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Environmental Pollution Prevention Project

CASE STUDY

Pollution Prevention Assessment for a Recycled Paper Mill

Executive Summary

A pollution prevention diagnostic assessment was conducted at a recycled paper mill which produces paper, paper board, and egg cartons. The objectives of this assessment were to: 1) identify pollution prevention options that would reduce the quantity of toxics, raw materials and energy used in the manufacturing process and thereby reduce industrial pollution and worker exposure to toxic chemicals; 2) demonstrate the environmental and economic value of a comprehensive pollution prevention assessment; and 3) improve manufacturing competitiveness and product quality for this facility.

The assessment identified six waste minimization and pollution prevention opportunities that together can save around US$741,500 per year for a one time investment of $586,000. The investment figure does not include plant modifications necessary to install the new projects or any duties or taxes, but does include the estimated cost of import duty from new electric motors ($27,500).

Five of the pollution prevention opportunities identified in the assessment are short-term savings options with payback periods of 9 months or less; the sixth is an intermediate-term project with a 21-month payback period. The short-term projects entail the following: reduction in steam losses; recovery of fibers lost in wastewater discharge; recovery of fibers lost due to poor housekeeping practices; and more efficient electrical motors for production Lines 1 and 2. The intermediate-term project involves the replacement of two boilers with one new larger boiler.

Facility Background

This facility manufactures a number of paper products from recycled materials. The plant employs 160 production workers and 40 administrative staff, and operates on a 24-hour day, 290-days per year basis. Steam is generated by on-site oil-fired boilers to meet the plant's thermal energy requirements, while electric power is supplied by the local utility grid.

Manufacturing Process

Production occurs on three manufacturing lines, known as Line 1, Line 2, and Line 3 (refer to Figure 1), each of which produces paper products from recycled materials.

Line 1 has five production steps. First, recycled paper products (newspaper, egg cartons, office paper, etc.) are fed into three pulpers, each of which handles different types of paper products. Water is added and the mixture is slurried together to form a pulp which is used as feedstock for the making of new paper products. The feedstock from each pulper is then fed separately into the paper machine, which rolls the feedstock flat and stacks the material from each pulper, thus producing a three-layered paper (the machine has five rolls, and is capable of making a five-layered paper). The newly formed paper is fed into squeeze rolls and partially dewatered. The paper is then fully dried in steam-heated drying rolls. Finally, the paper is trimmed to the proper width and either wound onto a roll or cut into sheets.

Line 2 has four production steps. There is a large single pulper, which combines recycled materials with

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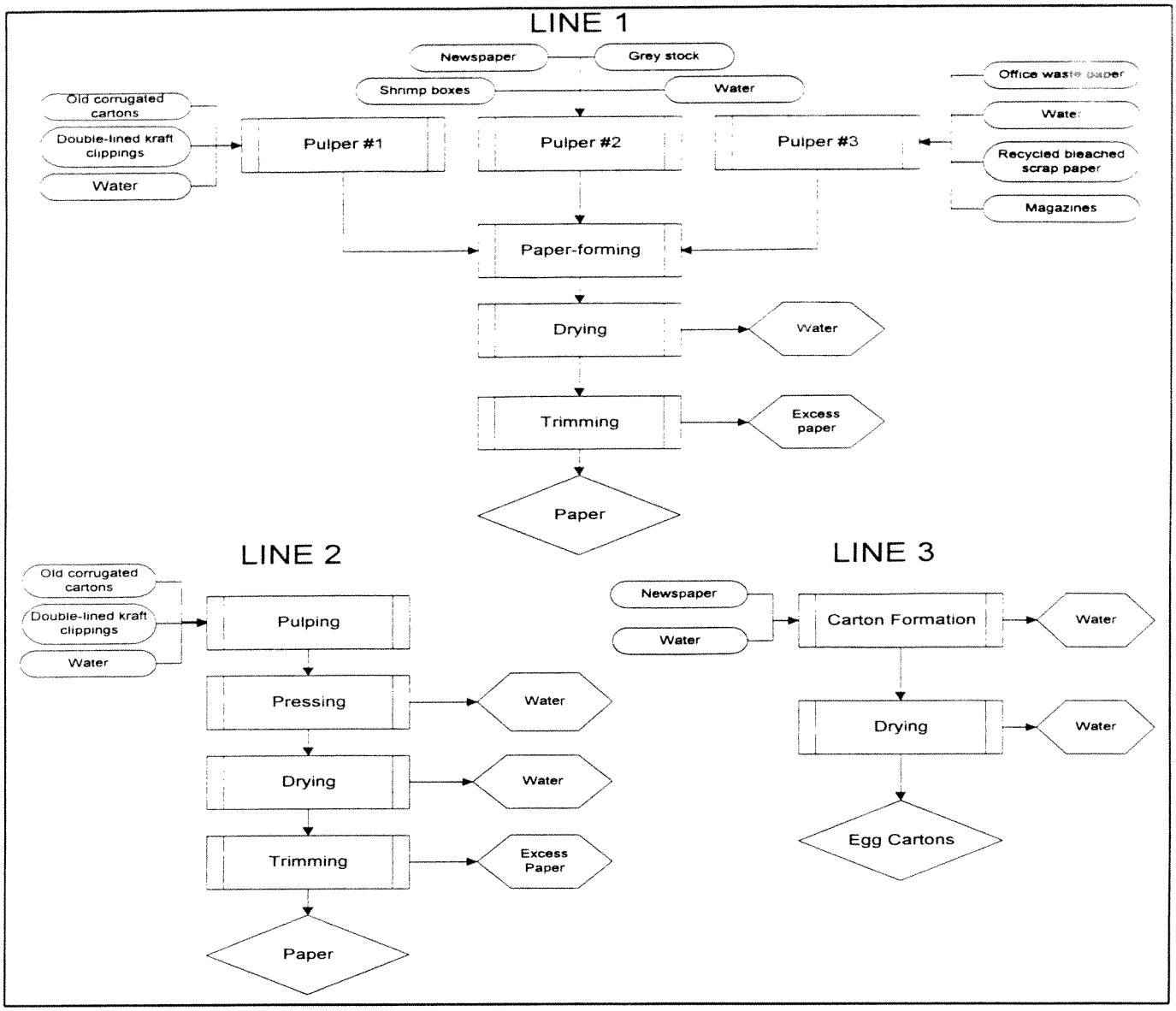
Figure I: Overview of Facility's Paper Milling Process



water to form a feedstock. This feedstock is pumped into a Fourdrinier machine, where it is deposited onto a moving, wire screen. Here, most of the water is drained, and the screen vibrates to order the fibers in a particular direction. The material is then transferred from the wire screen to a felt blanket, which carries it through a series of press rolls where more water is removed. The continuous pressed sheet of newly formed paper is processed through a set of steam-heated rolls to complete the drying process. The paper is then either rolled or cut into specified sizes of sheet paper.

Line 3 has three production steps. In the pulper, newspaper is continually pulped and fed into the forming section, where the pulp is picked up by the lower forming die vacuums, and then mechanically pressed in to the upper die to force out as much water as possible. The wet pressed egg cartons are placed on the screen trays in the dryer trucks to drain water. Virtually all of the remaining moisture is removed in the batch dryer.

Environmental Problems

There are water, air, and solid waste problems and inefficient energy use at this facility. Uncontaminated water is wasted during the pulping process on Line 2, because there is no automatic shut-off valve. Wastewater is contaminated with fibers, and is discharged into a nearby creek. Air pollution (including carbon dioxide, sulphur dioxide, nitrous oxides, and particulates) is emitted from the power generating plant. Solid waste is found in the form of excess and unused papers. Raw materials, especially fibers, are lost due to poor housekeeping. Energy is lost through steam escaping and inefficient motors.

Table I: Summary of Recommended Pollution Prevention Opportuntities

Operation	Pollution Prevention Option	Environmental and Health Benefits	One-Time Implementation Cost (US$)	Financial Benefits (US$)	Payback Period (Months)
Lines 1 and 2: Paper machines	Improved housekeeping practices	Reduced fiber losses, thus conserving raw materials and input and reducing the amount of fiber carried in effluent wastewater stream	$50,000	$138,000	4 1/3
Lines 1 and 2: Paper machines	Screen fibers from the water effluent going into the creek	Reduced fiber losses, thus conserving raw materials and input and reducing the amount of fiber carried in effluent wastewater stream	$250,000	$324,000	9 1/3
Utilities: Steam	Repair steam piping leaks; repair or replace steam traps and insulation on steam lines; insulate steam lines	Reduced or eliminated steam leaks to save water; reduced energy/fuel requirements, thus reducing emissions from boiler/s	$40,000	$55,600	8 1/2
Utilities: Steam	Replace two old boilers with one large new boiler	Increased boiler operating efficiency enables fuel savings and reduces emissions from boiler/s	$150,000	$87,000	21
Line 1: 5-roll paper machine	Replace electrical motors with premium efficiency motors	Reduced electrical energy usage, reducing emissions from power generating plant	$55,600	$79,600	8 1/2
Line 2: Fourdrinier machine	Replace electrical motors with premium efficiency motors	Reduced electrical energy usage, reducing emissions from power generating plant	$40,200	$56,500	8 1/2
Total	--	--	**$586,000**	**$741,500**	–

Pollution Prevention Opportunities

Table 1 lists the pollution prevention opportunities identified by this assessment, the environmental benefits associated with these opportunities, and projected implementation costs and savings.

Housekeeping Practices: Currently the plant loses a large quantity of fiber in the pulping area and around the paper-forming machines, due to poor housekeeping practices. By improving these practices, at a one-time cost of $50,000, it is estimated that $138,000 per year can be saved.

Fiber Screening: It is estimated that 70% of the lost paper fibers exit into the wastewater discharge system. Most of these fiber losses can be recovered by installing a filtering system in the wastewater system before discharging the water into the creek. An amount of fiber worth approximately $324,000 per year can be recovered with a filtering system. The one-time cost of the filtering system is estimated at $250,000, which would provide a payback period of 9.3 months.

Steam Losses: Major leaks are found throughout the plant in broken steam traps and rotary mechanical joints. In addition, large and small lines in the dryer drainage system are not insulated. It is estimated that the loss of steam and heat due to non-insulated pipes is costing the plant $55,600 per year. The estimated one-time cost to repair these items is $40,000.

Boiler System: There is a loss of heat transfer within the boiler due to fouling of the inside of the tubes, which is caused by poor control of the burner flame and a lack of boiler feed water which could be used to coat the outside of the tubes. This inefficient heat transfer results in a loss of $100,000 annually. The plant plans to replace the two older boilers with one new boiler. The new boiler should include an automatic blowdown and treatment system for the boiler feed water. It is estimated that the new boiler system,

at a one-time cost of $150,000, will allow the plant to recover $87,000 of the estimated losses. Although the pay back time is 21 months, the plant will have a greatly improved and more reliable steam supply system.

Electrical Motors: All of the electrical motors in the plant appear to be at least 15 to 20 years old. The motors in the plant are estimated to have an efficiency of 85-87%. Replacing these motors with new premium efficiency motors could save the plant about 1.65 million kWh/year in power consumption. It is recommended that a motor replacement program be initiated to replace all motors of 25 horsepower or more. Along Line 1, in the 5-roll paper machine, this replacement would cost $55,600, and create an annual savings of $79,600. Along Line 2, in the Fourdrinier machine, this replacement would cost $40,200 and annually save the firm $56,500.

Other Recommendations

Continuous Pulping: The pulpers in Lines 1 and 2 should be run on a continuous batch basis, as they were in the past. It was reported that the mill is limited in the grades of paper it can produce by the availability of the pulper. The pulper is currently operating in a batch mode, but additional capacity can be achieved by changing to continuous operation.

Pulper Redesign: Pulpers are no longer designed with round tubs as seen at this facility on Lines 1 and 2, because it was discovered that an irregular flow in the pulper produces better pulping than the continuous whirl produced in a round tub. To improve this process, the firm should install one of the systems available on the market that modify and improve the process by reconfiguring the round tubs.

Bailing Modifications: Tying the bails of compacted cardboard and scrap paper from the processes on Line 1 with fiber rather than wire will reduce the bailing cost. Eliminating the use of wires for bailing purposes will also prolong pulper rotor life.

Water Savings: Approximately 20 gallons of water per minute can be saved by installing an automatic cut-off valve in the water flushing line. This line should be installed on the vibrating screen reject discharge drum in the pulping process of Line 2.

Fiber Treatment: In Line 1, two of the refiners are operating in parallel. Adding a flow measurement device to each refiner will ensure that the flows are equal.

Cylinder Vat Temperature: Better paper formation and pressing will be achieved in the cylinder vats on Lines 1 and 2 if the temperature is raised from the ambient air temperature to between approximately 51°C and 54°C.

Steam Supply: Each dryer section of the drying machines on Lines 1 and 2 is supplied with fresh steam. A cascade or thermo-compressor system will make better use of the energy remaining in the used steam and would result in steam savings. The steam used is generated at a higher pressure than that used in production. The pressure is reduced with a pressure-reducing valve, but the temperature of the reduced pressure steam is not reduced, so the steam is superheated. The maximum energy available from the steam occurs when the steam is driven through the critical point and condensed to water. If excess superheat is in the steam, the condensing point is not reached and the steam consumption is greater than necessary. A de-superheater should be installed along Lines 1 and 2, at a cost of $7,500 each.

Vacuum Boxes: The felt cleaning vacuum boxes on the presses are connected with a common pipeline to one undivided vacuum pump. This is a poor arrangement since the clean felt gets more vacuuming than the dirty felt. A divided vacuum pump of similar size could be switched to felt-cleaning service, with a half-pump put on each box.

Conclusion

The recommended pollution prevention options are known to result in a product quality that is superior to the previous quality standard. Through reduced fiber losses, electrical consumption, steam losses, and improved boiler efficiency, paper manufacturers can become more competitive.

For Further Information

For further information on this assessment or other activities sponsored by EP3, call the EP3 Clearinghouse at (703) 351-4004, send a fax to (703) 351-6166, or on Internet: ep3clear@habaco.com