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IMPROVEMENT IN ENERGY EFFICIENCY AND ENERGY CONSERVATION INITIATIVES AT KHANNA PAPER MILLS LIMITED

Abstract:

Developing the future of energy and the environmental sustainability within the pulp and paper industry is pivotal for both sustainable growth and bolstering the nation's economy. Traditionally, wood and agro based mills average energy consumption is 10.77 and 9.6 Mkal/ton of paper respectively, whereas for RCF based paper mills it is 4.15(W/P) and 2.26 Mkal/ton (Packaging). It's estimated that the yearly percentage growth of wood, agro, RCF (w/p) and RCF (kraft) based mill will be 2%, 1%, 3 % and 4% respectively and therefore the production capacity of pulp and paper industry will touch 30 million tons per annum of production by the year 2029-30. To meet this production capacity paper industry will require 122,012,362 MCal of energy or 43,968,419 tons of coal equivalent.

M/s Khanna Paper Mill Limited (KPML) having four paper machines, deinking plants and in-house captive power plant of 33 MW, is the largest RCF based paper mill in India, with annual production capacity of half a million tons. KPML has carried out multiple initiatives for energy conservation and reduction in environmental impact in the mill over the past few years. These include replacement of all Standard efficiency (IE1) motors with Premium efficiency (IE3) motors, Replacement of Conventional Liquid Ring Vacuum Pumps with Energy efficient Turbo Blowers for Vacuum generation, replacing old inefficient APH modules with new Efficient modules resulting in Improved Boiler efficiency & reduction of O2% level in flue gas, Grid Islanding, etc.

These measures have not only led to improvement in the energy efficiency, reduction in carbon footprint due to reduced environmental impact, operational and production costs but also has provided enhanced reliability and reduced downtime of the plant. With such measures the plant has reduced its energy consumption by 1675 Toe from FY 17-18 to FY 22-23 while increased its production from 435 thousand ton to 458 thousand ton during the same time-period. This is quite evident from having won the prestigious State Energy Conservation Awards in the past and most recently in 2023.

Introduction:

Energy is one of the major inputs for economic development of any country and assumes critical importance in view of ever-increasing energy needs. Escalating energy demands with rise in industrial activities, have imposed serious threat of energy security on account of depleting primary energy resources and sizable import bills.

Pulp & Paper industry is one of the fifteen energy intensive industries / establishments specified as designated consumers of energy under the Energy Conservation Act 2001. One of the main provisions of the Act is to establish and prescribe energy consumption

norms for designated consumers. As per the draft notification, any pulp and paper mill or establishment having annual energy consumption equal to or more than 30,000 MT of oil equivalent (MTOE) per year has been notified as designated consumer.

Khanna Paper Mills Ltd. is highly concerned about Energy conservation and has carried out multiple energy saving initiatives in its facility over the past few years. This is quite evident from having won the prestigious State Energy Conservation Awards in the past and most recently in 2023.

Apart from replacing old inefficient APH modules with new Efficient modules

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resulting in Improved Boiler efficiency and replacement of all Standard efficiency (IE1) motors with Premium efficiency (IE3) motors, KPML has also taken various other energy saving initiatives including Replacement of Conventional Liquid Ring Vacuum Pumps with Energy efficient Turbo Blowers for Vacuum generation & reduction of O₂% level in flue gas, Grid Islanding, etc.

KPML is also keen in optimizing processes, adopting latest technologies and use of renewable energy sources eg. Utilisation of internal generated Plastic waste as per thermal substitution ratio by installing an Incinerator, Replacing 17.5 MW turbine with higher capacity 22.4 MW turbine to improve heat rate and own power generation, Utilisation of solar energy in process hot water for bleaching & washing, lighting etc. with a solar plant etc. to reduce the industry's carbon footprint. PV System revamp on the highspeed machines for thermal efficiency, Screening and cleaning system upgradation (UTL From Voith) will further reduce our load on the DIP Plant and reduce our imported HW pulp consumption – saving on the refining energy. These are few of the energy saving initiatives that KPML has decided to undertake in near future.

Case studies at Khanna Paper Mill, Amritsar

1. Replacement of old inefficient Air Preheater with Efficient Air Pre-heater system for reduction of FD fan Power consumption and improvement in Boiler Efficiency

At Khanna Paper Mills Ltd. the Air Preheater on 100 TPH Boiler, the tubes in the top and the bottom modules were found to have developed holes. It led to the short circuiting of the flue gas and air to the boiler. The leakage had increased due to the deterioration of the sealing system leading to loss of essential heat and increased power consumption in the Auxiliary equipment.

The reasons for increased power consumption include:

- Additional power consumption of FD fan to supply more air
- Mixing and cooling of the hot flue gas with the cold incoming air
- Overloading of the FD, PA and Induced Draft Fans.

Initiatives taken at KPML

Considering the loss of efficiency and increased loss on ignition due to damaged Air preheater, Khanna Paper Mills Ltd. decided to replace the old Top and bottom modules of the Air Pre- heater system with a new system, thereby resulting in increased performance

of the Boiler System and reduction of power consumption of the installed fans. The expansion bellow between the Economizer and the Air-preheater which got damaged was also replaced and it reduced the power consumption of the ID fan also. Due to the reduction in the O₂% from 7 to 4.5, the boiler efficiency increased by 1.5 % and the Boiler could be operated now by a single FD fan.

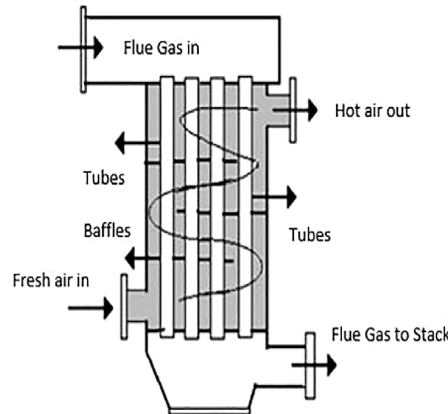


Fig. 1 Air preheater (Picture courtesy :Brainkart.com)

Savings Achieved

The total fuel savings achieved by the above initiative was **2100 MT** annually amounting to **INR 210 Lacs/Annum**. The annual savings in the FD power consumption was **266kWh** worth **INR 138 Lacs/annum**. The total investment involved was **INR 120 Lacs**.

2. Grid Islanding Project

Previously at Khanna Paper Mill, all plant loads were connected on the same network and separate load on the grid was not possible due to constraint of the distribution network. The turbine was running at the rated speed to match the Grid frequency as TG and Grid were running in parallel mode. So the Grid was always the master and TG sets were the follower. Hence the TG frequency could not be reduced in the synchronous mode. During any disturbances in the Grid network, disturbances were recorded in the TGs also. The machines also gets affected due to voltage surges, resulting in the failure of the electronic devices like Variable Frequency Drives, PLC cards etc. during blackouts, causing loss of production amounting to huge financial loss. Grid islanding relay will be provided to sense the grid disturbances and isolate the grid bus immediately.

Energy Saving Initiative

Khanna Paper Mills Ltd. has planned to introduce Grid Islanding and protection systems in March Annual Shut that would isolate the in-house generator in case of fluctuations happened on the grid side. It will prevent worst situations such as plant blackouts, production and financial loss.

It will offer the following advantages- Machine stoppage and TG tripping due to grid disturbance, Energy saving as the TG run at lower frequency and reduction of fault levels in the system which will also help in increased life of the switchgear.

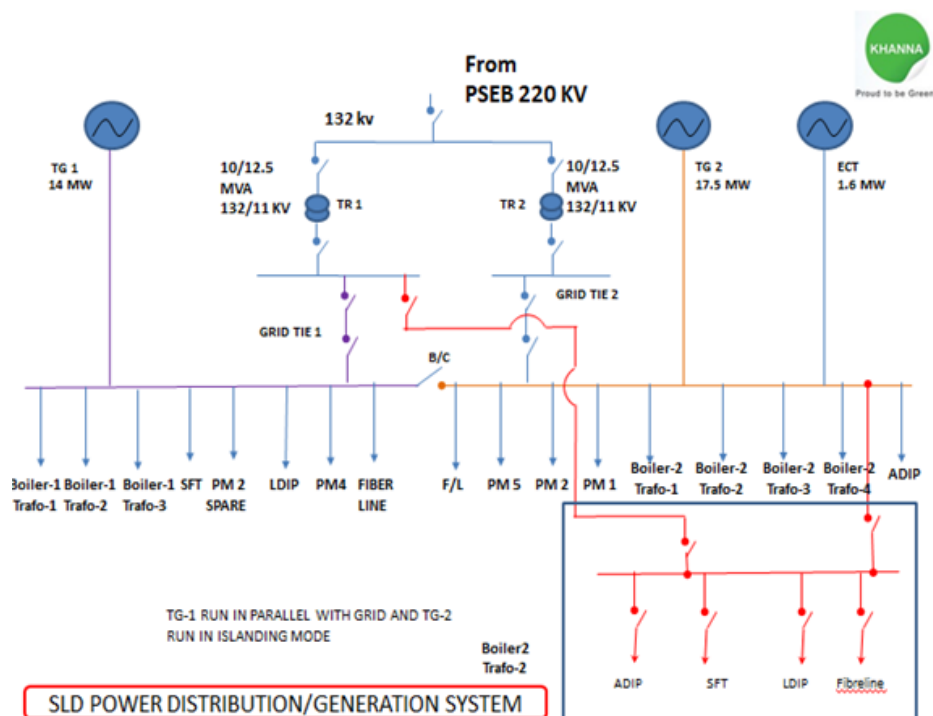


Fig. 2 Single Line Diagram for Power Distribution System

Estimated Savings

The total savings expected by implementing the above project would be **6.91 Lac kWh** amounting to **INR 518.0 Lacs** annually and would cost an initial investment of **INR 250 Lacs**.

Considering additional savings by avoiding Loss in Production / Quality & Electronic / Drive card failure cost worth **INR 50.0 Lacs** each, Net Savings would then increase to **INR 618.0 Lacs** annually.

3. Replacement of Standard efficiency (IE1) / Re-wound Motors with Premium Efficiency (IE3) Motors

Khanna Paper Mills Ltd. has carried out “**Critical motor replacement study**” that and have identified standard efficiency motors or the motors that have been rewound more than 3 times in the entire mill area.

The standard efficiency and rewound motors (more than 3 times) in the mill area, de-inking plant and utility area were replaced with Energy Efficient Premium IE3 motors.

The above proposal resulted in annual savings of **6.48 Lac kWh** resulting in savings of **INR 43.0 Lacs** annually and required an initial investment of **INR 94.0 Lacs**.

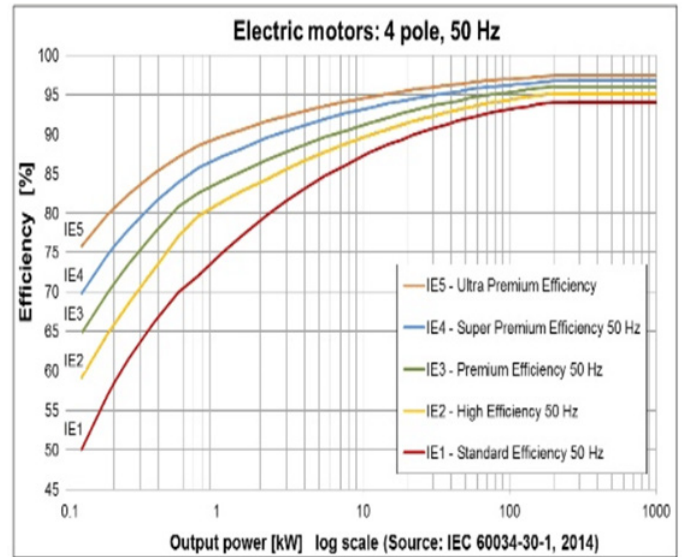


Fig. 3 Efficiency comparison between IE motors (Picture Courtesy: Research gate)

Area	EQUIPMENT NAME	Motor KW	Motor RPM	Application	Eff.Old %	IE 3 Eff %
PM 1	Fan Pump No. 5	45	1,500	Pump	91.5	94.2
PM 1	Fan Pump No. 7	37	1,500	Pump	91.5	93.9
PM 1	Fan Pump No. 8	37	1,500	Pump	91.5	93.9
PM 1	Pressure Screen no.1	37	1,500	Screen	91.5	93.9
PM 1	Mould Blower No.2	55	1,500	Blower	92	94.7
PM 1	Coating Blower No. 1	75	1,500	Blower	92.5	95
PM 1	Broke Pulper	75	1,000	PULPER	92	94.6
PM 1	Pope reel	75	1,500	SECTIONAL DRIVE	92.5	95
PM 1	Broke Tower pump	45	1,500	Pump	91.5	94.6
PM 2	Broke pulper agitator	45	1,000	PULPER	91.5	93.7
PM 2	Old T/C Coating Blower 4	45	1,500	Blower	91.5	94.6
PM 2	Trim Blower for rewinder	30	3,000	Blower	89	93.8
PM 2	Chest Pump No. 7	30	3,000	Pump	89	93.8
PM 2	UTM Pit No.2 Agitator	75	960	PULPER	91.6	94.6
FILLER PLANT	F/L T.D.R 24"	260	1,000	REFINER	92	96
FILLER PLANT	P/L. Mixing Chest No. 4	37	1,500	Pump	91.5	93.9
FILLER PLANT	Chest Pump No.1	30	1,500	Pump	91	93.8
SFT	Intensa Maxx Drive	75	1,500	Pump	92.5	95
SFT	Contaminax Drive	75	1,500	Pump	92.5	95
SFT	Stock preparation dilution pump	75	1,500	Pump	92.5	95
SFT	Pulper dilution pump	75	1,500	Pump	92.5	95
SFT	DF shower pump	75	3,000	Pump	92	94.7
BOTTOM PLANT	Krofta Feed Pump No.1	30	1,500	Pump	91	93.8

Fig 4. List of Replaced Motors at Khanna Paper Limited

4. Replacement of Liquid Ring Vacuum Pumps with Energy efficient Turbo Blowers

In Khanna Paper Mills Ltd. the mould, wire and the press section of PM 1 and PM4 uses conventional Liquid ring vacuum pumps. These pumps have high operating costs and more pulsation/variation in the vacuum system resulting in complex operation and affecting runnability of the machine. The maximum efficiency of these Vacuum pumps is about 70%. These pumps also consumed high sealing water which required additional clear water and use of anti-scaling chemicals. Existing power consumption for the vacuum system is around 520kwh for PM1 and 1275 kWh for PM4 respectively.

Energy Saving Initiative:



Turbo Vacuum Blowers
(Picture courtesy: TurbAir Vacuum Blowers)

The old in-efficient Liquid Ring Vacuum Pumps are proposed to be replaced with energy efficient Turbo Blowers in March Annual Shut. The project material is expected

to be delivered at KPML by Mid-February. Turbo Blowers operate on constant pulsation resulting in low variation in the vacuum system which ultimately results in the smooth operation of the machine. There will be no requirement of sealing water and anti-scaling chemical. It will also consume less power as compared to the liquid ring vacuum pumps. The revised power consumption of the vacuum system will be 330kWh for PM1 and 1110kWh for PM4 respectively, with the total saving potential of around 355 kWh. This replacement represented a progressive step towards more efficient, sustainable, and cost-effective industrial process.

Conclusion

Challenges related to energy consumption in the paper industry include the fluctuating costs of conventional energy sources and the need for substantial investments in energy-efficient technologies. However, addressing these challenges presents opportunities for cost savings and environmental sustainability. Improving the efficiency of Boilers through Air Preheaters, Grid Islanding, Replacement of Conventional Motors with Premium Efficiency (IE3) Motors and Replacement of conventional Liquid Ring Vacuum Pumps with Turbo Blowers help increasing the energy efficiency and sustainability too. Adopting best practices in energy management are crucial for paper mills in India to remain competitive and environmentally responsible.

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