. The unit needs both power and steam. The electrical power consumption is towards running refrigeration compressor and associated equipment like condensor pumps, chilled water pumps, cooling tower and lighting etc. The steam is used for de-humidification. In cold storage units. The temperature and RH control are most critical in cold storage units, and the moisture is absorbed by in adsorber using silicagel as deccicant. After absorption, the silica gel needs to be regenerated, and steam is used for ***Bry Air*** regeneration purpose. In ***Bry Air*** dehumidification in one cycle - adsorption of moisture takes place and in other cycle - re-activation of silica gel is carried out using hot air. Hot air is generated using steam in the radiator coils.

Initially, the unit went for 75HP LT connection with the SEB, which is meant for lighting only. For balance power requirements, 2 x 320 KVA DG sets were installed. For steam generation, 600 kg/hr capacity HSD fired boiler was installed. The unit requires around 185 Kw of power and 300-350 Kg/hr of steam. Initially the unit used to consume about 55-60 lit/hr Diesel in the DG sets and another 22-25 lit/hr Diesel in the boiler. The DG sets were used to operate for 12Hrs/day and the boiler was needed to operated about 10-12 Hrs/day. With this combination, the daily energy cost used to be around Rs.31,416/day, and the annual bill of the order of Rs.115 Lakhs/year. (All the costs are compared at the present rate).

When the cost of Diesel went up exorbitantly, the unit has gone for a gassifier, using rice husk as fuel, by investing Rs.15 Lakhs. The gassifier was supplied by M/s Ankur Scientific Energy Systems, Baroda. The rice husk is partially oxidized, and bio-gas is generated. The other by-products of the gassifier are ash & tar. The ash has very good market value and is being used by brick manufacturers and tar is sold as a lubricant. One problem with the gassifier is , the DG set cann't run on completely on 100% bio-gas. A minimum of 30% Diesel and 70% gas is needed. But this unit decided to use 40% Diesel and 60% bio-gas for running the DG sets. By installing this Gassifier, the Unit has reduced their total energy bill to Rs. 79 Lakhs from the initial Rs. 115 Lakhs a savings of by Rs.36 lakhs, a significant reduction of more than 31%.

When these people decided to go for a gassifier, the cost of Rice husk used to be in the range of Rs.700-800/ton. But over a period, when every body started using rice husk, the cost of rice husk also gone up and is now available in the range of Rs1500-1600/Ton, and almost doubled. At this stage, they approached National Productivity Council, to help them to reduce their energy bill further by carrying out Energy Audit in the year 2000.



After preliminary visits and taking some trails on DG sets, Boiler and refrigeration system, we thought Vapour Absorption Refrigeration (VAR) system would be best bet to replace the existing load of 100 TR , which is running on vapour compression Ammonia refrigeration system. Since steam is available and in case, if we want more steam, we thought we can generate from bio-gas. At this stage, two alternatives worked out. First one is to generate steam by installing Waste Heat Boiler(WHB), another alternative was to generate hot air directly from the Flue gas by installing simple air heater. First of all, why to generate steam and then produce hot air, if we are able to generate directly hot air, so that we can avoid one more inefficiency. But after working out various alternatives, our suggestion of heat recovery from DG sets exhaust gases and generating hot air was well appreciated. Since the DG sets are run continuously we felt this is an ideal case for Combined Heat & Power (CHP) generation.

The exhaust temperature of the DG sets used to be in the range of 390-400 ^{0}C. After detailed measurement of F.Gas flow, the potential heat available assessed to be around 1,00,000 Kcal/hr, which is more than sufficient to generate 1500 CFM hot air at 120 ^{0}C. This perfectly matched the plant requirements. After giving this idea, the unit has implemented the Waste Heat Recovery (WHR) system for their DG sets, in a record time of one month. Interesting part is, based on the heat duty, we have given them a rough estimate of heat transfer area required and the line diagram of the modification. The unit has fabricated the shell & tube heat exchanger on their own inside the factory itself at a cost of only Rs.3.5 lakhs(year 2000 cost) & present cost Rs.6 Lakhs. One single heat exchanger, with blower can cater to both the DG sets, with by-pass arrangement. When we gave them, the heat exchanger design, in fact, we ourselves were not confident of our own design. But after seeing the working model, which was giving hot air at 140-150 ^{o}C, at the exit of the Waste heat recovery system, we are proud that, we can do even designing.

By implementation of the WHR, the existing steam boiler was completely stopped and has become a stand-by boiler. By this the annual bill of the plant has further reduced to Rs.46 Lakhs from the initial Rs. 115 Lakhs. In another words, additional savings of Rs.33 Lakhs, by stopping the boiler alone. This amounts to reduction of another 42%. The following table-1 presents the cost comparison of three different combinations, i.e.1) DG set & Boiler, 2) DG set with Gassifier & Boiler and 3) DG set with Gassifier & WHR system.

Table-1: Cost Benefit Analysis of DG set Cogeneration with Gassifier

Sl.no.	Parameter	Unit	Case -1	Case-II	Case-III
			Only DG set	DG set with Gassifier	DG set with Gassifier & WHR
1.	DG set Rating	KVA	2 x 320	2 x 320	2 x 320
2.	Normal operation		320	320	320
3.	Avg.Power Generation	Kw	180	180	180
4.	Diesel Consumption in DG set	Lit/hr	55	22	22
5.	Rice husk consumption in Gassifier	kg/hr	0	200	200
6.	DG set F.Gas Exit Temp.	^{0}C	400	400	400
7.	Steam requirement	kg/hr	300	300	0
8.	Diesel consumption in the Boiler	Lit/hr	22	22	0
9.	Total Energy Cost	Rs./day	31416	21552	12576
10.	Annual Energy Bill	Rs. Lakhs	115	79	46
11.	Annual Energy Savings	Rs. Lakhs		36	69
12.	Investment towards Gassifier	Rs. Lakhs		15	15
13.	Investment towards Wast Heat Recovery	Rs. Lakhs		0	6

14.	Total Investment	Rs. Lakhs		15	21
15.	Simple Pay Back Period	Months		5	4

Basis: Cost of Diesel Rs.34/lit & Cost of Rice Husk Rs.1500/ton, Operating Hours = 12/day

After implementation of the scheme, one problem faced by the unit was the soot deposition and fouling of the heat transfer surfaces. Since the unit is using 60% bio-gas, the problem of soot deposition aggravated with the introduction of additional equipment in the flue gas path. So, the unit decided to operate the DG sets alternately so that they get sufficient time to clean the heat transfer surfaces and for any maintenance requirements.

This is a successful case study of a small cold storage unit, which experimented, by installing a gassifier and also the waste heat recovery system, there by reducing their energy bill from the initial Rs.115 Lakhs to Rs.46 Lakhs, a savings of Rs.69 Lakhs equivalent to 60% over a period. The simple payback period was hardly less than 4 months, really unbelievable. This savings are based on only 12hrs/day of operation. Imagine the savings, if the plant operates for 24 hrs and all the 3 shifts. This technology can be replicated not only in the similar cold storage units but also for other units, who needs combined heat & power (CHP) simultaneously and urge to reduce their energy bills. The significant other benefits are substantial reduction of CO_2 the main green house gas. Is there any takers for this technology! We have a video film to support this idea and seeing is believing.

I want to acknowledge my senior colleagues Mr. D.Pawan Kumar & Mr.R.Virendra for their inspiration & guidance in converting the idea to reality.