Cleaner production and eco-efficiency

http://www.c4cs.curtin.edu.au

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Cleaner production and eco-efficiency are guiding posts for the business journey to sustainable development. Cleaner production is about preventing waste and emissions, including the loss of energy, rather than dealing with them once they have been generated. Eco-efficiency is about better products that have a lower ecological impact, are competitive, and better meet customer needs.

Cleaner production deals with the efficient use of materials, energy, water and other natural resources when we conduct business, regardless of whether the business is in processing, manufacturing, service, transport, mining or agriculture. More precisely, it is generally defined as "the continuous application of an integrated preventive environmental strategy to processes, products, and services to increase eco-efficiency and reduce risks to humans and the environment".

Cleaner production aims at making more efficient use of natural resources (raw materials, energy and water) and reducing the generation of wastes and emissions at the source. This can be achieved in various ways.

A division in five prevention practices is most common:

- **Good housekeeping** refers to changes in operational procedures and management in order to eliminate waste and emission generation. Examples are spill prevention, improved instruction of workers and training.
- **Product modifications** change the product characteristics, such as shape and material composition. The lifetime of the new product is, for instance, extended, the product is easier to repair, or the manufacturing of the product is less polluting.
- **Input substitution** refers to the use of less polluting raw and adjunct materials and the use of process auxiliaries (such as lubricants and coolants) with a longer service lifetime.
- **Technology modifications** include for instance improved process automation, process optimization, equipment redesign and process substitution.
- **On-site recycling** refers to the useful application of waste materials or pollutants at the company where these have been generated. This could take place through re-use as raw material, recovery of materials or useful application.

The World Business Council for Sustainable Development coined the term Eco-Efficiency for business to get involved in sustainable development. Eco-Efficiency is "reached by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the earth's carrying capacity".

The WBCSD identified seven components of eco-efficiency:

- Reduce material intensity of goods and services;
- Reduce energy intensity of goods and services;
- Reduce toxic dispersion;
- Enhance material recyclability;
- Maximize sustainable use of renewable resources;
- Extend product durability; and
- Increase the service intensity of goods and services.

Implementation of these seven eco-efficiency components will most often call for practical changes that fall under either of the five generic prevention practices under the cleaner production umbrella (as above) and, vice versa, implementation of either of these five generic prevention practices will generally also achieve at least one, if not several, of the seven eco-efficiency components.

Eco-efficiency and cleaner production are truly complementary concepts, with eco-efficiency focusing on the strategic side of business ("value creation") and cleaner production on the operational side of business ("production"). Curtin's research therefore focused on eco-efficiency and cleaner production. Building on the collective strengths of these concepts, research efforts focus on development and application of sector-specific tools and metrics, currently for example for the minerals processing, energy and agribusiness sectors. ❐

Cleaner production

Case study on textile processing

http://wmc.nic.in

National Productivity Council, India

Introduction

M/s. Tirupur Arora is a textile processing Pvt. Ltd. company, located in Tirupur. The unit is engaged in the processing of cotton hosiery, with a processing capacity of about 2500 tonnes per annum (including printing: 80% and dyeing: 20%). This case study outlines the results of the cleaner production (CP) study.

Process description

The main operations carried out in the unit include:

Fabric pre-treatment

The fabric purification is carried out in the modern softflow machines as well as conventional winches. Fabric purification is done mainly to remove the oily substances, nitrogenous compounds, waxes and proteins and natural colouring material from the fabric by treating it with hot alkaline liquors containing other required chemicals like wetting agent, defoamer, detergent, stabilizer, etc.

Initially the machine is filled with the required quantity of water after which the fabric is loaded. After loading, scouring chemicals (water softener, wetting agent, defoamer, NaOH) are added at ambient temperature. The temperature of the liquor is raised by the addition of indirect steam. When the temperature reaches 50°C, bleaching chemicals (hydrogen peroxide and a brightening agent) are added. The temperature is then raised to 96°C and maintained for 40 minutes at the same temperature, followed by indirect cooling to 80°C by fresh water. The spent bleach liquor is discharged alongwith a fresh water rinse. The fabric is then subjected to two hot water washes. The resulting wash water is drained out. In order to remove residual alkalinity, the fabric is given acid (acetic acid) treatment in cold conditions. The spent acid liquor is drained out.

As of now, slitted fabrics are not being used, hence, the dried fabric is re-rolled and printed on the reverse side of the tubular fabric.

Dyeing

After fabric purification, dyeing is carried out in the same machine. The machine is then filled with fresh water. Initially, common salt, anti-creasing agent and de-foamer are added. The temperature of the solution is raised to 50°C. A concentrated dyestuff solution is prepared separately and is added to the liquor over a period of 20 minutes. After the addition of the dyes, the temperature is raised to 95°C and is maintained at that temperature for 20 minutes, followed by indirect cooling to 80°C. At this temperature, soda ash (dye-fixing agent) is added, over a period of 20 minutes. After the addition of soda ash, the fabric is kept in motion inside the liquor for 45 minutes at the same temperature. Spent dye liquor is discharged to the drain. In order to remove residual alkali and the dye stuff, the fabric is subjected to four washes in series, The first and third washes are with hot water, the second with hot soap solution and the final one with acid in ambient condition. The hot water wash is carried out at 70°C, for a 10-minute duration while the soap wash at 95°C, for a 15-minute duration. Wash water from each of these stages is drained out.

After whitening/dyeing, the fabric is unload from the machine and is first taken to the hydro extractor where it is evenly wetted by means of stretching, ballooning by compressed air (and dipping in water containing finishing chemicals in case of final finishing), followed by squeezing between the rollers. The squeezed fabric is then dried in a relax drier. The fabric is then given the uniform width and compacted in a layered form in a calendaring machine. After calendaring, the fabric goes to the roller section in which the compacted layers are put in a roll form. Next it goes to printing or despatch (in case printing is not needed).

Printing

The fabric after bleaching/dyeing is taken for printing. The rotary screen printing machine used in the unit has provision for printing 8 colours simultaneously. The colour print paste prepared is fed into the screens from which it is transferred to the fabric fed in. The fabric, after print paste transfer, is passed through a drying chamber at 145°C. The dried and printed fabric is then taken for further processing.

As of now, slitted fabrics are not being used, hence, the dried fabric is re-rolled and printed on the reverse side of the tubular fabric.

Finishing

After printing, the fabric is subjected to the finishing treatments. The fabric is padded with water containing finishing chemicals, followed by squeezing between the rollers. The squeezed fabric is then dried in a relax drier. The fabric is next given the uniform width and compacted in layered form in a calendaring machine. After calendaring the fabric goes to the roller section in which the compacted layers are put in a roll form. Next it goes for despatch.

Study focus areas

The unit has focussed on ways to reduce its pollutant load by optimizing chemical consumption and substituting chemicals which generated a lower load. The study outlines the results of the investigations.

Cleaner production opportunities that reduced envrionmental load and accrued economic benefits

The assessment study evaluated combustion efficiency by monitoring excess oxygen and analysing input and waste

outputs, and by evaluating resource loss and by conducting literature surveys to identify alternate chemicals. Based on the study, CP options were evaluated and the most significant CP opportunities that were implemented are as follows:

- Reducing the quantity of acid from 1.5 to 1.2 kg for soft flow and from 2.0 to 1.5 kg for winch machine. The benefits of this option are:
  Reduction in acid consumption = 13 tones per annum;
  Savings due to reduced acid consumption = Rs 5,50,000 per annum (CH_3COOH @ Rs 42/kg)
- Reduction in use of salt dyeing by 15% has resulted in cost reduction, along with the reduction in pollution load to the environment.
  Reduction in salt consumption = 70 tonnes per annum;
  Savings due to reduced salt consumption = Rs 2,10,000 lakhs per annum (Salt @ Rs 3/kg)
- Second hot wash water is used in the first hot wash of another machine and the results are: Reduction in water consumption = 2500m^3 per annum; Savings due to reduction in water consumption = Rs 75,000 per annum (Water @ Rs 30/m^3)

4. Using last rinse (after dyeing) for scouring liquor preparation has led to reduction in water consumption as well as the corresponding wastewater treatment cost. The option has led to a monetary saving of Rs.0.14 million.
5. Avoidance/reduction of bleaching agent for those fabric going for darker shades

Apart from the above, a number of simple housekeeping & equipment modification measures have been identified during the study, which are listed below:

- Providing 5 minutes drag out time after every discharge;
- Reuse of wastewater from washing steps (before dyeing) for blanket wash;
- Preparation of preventive maintenance schedule and maintain accordingly;
- Recover the print paste by simple piston like device prior to washing; and
- Modification of fuel firing practices in boilers to optimise combustion and thus reducing in fuel consumption.

The overall results achieved of the study are given in the following table.

S. No.	Parameter	Before CP (per annum)	After CP (per annum)	% change
1.	Acid consumption	57.5 tonnes	49 tonnes	-15
2.	Salt consumption	440 tonnes	370 tonnes	-16
3.	Water use	1,88,180 m^3	1,85,600 m^3	-2