TK CHEMICAL COMPLEX LIMITED

COMPANY DESCRIPTION

TK Chemical Complex Ltd is a privately owned, medium size paper mill located in Chor Khyderpur near Chittagong and produces office paper for the Bangladeshi market. The company is part of the TK Group of Industries and was established in October 1999. A total of 380 staff work in three shifts, and in two shifts during Ramadan and when there is insufficient supply of waste paper/pulp. The plant's annual production capacity is 36,000 tons but actual production is about 24,000 tons per year. Company management was keen to participate in the GERIAP project because they want to learn how to cut production costs through energy efficiency and to avoid negative environmental impacts of paper production. Before the GERIAP project they worked with Pump Smart Ltd, a Singapore based manufacturer of pumps, who helped the plant to improve the energy efficiency of pumps. Due to this project they became interested in Cleaner Production options as a way to minimize costs.

PROCESS DESCRIPTION

A brief description of the paper production process at TKCCL is as follows:

- ***Raw material procurement and sorting***: Raw materials purchased include imported pulp, recycled white paper, black recycled paper, calcium carbonate, talcum powder and kaolin clay. Black recycled paper is sorted manually, to remove unwanted impurities like plastics, metals, styrofoam etc.
- ***Pulping:*** Fibers are freed from raw material in the hydro-pulper using partly fresh water and partly reduced wastewater. The desired quality of stock is prepared by dispersion and dilution in the Hollander/beater.
- ***Stock Preparation****:* Stock is transferred to storage and chemicals for sizing and other purposes are added. From the storage chest, stock goes through a series of cleaning operations. Cleaned stock flows to the dilution box for adjustment to required consistency of pulp by mixing with recycled white paper.
- ***Paper making:*** Diluted stock is fed to the former drum where fibers form a uniform mat in the former drum screen. Excess with water along with drum cleaning water is discharged to the drain. The wet paper is dewatered mechanically using suction and pressing. The remaining moisture (more than 60%) is removed using thermal energy in the dryer rolls. Dried paper is rolled onto a reel.
- ***Converting section***: paper rolls are cut and rewound to the required width. After quality checks, the rolls are wrapped, strapped and stored for dispatch.

METHODOLOGY APPLICATION

The draft *Company Energy Efficiency Methodology* was used as a basis for the plant assessment to identify and implement options to reduce energy and other materials and wastes. Because this plant was also used as a demonstration plant to train the company's Team on the application of the methodology, many experiences are reported for this company:

- ***Task 1a–Meeting with top management:*** It was difficult to convince top management to start an energy efficiency project because the concepts of Cleaner Production and greenhouse gas reduction were new to them. "Energy efficiency" was a more familiar concept and top management associated this with money and not only with the environment.

Lesson learnt: Energy efficiency is a concept known and liked by top management.

- ***Task 1c–Pre-assessment to collect general information:*** When the plant layout and equipment specifications were reviewed, it was found that the plant had purchased almost the entire production equipment from Germany (as it was no longer meeting German environmental standards). However:
    - Equipment was designed for pulp and paper production, whereas the TK Chemical Complex Ltd is operating as a paper plant using imported waste paper and virgin pulp although it was intended as an integrated pulp and paper plant.
    - All drawings and written materials have been provided in German, which is often not understood by the plant's staff. In some instances this has resulted in inappropriate installation of equipment. In addition, in some instances there is a mismatch in the requirements and the equipment installed, for example the boiler.
    - Some equipment was supplied although this is not needed (e.g. second water tube boiler)

Lesson learnt: A review of the plant layout and equipment specifications will allow the Team to anticipate some of the areas where energy losses occur.

- ***Task 2a – Staff meeting and training*:** Staff at this plant received training during several stages of the project:
    - Three production staff attended a 1-week technical training on Cleaner Production, energy efficiency and the draft methodology that was to be tested at their plant.
    - An international consultant accompanied the external facilitators from Bangladesh during the energy assessment and many more staff were informally trained during the walkthrough of the plant, the data analysis and the brainstorm sessions to identify options
    - Three production staff attended a 3-day workshop held for all participating Bangladeshi plants to receive additional training on establishing a baseline and monitoring results of options
    - An international consultant revisited the plant as a demonstration plant to further train the company's Team on the application of the methodology

Staff gave the feedback that most of what they knew about the production process and equipment was learnt on the job. They therefore welcomed training from outsiders and showed that they were very eager to learn more on how to run the plant more efficiently. The training paid off: it was found that in addition to the nine options selected for feasibility analysis during the energy assessment, since then the plant's Team independently identified and implemented many more options.

Lesson learnt: Staff training not only helps staff to carry out the energy assessment the first time, but also increases the chance that they independently will continue to identify and implement energy efficiency options in the future.

- ***Task 2d – Quantify inputs and outputs and costs to establish a baseline:*** Before data collection started, an overview of existing reports was made as given in the table below. It was found that energy cost and consumption data are taken from monthly invoices but that the plant itself does not monitor energy because energy is considered as a fixed cost and therefore not actively managed. As a result a breakdown by days or sections was absent. Daily and monthly reports are disseminated amongst management but not communicated to section heads or staff. Therefore section heads and staff members are not provided with the information to identify ways to improve energy efficiency and production. The team therefore had to spent several weeks to collect data for electricity, furnace oil, raw materials, steam, compressed air, waste, water and waste to be able to establish a baseline.

Lessons learnt: preparing an overview of existing monitoring and reporting of energy will help the Team estimate how much time is needed to collect data to establish a baseline. If few data are available then this task could take several weeks.

Report name	Frequency	Information included	Prepared by	Distributed to
Daily Production Report	Daily	- Paper production (gross tonnes) - Running hours and down time - Breakdown by reasons for down time, such as power failure, voltage fluctuation, and shortages of steam, raw materials and furnace oil	General Manager, Factory	Director Finance Project Directors
Production & Consumption Report	Monthly	- Paper production (net tonnes) - Paper materials consumption (waste paper and pulp) - Total running hours and down time - Breakdown by reasons for down time - Chemical consumption and stock position	General Manager, Factory	Managing Director, Director (O&M), Director (Finance), Project Directors TKCCL, GM (Admin), Store Office
Production & Delivery Report	Monthly	- Stock in ream & weight - Total stock - Delivery - Balance Stock - Target	Finance & Accounts department	Managing Director, Director (O&M), Director (Finance), Project Directors TKCCL
Cost Sheet	Monthly	- Quantity of raw materials & value - Quantity & value of chemicals - Quantity and value of power & fuel - Overhead expenses	Accounts Department	Managing Director, Director (Finance), Project Directors, TKCCL

- ***Task 2e – Quantify losses through a material balance*:** Based on the losses of energy and resources, the potential for efficiency improvement was calculated / estimated as follows:
Lesson learnt: a material balance can help estimate the potential savings of resource and energy efficiency even before options are identified.

Resource	Potential improvement	Percentage improvement	Potential annual savings (based on 20,000 T production/yr)
Water	10 m^3/T	25%	400,000 BDT
Raw Material	20 Kg/T	2.4%	12 Mill. BDT
Electricity	100 KWh/T	12%	8 Mill. BDT
Fuel oil (1) Cogeneration (2)	22 L/T 290 L/T	9% 100%	5.2 Mill. BDT 69.6 Mill. BDT
Increased Production	4000 T	20%	Estimated at 425,000 US$
		Total without cogeneration Total with cogeneration	25.6 Mill. BDT (0.45 Mill. US$) 90 Mill. BDT (1.5 Mill.US$)

- ***Task 3a – Determine causes of options:*** An external trainer facilitated a brainstorm session was used to determine possible causes of the excess use of fuel oil. Because

management and many production staff were involved in this session many possible causes were found:

- Surface sizing of major products, including writing and printing paper, requires additional drying after sizing
- More paper break due to size press
- Percentage of fiber furnace
- Possibility of slimes escaping from cleaning system causing excess paper break
- Possibility of non-uniform mechanical dewatering
- Additional steam demand for starch cooking
- Non-uniform drying at the dry end of machine
- Poor boiler efficiency (average 10.5 ton of steam per ton of fuel oil compared to 14 ton of steam per ton of fuel oil).
- Excess machine broke and percentage broke in converting section.

Lesson learnt: a brainstorm session with as many staff as possible will result in the identification of more causes of observed energy losses.

- ***Task 5a – Implement options and monitor results:*** The company lacked the necessary monitoring equipment to measure the parameters needed to calculate energy consumption and CO2 emissions before and after implementation of options. The monitoring equipment provided to the external facilitator through the GERIAP project helped to measure these parameters, although this did not solve the need to take continuous measurements over a longer period of time.

Lesson learnt: Monitoring equipments provided by an external facilitator helps in the short term to measure the parameters of implemented option but it is not a long-term solution.

- ***Step 6 – Continuous improvement:*** The plant's Team is interested to continue improving energy efficiency and have the support of management. At the end of a revisit to the plant to evaluate the results of implemented options, the international consultant and the external Bangladeshi facilitators recommended the following focus of a next energy assessment:

  - Identify and implement a large number of simple options at the water pumping, storage, treatment & distribution sections where significant potential exist
  - Carry out an energy assessment for technology related options in the cold rolling mills and galvanizing mills

Lesson learnt: By determining what the focus of a future energy assessment should be, the chance that the plant continues with energy efficiency is greater.

OPTIONS

- The focus areas selected for the project were (1) Boiler and steam generation, (2) Steam utilization and condensate recovery, (3) Combined steam and electricity use and (4) Plant efficiency and wastage reduction.
- The Team identified numerous options and investigated a total of 9 energy and waste minimization options. At time of writing of this case study, three options were (partially) implemented. Four other options are planned for implementation after the constuction of a new plant at the complex, one option requires further analysis, and one option was not implemented.
- For the three partially implemented options, no investment was required, annual savings was approximately US$ 2,600 and the payback period was immediate.
- As a result of the three partially implemented options, the plant saves 20 kiloliters of fuel oil per year and annual greenhouse gas emissions are reduced by 53 tons CO_2.
- A summary of the options investigated and implemented at TKCCL is given in Table 1.

Table 1: EXAMPLES OF OPTIONS IMPLEMENTED AND INVESTIGATED

FOCUS AREA/ OPTION	CP TECHNIQUE	FINANCIAL FEASIBILITY	ENVIRONMENTAL BENEFITS	COMMENTS
Blow Down in boiler at high TDS levels only to reduce the number of blowdowns *(see case study)*	Good housekeeping	▪ Investment: none investment ▪ Cost savings: US$ 800/yr ▪ Payback period: immediate	▪ Fuel oil savings: 6 kl/yr ▪ GHG emission reduction: 16 tCO_2/yr	▪ Implemented (2 blow downs per shift instead of 3) ▪ Potential savings are higher
Boiler / Increase of Condensate recovery from boiler *(see case study)*	Good housekeeping	▪ Investment: none ▪ Cost savings: US$ 1200 /yr ▪ Payback period: immediate	▪ Fuel oil savings: 12 kl/yr ▪ GHG emission reduction: 32 tCO_2/yr	▪ Implemented (increase from 70% to 90% condensate recovery)
Boiler / Installation of Desuperheater at boiler to feed steam to the paper machine at lower temperatures *(see case study)*	Equipment modification	▪ Investment: none ▪ Cost savings: US$ 266/yr ▪ Payback period: immediate	▪ Fuel oil savings: 2 kl/yr ▪ GHG emission reduction: 5 tCO_2/yr ▪ Decreased waste through reduced paper breakage	▪ Partially implemented ▪ Potential savings six times as high
Boiler / Replace furnace oil with natural gas in boiler	Production process / equipment modification	▪ Investment: US$ 68,965 ▪ Cost savings: US$ 213,793 ▪ Payback period: 4 months	▪ Fuel oil savings: 1,550 kl/yr ▪ GHG emission reduction: 4,154 tCO_2	▪ To be implemented after construction of new plant
Boiler/ Use the second fire tube boiler with smaller capacity to produce saturated steam if the production capacity is lower	Production process / equipment modification	▪ Investment: US$ 8,620 ▪ Cost savings: US$ 51,724 ▪ Payback period: 2 months	▪ Fuel oil savings: 380 kl/yr ▪ GHG emission reduction: 1,080 tCO_2	▪ To be implemented after construction of new plant ▪ Steam requirement (11 TPH) is lower than boiler capacity (20 TPH) ▪ Current boiler is operated at 9 bar instead of 18 bar rating
Feed Water/ Install an additional low-pressure pump to operate the	Production process/ equipment modification	▪ Investment: US$ 2,586 ▪ Cost savings: US$ 4,310 ▪ Payback	▪ Electricity savings: 50 MWh/yr ▪ GHG emission reduction: 27	▪ To be implemented after construction of new plant

present economizer as a feed water heater continuously		period: 9 months	tCO_2/yr	
Steam / Insulation of steam valves, flanges and other pipe fittings	Good housekeeping	▪ Investment: US$ 3,448 ▪ Cost savings: US$ 5,172 ▪ Payback period: 8 months	▪ Fuel oil savings: 37.5 kl/yr ▪ GHG emission reduction: 100 tCO_2/yr ▪ Water savings through reduced make-up water	▪ To be implemented after construction of new plant ▪ Assumes insulation with 40-50 mm rockwool
Combined steam and electricity (4 MW gas turbine system along with a waste heat recovery boiler)	Production process/ equipment modification	▪ Investment: US$ 1,551,240 ▪ Cost savings: US$ 803,448 ▪ Payback period: 2 years	▪ Fuel oil savings: 450 kl/yr ▪ Electricity savings: 200 MWH/yr ▪ GHG emission reduction: 1314 tCO_2	▪ To be further investigated ▪ Investment cost is main barrier ▪ To avoid impact from frequent electricity blackouts: in Sep 03 this caused 39 hrs downtime and 140 tons production loss
Plant efficiency and wastage reduction: ▪ Balancing and removing bottlenecks ▪ Adopt appropriate maintenance and repair regime	Good housekeeping	▪ Investment: US$ 34,482 ▪ Cost savings: US$ 224,137 ▪ Payback period: 2 months	▪ Waste reduction	▪ Not implemented ▪ Cause is that plant is re-commissioned plant from Germany and current efficiency is <80% of design ▪ Management commitment is needed

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