Small Scale Co-Generation for Kraft Paper Mills

G.R. Narasimha Rao

Tata Energy Research Institute, P.B. No. 7117, 4th Main, Domlur II Stage, Bangalore-560 071

ABSTRACT

Recent energy conservation studies carried out by Tata Energy Research Institute (TERI) on such Kraft paper production units have revealed that significant reduction in energy consumption is possible. Small-scale co-generation is one of the options suitable for these mills, (or combined heat and power) which offers one of the most cost-effective means of reducing pollution in the energy sector. In addition, it saves energy, cuts costs and improves competitiveness - it should be a 'no lose' energy option for kraft mills in India.

INTRODUCTION

Waste paper is recycled to produce Kraft paper and boards of different GSM (range 80-240 GSM) in Kraft mills. Wastepaper from developed countries (like USA, Canada, UAE) are much improved and recycled in Kraft mills. The daily production rate of these Kraft mills varies from 40-200 tonne. Kraft mills are also energy intensive like other pulp and paper industries, in the sales turnover of the industry around 15-20% is used for power and fuel.

The thermal energy requirement in Kraft mills is normally met by coal and lignite. Combined heat and power (CHP) is a master term for onsite power generation technologies that simultaneously produce electrical (or)mechanical energy and useful thermal energy. Co-generation has existed for more than 100 years and is now achieving a greater level of acceptance due to increase reliability and overall cost efficiency. Capturing and using the thermal energy produced as a byproduct from fuel sources increases the power gained from the original fuel source. CHP technologies have the potential to reduce energy consumption - decreasing energy bills, as well as pollution.

The recent energy conservation studies done by TERI on group of such mills have identified the co-generation potential in the Kraft mills. It is an economically viable solution for the reduction of power and fuel cost.

Energy conservation studies have been carried out in four Kraft mills located in western part of India. These plants manufacturer Kraft paper with GSM ranging from 80 to 240 and BF ranging from 14 to 28. These plants use imported waste paper as the raw material. The installed capacity and sales turnover of the plants are given in Table 1.

Sources of Energy: Electricity, coal and lignite are the main sources of energy. The main source of electricity is from state grid. Electricity is used for driving the motors of pumps, air compressors, vacuum pumps, paper machine drives, air conditioning equipment and lighting. Coal and lignite, as a mixture is used for generation of steam in the boiler.

Energy consumption: The energy consumption patern of Kraft mills during the year 2000-01 is given Table 2. The equivalent cost of electricity works out to be Rs. 5.30 per kWh including demand charges and unit charges. The landed cost of coal and lignite to mills is Rs. 2200 per MT.

Due to high share of energy cost in the turnover these Kraft mills hare opted for energy audits. Detailed energy audits of these mills were undertaken during end of 2001 to evaluate the existing energy consumption and to identify the scope for energy efficiency improvement in the mills.

Findings of Energy Conservation Studies

During the study, every attempt was made to understand the operational features and the actual working in the right perspective. All analyses have been based on actual data collected and also based on the on-site measurements/observations made using portable diagnostic instruments. The specialized instruments that were used during the studies include:

- Portable load manager for electrical parameters
- Clamp on electrical power analyzers
- Ultrasonic flow meter
- Thermo hunter
- Stroboscope
- Multi function kit
- Anemometer
- Thermo couples & Indicators

Table 1 Installed Capacity and Sales Turnover of the Plants

(Figures for the year 2000-01)

Plant	Installed capacity (MT/day)	Annual production (MT)	Sales turnover (Rs. Lakh)	Type of product	Co-generation system
Plant-I	40	10,314	1609	Kraft paper	-
Plant-II	120	33,450	5800	Kraft paper	1.2 MW*
Plant-III	75	16,885	2609	Kraft paper	-
Plant-IV	60	14,771	2534	Kraft paper	-

* Operating at 75% of installed capacity

Table 2 The energy consumption pattern of kraft mills during the year 2000-01

Plant	Annual Energy Consumption		Energy Cost	Energy cost in turnover
	Electricity (lakh kWh)	Coal & Lignite (MT)	(Rs lakh)	%
Plant-I	39.67	5811	319	19.8
Plant-II	147.15	19843	850	14.6
Plant-III	62.73	6694	481	18.4
Plant-IV	58.14	5586	411	16.2

Table 3 The identified energy saving potential in these kraft mills

Plant	Annual Energy		Investment required (Rs lakh)	Payback period (years)	% savings in energy cost
	Cost (Rs lakh)	Saving potential (Rs lakh)			
Plant-I	319	32.5	33.5	1.0	10.2
Plant-II	850	142.0	129.0	0.9	14.2
Plant-III	481	59.9	59.3	1.0	12.5
Plant-IV	411	60.0	60.2	1.0	14.5

- CO_2 & O_2 Analyzers
- Lux meter

Based on the analysis and observations, the energy saving opportunities has been identified for the plants. The recommendations have been discussed with the plant management during the course of the study, to allow concurrent implementation and to ensure that the suggestions made are realistic, practical and implementable.

The identified energy saving potential in these Kraft mills are given in Table 3. From the above table identified energy saving potential is around 10-14% of annual energy bills. The payback period for the investments will be one year. The energy savings that can be achievable with small investment are very sizable in above savings, are given in Table 4.

Apart from the above energy savings, it is also found that small-scale co-generation systems can be integrated in these kraft mills. Nearly 10% of the mills electrical load can be met from the small co-generation units.

Co-generation Potential

The steam turbine has always traditionally been important for co-generation and, although not used so frequently now, can still be the right solution in certain instances. Steam turbines are powered by steam from boiler and are usually applied to co-generation when a solid fuel such as coal or lignite is to be burnt.

There are two types of steam turbine:

- The back pressure turbine in which low pressure steam is exhausted from the exit of the turbine for low pressure process equipment
- The extraction turbine in which steam is fully condensed by the turbine with somebeing extracted part-way along the turbine chamber

The type of turbine used depends mainly on the required steam characteristics. Extraction turbines can be tailored to produce steam at specific conditions but are more complex and hence more expensive than

Table 4 The energy savings that can be achievable with small investment

Plant	No. of proposals	Annual energy savings (Rs lakh)	Investment required (Rs lakh)	Payback period (years)
Plant-I	7	29.5	23.8	0.8
Plant-II	23	101.3	37.0	0.4
Plant-III	15	37.4	16.7	0.5
Plant-IV	11	36.6	10.7	0.3

Table 5 Kraft mills power and steam requirements along with installed boiler capacities

Plant	Electrical load (kW)	Steam requirement (TPH)	Installed boiler capacity (TPH)	Design boiler pressure (kg/cm²)
Plant-I	500	3	5	10.5
Plant-II	1050 + 850 *	11	10.5	42
Plant-III	850	5	6	10.54
Plant-IV	800	5	6	10.54

*TG Power

Table 6 Co-generation potential by installing saturated backpressure steam turbine

Plant	Electrical load (kW)	Co-generation power generation potential (kW)	Annual cost Savings (Rs. lakh)	Investment (Rs lakh)	% savings in annual energy cost
Plant-I	500	46	16	15	5.0
Plant-III	850	100	25	22	5.2
Plant-IV	800	86	22	22	5.3

the simple backpressure turbines. Studied Kraft mills power and steam requirements along with installed boiler capacities are given below.

Apart from the plant - II, other plant boilers are operating at 7-8 kg/cm² and steam is passed through pressure reducing valve to reduce the steam pressure as per user requirements (4-5kg/cm²). White inthe case of plant-II, generated steam (42 kg/cm²) is passed through backpressure steam turbine and exhaust steam turbine pressure is 3.5 kg/cm². Steam reduction process through turbine is generating 850-925 kW power as per mill process steam demand.

Installing a backpressure-saturated steam turbine in place of pressure reducing valve in other three plants also produces good quantity of power. Pressure-reducing valves are fitted in the steam line between the boiler and the user end. A saturated backpressure steam turbine does the same work of pressure-reducing valve. but with the additional benefit of power generation. The difference in enthalpy in the high pressure and low-pressure steam is converted into electric power by the turbine rotor.

The boilers are designed to operate at 10.5 kg/cm², but the operating pressures are lower than design. In order to generate the maximum power from the saturated backpressure turbine, these boilers should operate at maximum pressure i.e. 10-10.5 kg/cm². The outlet pressure of the saturated backpressure turbine can be set at the desired steam pressure at the paper machine i.e. 4.5 - 5.0 kg/cm². After installing the backpressure turbine, the steam consumption of the mill goes up by 10%, as the output steam of the backpressure turbine is going to be of 95 to 98% dryness fraction. The cogeneration potential by installing saturated backpressure steam turbine is given in Table 5 and 6.

From the above table it can be seen that installing saturated back pressure steam turbine in the Kraft mills will reduce the annual energy cost by 5%. The annual cost savings after installing backpressure steam turbine depends on annual production rate. The out come of the energy conservation studies, identified about 15-20% reduction in energy cost including the co-generation potential.

RESULTS AND DISCUSSION

Plant -II has already installed co-generation system of 1.2 MW capacity with high pressure boiler. The operating energy cost of plant - II is 13-14% less