IMPROVING ENERGY EFFICIENCY IN THE PAPER INDUSTRY

Anand Tissues Ltd (ATL), a manufacturer of MG Kraft paper, is a 50 TPD agro-and waste-paper-based paper mill located in Meerut, Uttar pradesh. The plant was established in 1994 and is involved in the production of various grades of Kraft and Absorbent Kraft Paper.

Under the "India: Second Renewable Energy Project." IREDA is operating a World Bank Line of Credit to finance energy efficiency and conservation project. As a part of this project, DSCL Energy Services carried out energy auditing in ATL. DSCL carried out an energy audit to study the operations and performance of both electrical and thermal energy-intensive equipments/systems for identification of potential energy saving areas. Beside this, the DSCL team also studied the load distribution/energy consumption pattern of the unit.

The projects identified and details of each project are discussed in this article. Most of the project ideas have been implemented and a lot of energy savings have been made possible.

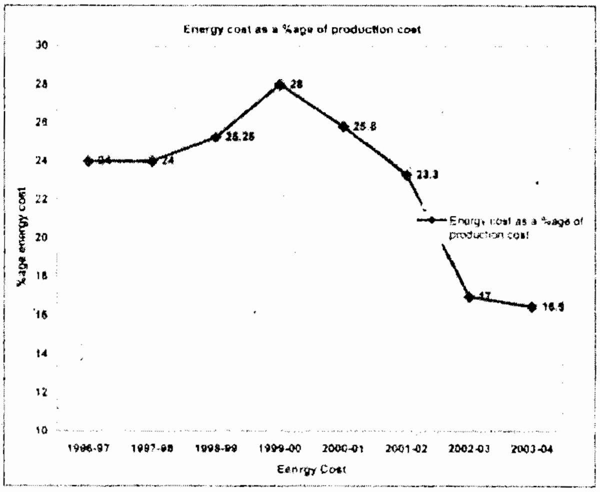

Fig.1 : Energy cost vs production cost

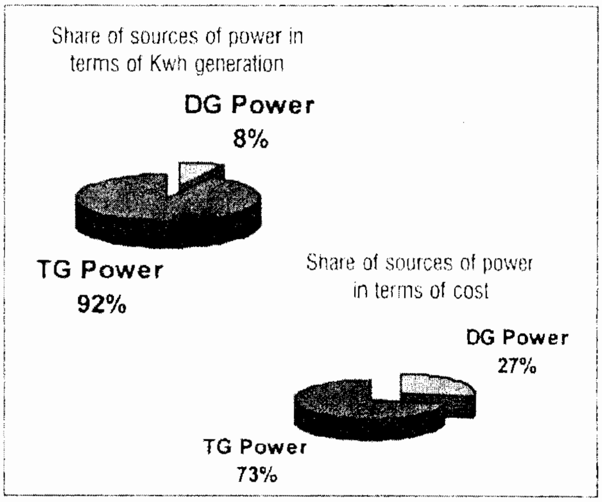

Fig.2 & 3: Share of source of power

Energy Scenario at ATL

The production process is energy-intensive and energy costs are nearly 20 percent of the total production cost.

Major sources of energy at ATL are biomass and diesel. Since the commissioning of a 2.5 MW cogeneration plant in August 2002, no power is drawn from the state grid. In addition to the steam and electricity demand of the paper mill, the cogeneration plant also serves the steam and electricity demand of a steel ingot production unit located adjacent to the paper mill and operated by a sister concern of ATL. Fuel used in the cogeneration plant includes rice husk, coal and bagasse pith. Apart from the cogeneration plant, additional electricity

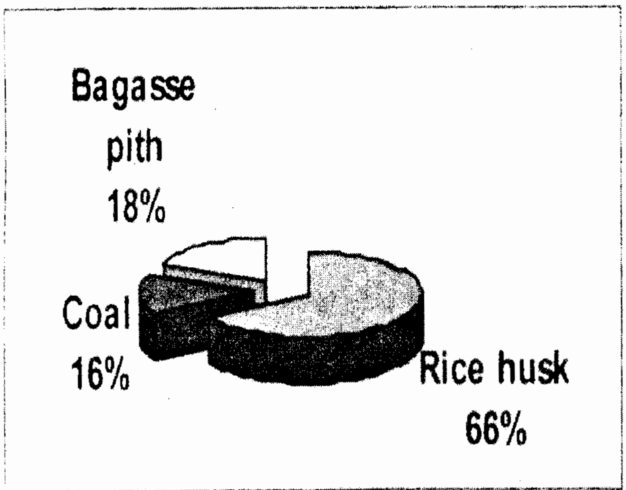

Fig.4: Share of various fuels for a cogeneration plant

demand is met by power generated through DG sets.

Figures 2 and 3 show the distribution of DG and TG power based on both generation and cost basis. On generation basis, the contribution by DG is about 8 percent, whereas on terms of cost basis the contribution is 27 percent.

The total energy bill is about Rs 1.73 crore per annum. The cogeneration plant at ATL comprises a 20 TPH FBC boiler operating at 43 kg/cm²/430 °C designed to fire rice husk (70%) and bagasse pith (30%). In addition, ATL also uses steam grade coal when rice husk is short in supply. The cogeneration plant also includes a 2.5 MW extraction condensing turbine (extraction pressure 4.5 kg/cm²/220 °C, steam flow - 12-14 t/h). The actual distribution of various fuels is shown in Figure 4. Around 66 percent of the total fuel is rice husk.

ATL has two DG sets each of 1,000 kVA. Only one set is operated at 50-60 percent of its capacity. Its cogeneration plant has been maintaining power factor between 0.86 and 0.89.

Energy Usage at ATL

Major electricity consumption areas in ATL are stock preparation, pulp mill, paper machine, power plant and electric arc furnace in the steel unit. Electricity generated from the DG set is used entirely in the pulping section. Major electricity loads include the power plant auxiliaries, refiners, fan pump, vacuum pump, and DC drives on the paper machine.

The cost of energy is in the range of 16-26 percent of the total production cost and averages about 20 percent. The figure below shows the variation in energy cost vis-a-vis paper production over the last six years.

Steam at 4.5 kg/cm², which is extracted from the turbine, is consumed in various section including the pulp mill digestor, paper machine, de-aerator and ejector. The extraction temperature at the turbine is 220 °C; however, since the process requirement is at 170 °C, steam extracted is passed through a PRDS. Water for the PRDS is taken from the boiler feed water pump.

Energy Conservation Activities at ATL

Energy conservation activities at ATL are being carried out on a continuous basis, including:

- Successful installation of a turbine generator.
- Conversion of DC drives to AC drives.
- Upgradation of the paper machines and capacity increase.
- Installation of screw compressors.
- DG heat recovery.

Some of the energy conservation projects planned are:

- VFD for ID fan.

- VFD for FD fan.
- PLC-based control system.
- Online oxygen analyzer.
- Weight meter for fuel metering.
- Moisture control for paper machine.

ATL has installed appropriate information systems for monitoring of plant performance. The specific energy consumption has reduced over the years and is currently at 730 kWh/t of paper production.

Energy Cost Reduction Projects

Project 1: Boiler Feed Water Pump

Project Description

The boiler feed water-pumping system was studied in detail and analyzed for energy efficiency improvement. The study involved measurement of feed water flow, head delivered by the pump, power consumption and pressure drop. The pump was operating on a lower efficiency range and this could be improved by replacing it with a higher efficiency pump. Also, there was a pressure drop of 10 kg/cm² across the control valve that amounted to a loss of 17 percent of the total power consumption. See Figure 6.

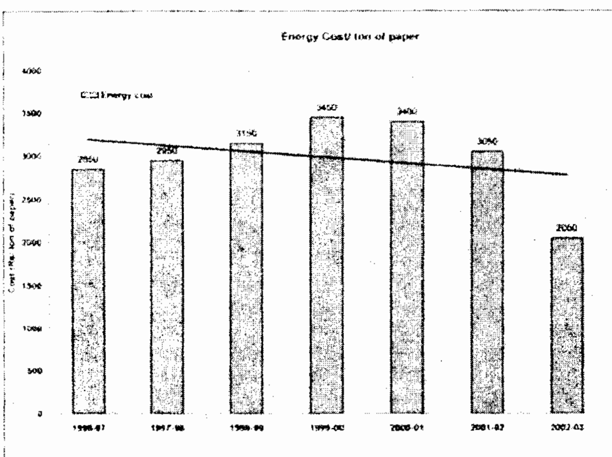

Fig.5: Variation in energy cost

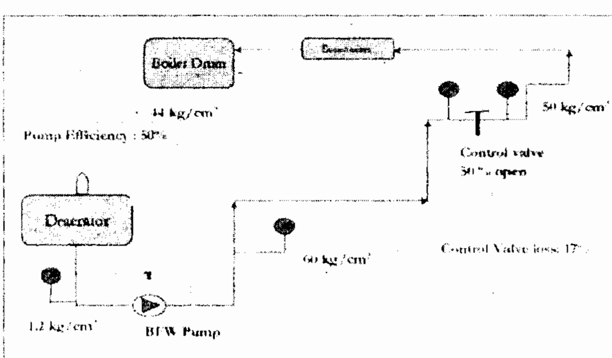

Fig.6: Existing boiler feed water system

There is a possibility of reducing the losses across the control valve by having an adequate instrumentation and control system installed. This, along with a VFD for the pump, would make the boiler feed water system efficient. The logic of the control loop would be such that the control valve would be in line only when the boiler load is below 70 percent of the rated capacity. The log sheets show that the boiler is loaded above 70 percent of the rated capacity for most of the time. Hence, there is a big potential to save energy for most of the operating hours. Figure 7 (on page 12) represents the proposed system.

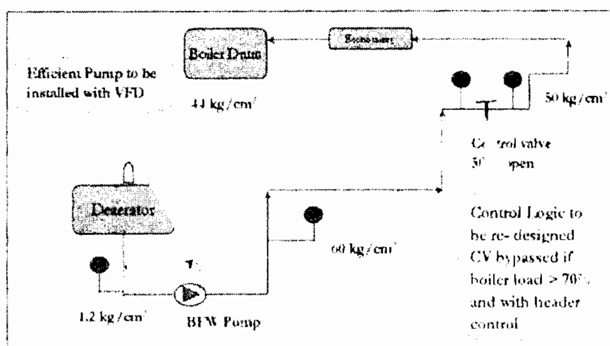

Fig.7: Proposed system

Project Financials.

See Table 1 (on page 13) for the possible savings accruing from the improved system. The financials for the feed pump was based on DSCL's database on pump quotations.

Table 1: Project 1 Financials

Description	Value
Electrical savings (kWh/yr)	166,667
Monetary savings (Rs lakh/yr)	3.5
Estimated project cost (Rs lakh/yr)	4.57
Equipment cost	4.35
Erection & commissioning	.22
ROI	77%

Project 2: Boiler Air Control

Project Description

The oxygen level in the exit flue gases was measured and found to be 9 percent, which was on the higher side. With adequate instrumentation and control, this oxygen level could be brought down to 5 percent, which means savings in both fuel and power. Figure 8 represents the present efficiency level of the boiler with reference to the oxygen level in flue gas and the proposed efficiency level.

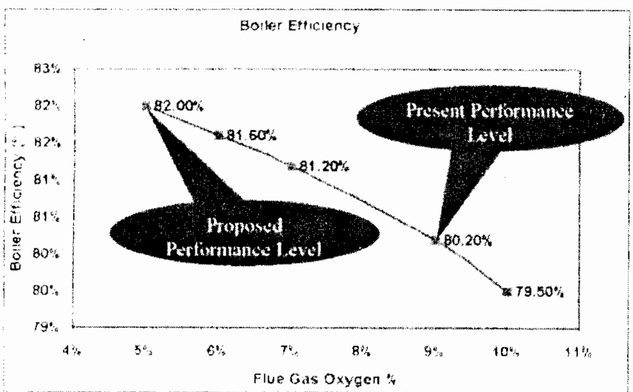

Fig.8: Operating and proposed efficiency graph

This can be achieved by installing a flue gas oxygen controller, which consists of an oxygen sensor with PID controller. This system will work more efficiently if it is coupled with a combustion control loop consisting of a steam transmitter and controller.

Project Financials

See Table 2 for possible savings with the improved system.

Table 2: Project 2 Financials

Description	Value
Electrical savings (kWh/yr)	–
Monetary savings (Rs lakh/yr)	20
Estimate project cost (Rs lakh/yr)	7.58
Equipment cost	7.15
Erection & commissioning	0.14
Taxes & Duties	0.29
ROI	264%

Project 3: Installation of VFD on ID Fan

Project Description

During the study of the air and flue gas system in the boiler section, it was observed that the draft in the boiler furnace was maintained by varying the damper position of the ID fan. This throttling results in a pressure drop, which is a loss in the system. See Figure 9.

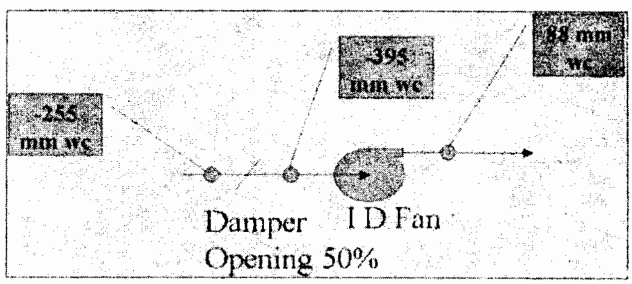

Fig.9: Throttling losses across damper

The estimated pressure drop across the damper is 140 mm wc which accounts for 28 percent of the power loss. Operating the ID fan with a VFD control instead of damper control can reduce this loss.

Project Financials

See Table 3 for the possible savings with the improved system.

Table 3: Project 3 Financials

Description	Value
Electrical savings (kWh/yr)	142,857
Monetary savings (Rs lakh/yr)	3
Estimate project cost (Rs lakh/yr)	2.66
Equipment cost	1.99
Erection & commissioning	0.15
Taxes & Duties	0.52
ROI	113%

Project 4: New Pump for De-superheating Water Pump

Project Description

At present the water for de-superheating of extraction steam from turbine is supplied from the boiler feed water pump. The water to be supplied to the steam, which is at 4.5 kg/cm^2 pressure, is being unnecessarily pumped to a pressure of 60 kg/cm^2, See Figure 10 for the present system.

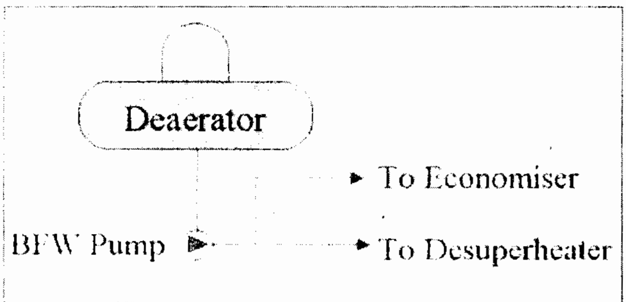

Fig.10: Existing system

There is a possibility of saving energy by installing a separate pump for the de-superheating water, which will deliver water at a lower pressure. See Figure 11 for the proposed system.

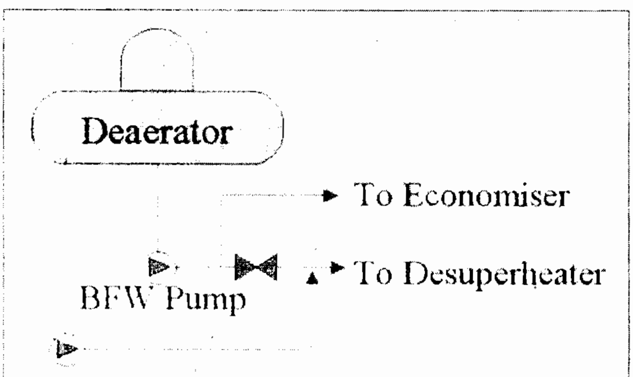

Fig.11: Proposed system

Project Financials

See Table 4 for the possible savings with the improved system.

Table 4: Project 4 Financials

Description	Value
Electrical savings (kWh/yr)	14,286
Monetary savings (Rs lakh/yr)	0.3
Estimate project cost (Rs lakh/yr)	0.5
Equipment cost	0.37
Erection & commissioning	0.05
Taxes & Duties	0.07
ROI	61%

Project 5: Flash Steam Recovery

Project Description

A condensate recovery flash vessel is installed at the paper machine section of the plant. The flash steam, along with the condensate, is pumped to the boiler section where the return condensate is stored in a hot water tank, which is not insulated besides being open to the atmosphere. This causes a lot of heat loss through condensate flashing. See Figure 12 for the present system.

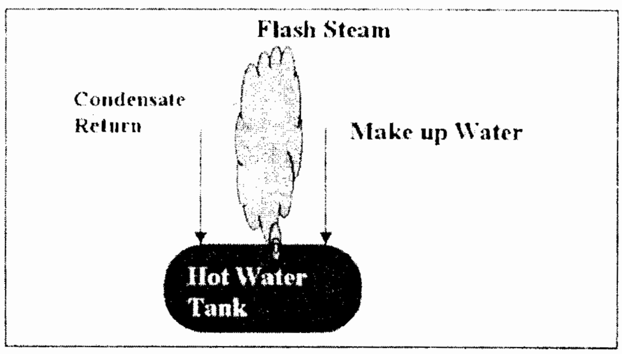

Fig.12: Present system for flash steam recovery

Project Financials

See Table 5 for the possible savings with the improved system.

Table 5: Project 5 Financials

Description	Value
Electrical savings (kWh/yr)	
Monetary savings (Rs lakh/yr)	2
Estimate project cost (Rs lakh/yr)	1.78
Equipment cost	1.35
Erection & commissioning	0.16
Taxes & Duties	0.27
ROI	112%

Project 6: Boiler Hot Water Tank Insulation

Project Description

As described above, the hot water tank used for collecting return condensate from the plant is not insulated. The average temperature of the tank surface is 60 °C. With the ambient temperature in the range of 25 °C, there is scope to reduce the radiation and convection heat losses by insulating the hot water tank.

Project financials

See Table 6 for the possible savings with the improved system. The investment for the insulation material is as per the experience of the client, since this is a regular maintenance related activity.

Table 6: Project 6 Financials

Description	Value
Electrical savings (kWh/yr)	—
Monetary savings (Rs lakh/yr)	0.2
Estimate project cost (Rs lakh/yr)	0.4
Equipment cost	0.4
ROI	50%

Project 7: Digester Insulation

Project Description

During the study of the digester section, it was found that the digester surface was not insulated. Thereafter, the digesters were studied in detail. The surface temperature was measured for different digestion cycles with the approximate cycle time. Table 7 gives the average surface temperatures for different stages.

Table 7: Average surface temperatures

Cycle	Avg. Surface Temp (°C)
Cooking	135
Steaming	105
Blowing	135

This level of surface temperatures leads to higher radiation and convection heat losses. Insulating the digester surface can minimize these losses.

Project Financials:

See Table 8 for the possible savings with the improved system. The investment for the insulation material is as per the experience of the client, since this is a regular maintenance related activity.

Table 8: Project 7 Financials

Description	Value
Electrical savings (kWh/yr)	—
Monetary savings (Rs lakh/yr)	5.7
Estimate project cost (Rs lakh/yr)	2.2
Equipment cost	2
Erection & Commissioning	0.2
ROI	259%

Project 8: Vacuum Pumps Replacement

Project Description

At various points such as a wire part, couch and press zones, vacuum is applied that helps in dewatering. Liquid ring vacuum pumps are being used. There are five vacuum pumps-four in operation and one is standby. Even though all the vacuum pumps are connected to a common piping network, the system has the flexibility of dedicating different vacuum pumps for different systems by suitably opening and closing certain valves. The wire section has a separate dedicated vacuum pump. Vacuum requirement for different sections is different and varies from 250 mm Hg to 280 mm Hg.

It was observed that the vacuum pumps are operating at a lower efficiency level. There is a possibility of energy saving by replacing these pumps with higher efficiency pumps.

Project Financials

See Table 9 for the possible saving with the improved system.

Table 9: Project 8 Financials

Description	Value
Electrical savings (kWh/yr)	309,524
Monetary savings (Rs lakhs/yr)	6.5
Estimate project cost (Rs lakhs/yr)	39
Equipment cost	32.88
Erection & commissioning	1.61
Taxes & Duties	4.98
ROI	16%

Project 9: Fan Pump Replacement and Installation of VFD

Project Description

Measurements were carried out for the fan pump of the paper machine. The flow was measured along with the head delivered. Simultaneously, power was also measured for the motor. On evaluation it was found that the fan pump was inefficient. The pump was running at an efficiency level of 35 percent. There is a potential for energy savings by replacing the fan pump with an efficient pump.

Besides, a pressure profiling was also carried out for the same pump. It was observed that there was a pressure drop across the control valves both in the suction and discharge line. Hence, installation of a VFD will eliminate the pressure drop and enhance the efficiency of the system.

Project Financials

With the improved system, the possible savings are as shown in Table 10.

Table 10: Project 9 Financials

Description	Value
Electrical savings (kWh/yr)	285,714
Monetary savings (Rs lakh/yr)	6
Estimate project cost (Rs lakh/yr)	5.07
Equipment cost	4.06
Erection & commissioning	0.2
Taxes & Duties	0.81
ROI	118%

Project 10: Efficiency Improvement of VT Pumps

Project Description

There are two VT pumps that are used to draw underground water. Measurements were carried out for these pumps by noting the flow from the meters installed on the pump discharge line and the delivered head. Simultaneously, power was also measured for the motor. On evaluation it was found that the pumps were running at an efficiency level of 58.4 percent and 61.6 percent, respectively. There is a potential for energy saving by replacing these pumps with efficient ones.

Project Financials

See Table 11 for the possible savings with the improved system.

Table 11: Project 10 Financials

Description	Value
Electrical savings (kWh/yr)	57,143
Monetary savings (Rs lakh/yr)	1.2
Estimate project cost (Rs lakh/yr)	1.54
Equipment cost	1.11
Erection & Commissioning	0.2
Taxes & Duties	0.22
ROI	78%

Project 11: Efficiency Improvement of Stock Pumps

Project Description

The following stock pumps were selected for a detailed analysis.

- Pump no.4 (chest to refiner)
- Pump no.7 (chest no.7 to chest no. 4)
- Chest pump 9 (to chest 7)
- Chest pump 10 (to refiner)
- Potcher pump no.1
- Potcher pump no.2

The study process involved the measurement of operating parameters.

- Flow
- Suction
- Discharge head
- Power consumed by the pump motor

This data was then analyzed to determine the operating efficiencies of the pump. See Table 12.

Table 12: Pump Operating Efficiencies

Pump ID	Efficiency (%)
Pump no.4 (chest to refiner)	54
Pump no.7 (chest no.7 to chest no.4)	39
Chest pump 9 (to chest 7)	28
Chest pump 10 (to refiner)	31
Potcher pump no.1	31
Potcher pump no.2	23

These efficiencies are on the lower side and can be improved to a level of 70 percent by proper sizing and selection of pump.

Project Financials

See Table 13 for the possible savings with the improved system.

Table 13: Project 11 Financials

Description	Value
Electrical savings (kWh/yr)	238,095
Monetary savings (Rs lakh/yr)	5
Estimate project cost (Rs lakh/yr)	11.04
Equipment cost	8.78
Erection & commissioning	0.5
Taxes & Duties	1.76
ROI	45%

Project Description

Various water pumps in the plant were studied. The study process involved the measurement of the following operating parameters:

- Flow
- Suction

- Discharge head
- Power consumed by the pump motor.

This data was then analyzed to determine the operating efficiencies of the pump. The following pumps were found to be inefficient and replacing these with efficient ones can save energy.

Table 14: Pump Operating Efficiencies

Pump ID	Efficiency (%)
Fresh water pump no.1 (Paper machine)	53.7
Pulp mill fresh water pump	60
Back water pump no.2	45

Project Financials

See Table 15 for possible savings with the improved system.

Table 15: Project 12 Financials

Description	Value
Electrical savings (kWh/yr)	95,238
Monetary savings (Rs lakh/yr)	2
Estimate project cost (Rs lakh/yr)	1.78
Equipment cost	1.4
Erection & commissioning	0.1
Taxes & Duties	0.28
ROI	112%

Project 13: Elimination of Chest Pump No.7

Project Description

As shown in figure 13, the pulp flows from chest no.9 to chest no.7 and then to chest no.4.

This shows that chest no.7 is used only as a storage tank. There is a possibility of energy savings by shutting down pump no.7 and transferring the pulp directly to chest no.4. In this case, the present system would be in standby for any emergency.

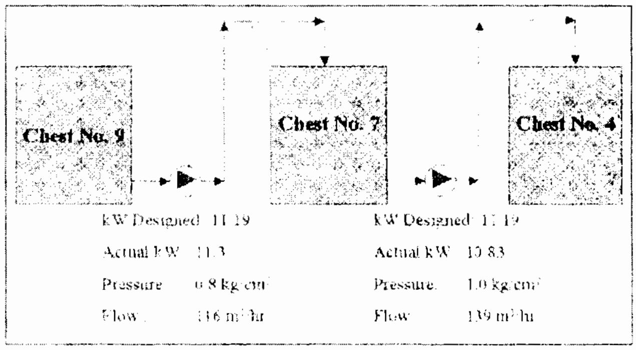

Fig.13: Arrangement of chests

Project Financials

See Table 16 for the possible savings with the improved system. The investment is very minimal and needs only relocation of the pipelines.

Table 16: Project 13 Financials

Description	Value
Electrical savings (kWh/yr)	47,619
Monetary savings (Rs lakh/yr)	1
Estimate project cost (Rs lakh/yr)	0.5
Equipment cost	0.5
ROI	200%

Project 14: Installation of Moisture Control on Paper Machine

Project Description

The moisture level in the manufactured paper at pope reel was analyzed. It was found that for 45 percent of the time the moisture level was above 60 percent. See Figure 14.

The moisture in the paper varies from 6 percent to 8 percent. Maintaining the moisture level at 6 percent level can save energy both in terms of power and steam. The savings will be much more than the figures shown in Table 16, if the steam savings is also included.

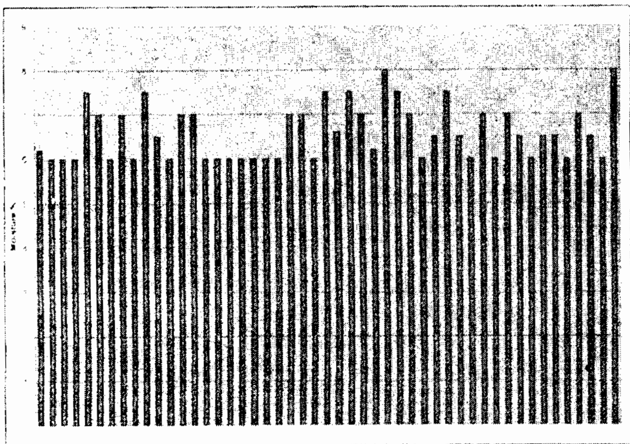

Fig.14: Moisture variations

Project Financials

See Table 17 for possible savings with the improved system.

Table 17: Project 14 Financials

Description	Value
Electrical savings (kwh/yr)	571429
Monetary savings (Rs lakh/yr)	12
Estimate project cost (Rs lakh/yr)	32.57
Equipment cost	28.5
Erection & commissioning	1.11
Taxes & Duties	2.96
ROI	37%

Project 15: Cooling Tower Fan Automation

Project Description

At present, one cooling tower fan out of two is switched off during the winter season. This is a good practice towards energy conservation. However, there is still more possibility for energy savings by putting an automatic water temperature control system or a VFD. Sensing the water temperature the controller will regulate the fan operation.

Project Financials.

See Table 18 for the possible savings with the improved system.

Table 18: Project 15 Financials

Description	Value
Electrical savings (kWh/yr)	31,093
Monetary savings (Rs lakh/yr)	0.65
Estimate project cost (Rs lakh/yr)	1.06
Equipment cost	0.76
Erection & commissioning	0.1
Taxes & Duties	0.2
ROI	62%

Project 16: Installation of VFD on TDRs

Project Description

ATL is operating two Triple Disc Refiners (TDRs). During the study it was observed that the two TDRs are operating on variable loading pattern. Installation of a VFD on refiners will result in energy savings.

Project Financials

See Table 19 for the possible savings with the improved system.

Table 19: Project 16 Financials

Description	Value
Electrical savings (kWh/yr)	224,000
Monetary savings (Rs lakh/yr)	4.7
Estimate project cost (Rs lakh/yr)	7.5
Equipment cost	5.7
Erection & commissioning	0.3
Taxes & Duties	1.5
ROI	63%

Project 17: Installation of VFD on Re-winder

Project Description

The loading pattern of the re-winder recorded through the power analyzer. On analysis of this data it was found that the re-winder is not in continuous operation, and during operation it runs on variable load.

Based on the sample study, the annual operating hours of re-winder were estimated to be 5,000 hrs. Figure 15 shows the loading pattern of the re-winder motor for two sets of readings.

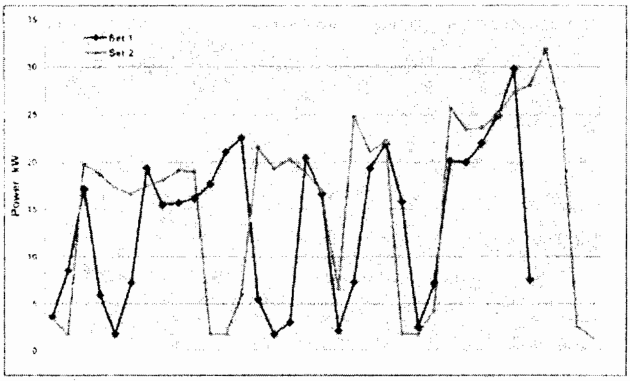

Fig.15: Rewinder load variation

Form the above the duration for different loads was estimated. See Figure 16.

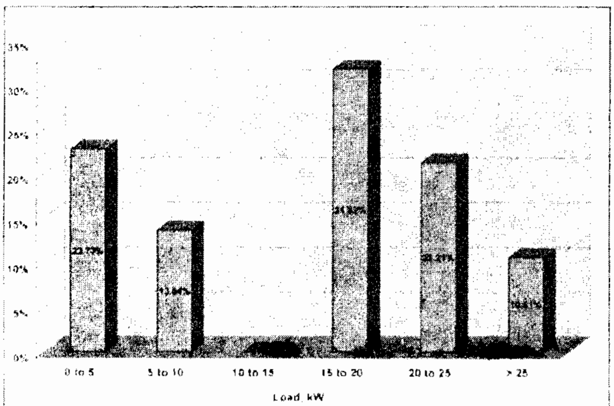

Fig.16: Load variation

It can be clearly seen that for 70 percent of the time the motor loading is below 20 kW. There is a possibility of energy savings by installation of VFD.

Project Financials

See Table 20 for the possible savings with the improved system.

Table 20: Project 17 Financials

Description	Value
Electrical savings (kWh/yr)	13,000
Monetary savings (Rs lakh/yr)	0.27
Estimate project cost (Rs lakh/yr)	1.06
Equipment cost	0.76
Erection & commissioning	0.1
Taxes & Duties	0.2
ROI	26%

Conclusion

Eleven projects have been implemented and a good amount of savings made possible.

Courtesy: S.K. Sadhu, GM (Tech), Anand Tissues Ltd, Meerut, Uttar Pradesh, and R.Rajmohan, Sr Manager, DSCL Energy Services Ltd, New Delhi.

(Source: The Bulletin on BEE Dec.2005)

Did you know?

Hydrogen Isotopes: Protium vs Tritium

The hydrogen economy uses the most common type of hydrogen: the isotope protium. Hydrogen bomb technology uses a rare hydrogen isotope called tritium. Both tritium, plus the super-intense heat from the detonation of a nuclear fission bomb are needed to induce the nuclear fusion reaction that makes a hydrogen bomb. Tritium is radioactive and does not occur naturally, but can be made with litium or a conventional nuclear reactor. This technology bears no resemblance to the simple chemical reactions associated with the hydrogen isotope, protium, in hydrogen production, storage, distribution, and use in the hydrogen economy.