Co-generation - APPM Perspective

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ABSTRACT

As on today, APPM is equipped with three TG sets for power generation. The total power requirement of APPM is 20 MW with a peak load of 21 MW. One 12 MW double extraction condensing set and one 5MW Stal condensing TG set are run, generating 11+4 MW power. The extraction backpressure 5 MW TG set is a standby which is run during the shut of 12 MW TG set. The balance power requirement is met by drawing power from grid. The steam requirement of the plant is met with 5 coal fired boilers and three soda recovery boilers. In normal operation four coal fired and two soda recovery boilers are run, to meet the steam demand of the plant.

INTRODUCTION

The cogeneration is economically much more remunerative (1-4) than most of the large utility power generators, owned at present by the state and central grids. In utility power generators, a large part of the heat goes out wastefully as vapour to the condenser. In fact, with a condenser additional energy needs to be spent in the form a cooling tower to let go off the wasteful heat to atmosphere. (Fig. 1).

The above Sankey diagram indicates the relative energy efficiency of a cogeneration plant as against a condensing turbo generator.

A lot of advancements have taken place in the utility power generators so as to increase the effectiveness of energy recovery from fuel calorific value. Some noteworthy endeavor had been raising the boiler operating parameters to super critical range (25.5Mpa, 545°C), application of intermediate steam superheating, more automation, Development of fuel cells, advent of Magneto Hydrodynamic (MHD) plants,

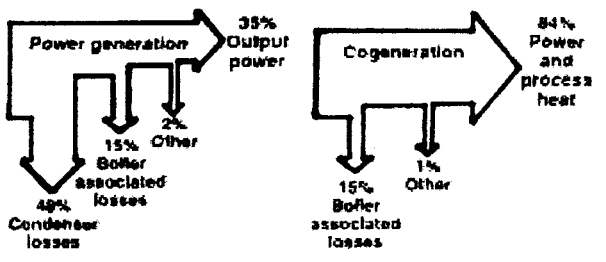

Fig. 1

operation of combined cycle power plants where good supplies of gas are available. The best available utility boiler technology has brought the overall thermal efficiency, as near as possible, to the Thermodynamic limit, slightly above 40%, in case of conventional methods and between 50 to 60% in case of MHD plants. This is far away from the overall thermal efficiency levels of an ordinary cogneration plant, which is usually more than 80%.

Our Industry's Vision

Nothing will be more gratifying than the vision declared by the The Forest, Wood and Paper Industry Technology Summit held in May 2001 in Peachtree City, Georgia, USA. The Technology Summit was sponsored by TAPPI, AF&PA and the U.S. Department of Energy's Office of Industrial Technology.

It was declared that integrated paper manufacturing would ultimately require no fossil fuel energy and even be an Exporter of electricity. Black liquor and biomass gasification combined cycle is a key element in achieving this.

At the Technology Summit, a group of pulp and paper industry energy experts gathered to mark the path for research to be pursued under the Agenda 2020 programme to deliver commercially viable gasification/combined cycle systems by 2008. There are two basic lines of black liquor gasification (BLG) development; Low temperature, represented by the Steam Reformer from Manufacturing and Technology Conversion International Inc. (MTCI), and high temperature, represented by Chemrec's unit. Both lines of development are poised for commercial

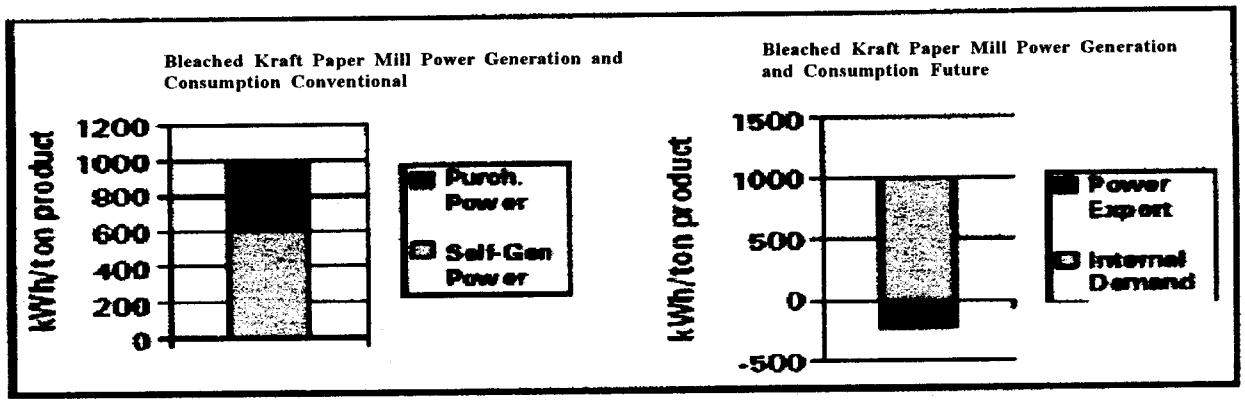

Fig. 2 Comparision of conventional Power generation and consumption with predictions for a future model.

demonstration, but some critical issues require resolution. APPM, (Fig 3) has adopted cogeneration concept in the year 1972, by installing a 5 MW extraction backpressure TG set. Mill has expanded further needing more power and more steam to be passed through the TG set, to met with the requirement of the plant. To minimize the dependence on grid power and to cater to the needs of the plant, APPM has gone is for a 10 MW double extraction, condensing TG set, in the year 1991. An Extraction back pressure set needs its throughput to be maintained and any reduction either in extraction or back pressure steam results in venting steam, to maintain same power generation. Venting steam is resource wastage besides huge noise pollution. Variation in process steam requirement is unavoidable in a paper industry. Keeping these aspects in view APPM has preferred double extraction, condensing TG set, which can take

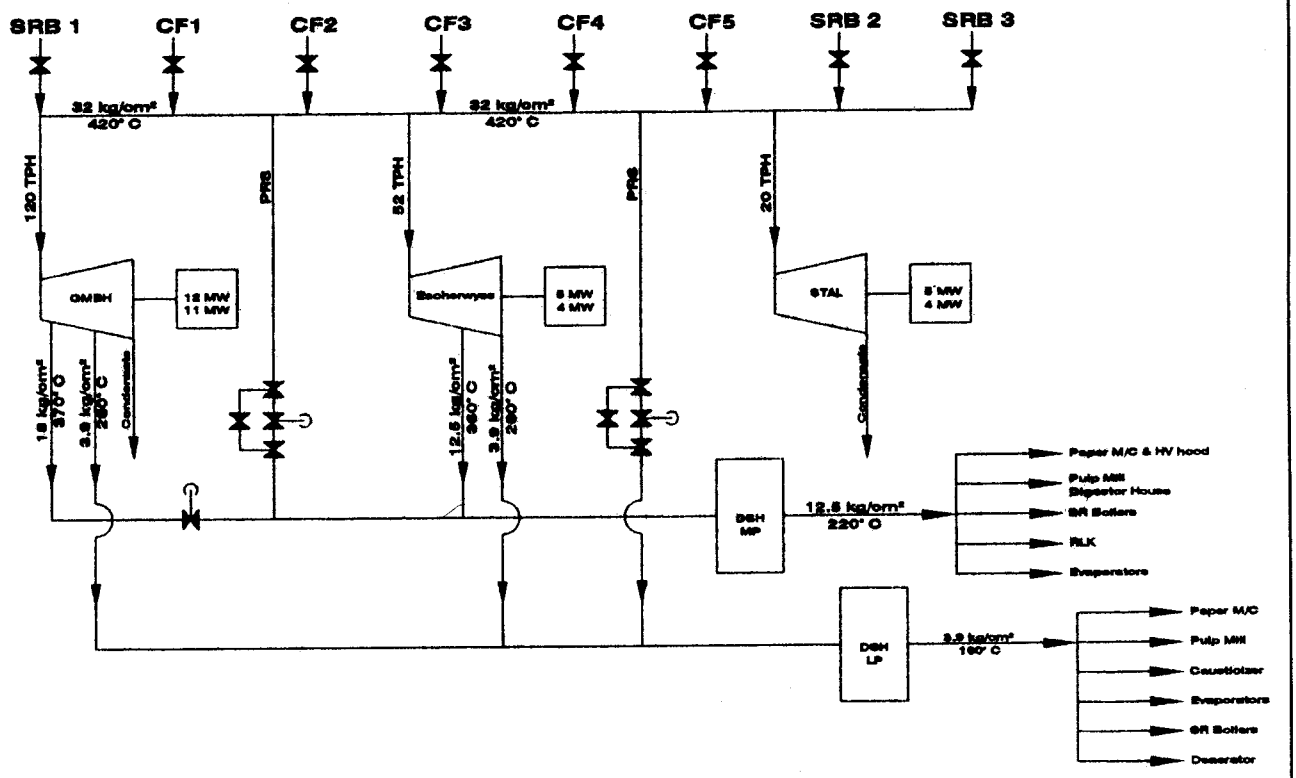

Fig. 3 APPM Steam Generation and Distribution

care of about 15% variation in the extraction and back pressure steam demands, without effecting power generation.

Further expansion of the mill has necessitated further study in the matter. On enquiry, it was known that the 10 MW TG set has an inbuilt capacity of 12 MW power generation from turbine as well generator point of view. In the year 1996, APPM has harnessed the inbuilt capacity of the set, by re-setting the inlet steam regulating valves openings and allowing more steam in to the turbine and by changing the operational parameters.

Coal Fired -1) 33tph 420 c FBC converted

Coal fired - 2) 33tph 420 420 C FBC converter

Coal fired - 3) 27 tph 420 C FBC converted

coal fired - 4) 27tph 420 C FBC converted

Coal fired - 5) 45 tph 420 C spreader stoker fired boiler.

Soda Recovery- 1) 120 TPD Black liquor solids firing

Soda Recovery- 2) 270 TPDBlack liquor solids firing

Soda Recovery- 3) 170 TPD Black liquor solids firing.

All the boilers operate in battery generating steam at 32 Kgs/cm^2 and 430°C temperatures The mill has got certain limitations in running the extraction back pressure turbine parallel to the 12 MW double extraction condensing set, as the process steam requirement is less than the generation from both the sets. Hence, it is a standby for the 12 MW TG set and condensing Stal TG set is run. The inlet pressure and temperature of turbines play a vital role in the economy of power generation. The mill has gone for DCS system for all the four FBC boilers, to take care of the process steam fluctuations and to maintain the inlet steam parameters of the TG sets. This has resulted in the improved efficiency of the boilers and reduced fuel cost. At the same time, the mill is able to maintain the inlet parameters of the TG sets close to the designed parameters.

The 12 MW TG set is generating power at 11000 volts and Stal TG set at 6250 volts. Majority of the prime movers of the mill equipments are operating on 415 Volts 3 phase and 230 v single phase. It was observed that most of the distribution transformers supplying these LT loads are rated 424 V. Hence, all the LT loads are receiving higher voltage than the rated voltage, which results in higher consumption of power, which results in lower efficiency and lesser power factor. Whenever these equipments are run on grid power, it was observed that the plant does not have any problem, though the frequency of AP Transco varies from 48 to 50 Hertzs. This was observed during the energy conservation study. When the equipments are run on TG set power, they are operating at 50 Hz frequency, resulting in increase in the power drawn by the equipment due to higher operating speed. Accordingly, the frequency of 12 MW TG set was reduced to 49.5 Hz in the year 1996. During the recent study, possibility of further reduction in frequency was observed and the frequency of both 12 MW and Stal TG set from 49.5 to 49 Hz, it is observed that power reduction is 2.2% of total power generaton. The frequency of 5 MW TG set was also reduced from 50 Hz to 49 Hz.

The 12 MW TG set is equipped with hydro electronic governing system and 5 MW Stal TG set is equipped with throttle valve mechanical governing systems, in the past. To overcome this problem it is proposed to go in for electronic governing system for both the sets. The proposal is under active consideration. The total savings expected by reduction of frequency and electronic governing system is Rs. 60 lakhs per annum. APPM has replaced the Aluminum and Cl components such as Blades and Hub of Cooling Tower and a saving of 6 kWh per fan was also achieved. In the operation of FBC Boilers, APPM observed that the depth of bed and fluidization velocity plays a vital role in the performance and operation of the boiler. Certain minimum bed depth is observed to be critical because enough residence time is needed for complete combustion of fuel. Depending on the dosing and experience in the operation of boiler, optimum depth of bed was arrived at. Deeper bed also permits quicker start up of the boiler after intermittent shut down. APPM has gone for DCS system for the FBC Boilers and achieved an increase of 1 to 2% in the efficiency of the Boilers. This has helped in maintaining the Steam costs low in spite of increase in the fuel cost.

CONCLUSION

The bed temperatures of FBC boilers is to be maintained in the range of 850 to 900°C. The Super heated steam temperature and pressure are to be maintained as per the requirement by effective control of air and fuel supply and de-super heater, if existing. DCS control system is more effective in this regard. The vacuum of the exhaust chamber of turbine is to be maintained close to the design specifications and exhaust chamber temperature is to be maintained accordingly. The cooking tower should be checked

and maintained periodically for efficient operation. Cooling water quality is to be maintained for effective heat transfer in the condenser tubes for reducing the frequency of tube cleaning by preventing scaling tendency. The inlet pressure and temperature are to be maintained close to the designed parameters for economical power generation. Lower Silica levels are to be maintained in the Boiler water and there should be proper control of pH to avoid deposition of scale on the turbines blades. Online vibration monitoring of the TG set will help in keeping a continuous watch on the health of the TG set. Periodic condenser and oil cooler cleaning will help in maintaining the chamber temperature as well lubricating and governing oil temperatures. Turbine oil sump level is to be maintained by topping up oil as per requirement. The oil is to be centrifuged periodically to remove water content and dirt in the oil. Oil sampling and analysing for compatibility at least once in a year is advisable. Last but not the least, continuous monitoring of all the parameters of turbine and immediate attention, in case of any variation result in improved efficiency and availability of the equipment.

ACKNOWLEDGEMENT

We thank Sri PK Suri, Vice President (Operations), Sri PK Sarkar, General Manger (Works) and Sri MVV Sitaram, Sr. Manager (Power Block) and Senior colleagues of the The Andhra Pradesh Paper mills for the guidance and motivation and for permission for submitting this paper.

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