Pollution Prevention Assessment for a Flexible Packaging Manufacturer

Executive Summary

A pollution prevention assessment was conducted in a facility that manufactures flexible packaging. The purpose of the assessment was to identify pollution prevention options that would reduce the quantity of toxic materials, other raw materials, and energy used in the manufacturing process; demonstrate the economic and environmental value of a pollution prevention assessment; and improve manufacturing competitiveness and product quality. The assessment was done by a team of U.S.-based pollution prevention experts, U.S. process specialists, and local consultants.

The team identified 9 pollution prevention options that could save the facility between US$964,400 and $971,400 per year for an implementation cost of US$43,500. Both the cylinder-making and printing areas of the facility were found to have significant pollution prevention opportunities. If implemented, the opportunities will save an estimated 3,780,000 meters of printed substrate; 23,010 kg of ink; 35,700 liters each of toluene and ethyl acetate; and 1,450 kg of copper, nickel and chrome.

Most significantly, the implementation of these opportunities would lead to a dramatic reduction in rejects, especially of cylinders. For example, 150 cylinders per month (30% of total cylinder production) are placed on the press and fail before 4,000 meters of substrate are printed. The reduction of the reject rate alone will save press downtime, process materials, and environmental releases, and will increase overall profitability without a need for increased sales.

Facility Background

The facility is a medium-sized flexible packing manufacturer. The plant started operations in 1986 and presently employs 300 workers, operating in three shifts, five days per week. Occasionally the plant will be operated more than five days per week when required by production demands. Product output is about 50 million meters of printed packaging annually. For its monthly production, this facility uses an estimated 5 tons of paper, 20 tons of aluminum sheet, 100 tons of extruded plastic, 18,000 liters of ethyl acetate, 16,000 liters of toluene, and 25 tons of ink of various colors.

Process Description

The process of producing flexible packaging can be divided into five main processes. These are: 1) cylinder making; 2) image creation; 3) printing; 4) laminating; and 5) slitting. The cylinder making process prepares a steel tube to accept an etched image that will eventually transfer ink to a substrate during the printing process. Figure 1 illustrates the process of preparing the cylinder. The process involves electroplating the tube with nickel, then copper, transferring an image to the surface of the tube, and finally chrome electroplating to protect the image from abrasion during the printing process. Numerous polishing steps, both by hand and by automatic polishing machines, are required throughout the process.

After reproducing the image on the surface of the cylinder, the etched image is corrected and "proofed" by actually printing a sample. At any stage a defect
may be detected, requiring grinding, polishing, etching or dechroming to correct the problem. Some cylinders are produced from a bare steel surface, while others are produced by removing an image from a previously used cylinder through dechroming, etching and grinding.

After proofing, the etched cylinder is placed in a printing press and flooded with a solvent-based ink. A different color (up to seven colors) is used for each cylinder. The ink is transferred to the substrate (polypropylene, OPP, polyethylene, or low-density polyethylene) by rotating the cylinder through the ink "fountain," wiping away the excess with a "doctor blade," and then rotating the cylinder against the substrate. Some products go through a laminating process that is done on separate equipment. The final product is sized according to customer needs by slitting large multiple-image rolls of printed, laminated material to smaller rolls that may be only one image wide.

Environmental Problems

There are three main types of contaminants from this facility that adversely impact the environment. They are: 1) vapors which are released from chemical solutions for cylinder making and dechroming, solvent adhesive, and ink; 2) liquid chemicals and heavy metals that are discharged from spent cylinder-making solutions, spent ink, and spent solvent; and 3) solid waste which includes copper dust; sludge; spent film from the cylinder-making process; and excess substrate from slitting, printing and laminating and bobbin cutting.

Pollution Prevention Opportunities

The assessment identified 9 pollution prevention opportunities that address the problems identified above. Table 1 lists the opportunities recommended for this facility and presents the environmental and financial benefits and financial costs of each.

Cylinder Making: The current composition of the three plating baths causes many defects on the finished cylinders. Of the total 500 cylinders that are chrome plated every month, about 50% must be replated. This is due to improper plating bath composition, maintenance, dechroming, and grinding procedures. Taking measures to improve this process will benefit the entire production process, improving quality of the
Table I: Summary of Recommended Pollution Prevention Opportunities

<table>
<thead>
<tr>
<th>Operation</th>
<th>Cleaner Production Action</th>
<th>Environmental Benefit</th>
<th>Implementation Cost</th>
<th>Financial Savings</th>
<th>Payback Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder Making</td>
<td>Change concentrations, maintain baths, improve storage</td>
<td>Reduce releases of chrome, nickel, copper to the environment</td>
<td>5,900/year</td>
<td>680,000/year</td>
<td>immediate</td>
</tr>
<tr>
<td>Cylinder Making</td>
<td>Replace toluene with alkaline cleaner</td>
<td>Eliminate releases of toluene to water</td>
<td>2,000 to implement; 2,700/year</td>
<td>7,700/year</td>
<td>5.3 months</td>
</tr>
<tr>
<td>Cylinder Making</td>
<td>Recover copper fines</td>
<td>Eliminate copper releases from this source</td>
<td>50/year</td>
<td>150/year</td>
<td>4 months</td>
</tr>
<tr>
<td>Printing</td>
<td>Recover ink from ink cans</td>
<td>Reduce ink consumption between 3840 and 5760 kg/year</td>
<td>none</td>
<td>14,000 - 21,000/year</td>
<td>immediate</td>
</tr>
<tr>
<td>Printing</td>
<td>Computerize ink inventory and use color matching system</td>
<td>Reduce waste ink; reduce rejects due to poor ink quality</td>
<td>41,400</td>
<td>62,700/year</td>
<td>8 months</td>
</tr>
<tr>
<td>Printing</td>
<td>Zahn cup clean-up</td>
<td>Reduce solvent use by 90% and reduce solvent releases</td>
<td>10</td>
<td>76,000/year</td>
<td>immediate</td>
</tr>
<tr>
<td>Printing</td>
<td>Modify doctor blade settings</td>
<td>Reduce releases of chrome due to the need for rework</td>
<td>none</td>
<td>40,000/year</td>
<td>immediate</td>
</tr>
<tr>
<td>Printing</td>
<td>Improve temporary fluid storage</td>
<td>Reduce releases of and exposure to evaporated solvents</td>
<td>10</td>
<td>19,800/year</td>
<td>immediate</td>
</tr>
<tr>
<td>Engraving</td>
<td>Index film to cylinder key</td>
<td>Reduce substrate loss</td>
<td>100</td>
<td>72,700/year</td>
<td>immediate</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
<td></td>
<td>43,500 (one-time costs); 8,650/year</td>
<td>973,000 - 980,000/year</td>
<td></td>
</tr>
</tbody>
</table>

finished product and reducing waste. The actions that should be taken to reduce the number of defects on the cylinders include:

1) Change the concentrations of the sulfuric acid and alter the components in the nickel, acid copper and chrome baths. For a nominal cost, these measures will reduce problems such as cracking, corrosion, hardness, and lack of brightness on the cylinders.

2) Maintain the acid copper, chrome, and nickel process solutions according to standard practice. Currently, the solutions are changed with a high frequency. The acid copper solution should last several years rather than two weeks and the chrome and nickel solutions should seldom require replacement.

3) During dechroming, maintain the hydrochloric acid concentration at 10% by volume and plug the cylinders to prevent HCL attack of the exposed steel on the interior of the cylinder.

4) Improve storage conditions by drying cylinders and placing them in a plastic bag with silica gel to prevent corrosion in storage. It is estimated that 100 cylinders per month must be rechromed because of corrosion from the HCL bath and from the humid conditions.

Total savings from these changes could reach $680,000/year from reduced press downtime and less need for rework. Increases in annual operating cost are $5,900/year. The payback period for these changes is immediate.

Cleaning: Toluene is currently used to clean the cylinders. This system should be replaced with an alkaline cleaning system which will improve cleaning and reduce the need for toluene. The cost of a new
cleaning system is $2,000. Annual savings are $5,000. The payback period is 5.3 months.

Copper Recovery: The grinding operation has an output of solid copper fines that are currently directed outside to the drainage ditch, where they have collected to some depth. To eliminate copper releases, the fines in the drainage ditch should be scooped out, washed and sold as scrap. A porous bag should be attached to the grinder output pipe to collect all fines in the future. Net savings are $100/year and the payback period is 4 months.

Ink Waste: When a new can of ink is opened at the press, it is divided up and diluted with solvent. The empty ink can is then put aside next to the cleaning tank and filled with waste solvents. The cans still contain some ink which can be recovered and used on the press. This will reduce ink consumption, saving between $14,000-$21,000 each year.

Improve Ink Management: The flow of ink through this facility is complicated and inefficient. There is little inventory control and many cans of ink remain in the warehouse for several years, often becoming unusable. Excess ink at the printing presses often remains unused and evaporates. A computer system should be installed to track shelf inventory and ink usage. A color matching system and a new spectrometer would also enable the ink manager to do color matching more efficiently. These recommendations reduce the amount of ink returned to the supplier or thrown away. Installation and training costs are $41,400; annual ink savings are $62,700. The payback period is 8 months.

Solvent Use: The viscosity of ink in the fountain is monitored regularly using a Zahn cup. The Zahn cup is washed after checking the viscosity. To do this, the operator soaks the Zahn cup in fresh solvent. This solvent is considered waste solvent after 3 Zahn cup cleanings. To reduce the solvent used in the process by 90%, the facility could use a triple counter rinse system which would ensure that solvent was thrown out only after it was no longer usable. The system could save the facility $76,000/year. Implementation costs are less than $10.

Doctor blades: Doctor blades are used to remove excess ink from the cylinder before the impression is made on the substrate. The facility could change the material of the doctor blade from stainless to carbon steel, ensure that it is mounted properly, and set the blade at a steeper angle to reduce the entrapment of particles under the blade. With these changes, the doctor blade will perform better, keeping impurities from getting on to the print surface of the cylinder and reducing the production of waste. Savings are expected to be $40,000/year.

Reduce Solvent Losses in Temporary Ink Storage: Several ink cans reside in temporary storage near the presses at any given time. Many of these are left with pouring holes open or are cut to expose half the lid. This results in evaporation of the inks, exposing workers to harmful fumes. All ink cans in temporary storage should be sealed when not in use, and durable plastic lids can be used for the doctor blade cleaning drums. The savings from reducing solvent evaporation can reach $19,800/year. Implementation cost is $10 to install new lids.

Indexing Film to Cylinder Keyway: Typically, several cylinders are used (one for each color) during any given printing run. The cylinders must be properly aligned to ensure that colors are overlayed correctly. The current method used to position the cylinders does not index the beginning of the film to a constant point on the cylinder and successive cylinders on the press are in alignment at the beginning of a run only by chance. A pointer mounted in a fixed relation to the collar can be used to position the film on the cylinder at a constant point. Implementation cost is $100 and savings are $72,700/year.

Conclusion:

Many of the product quality and environmental problems of this facility stem from problems in making and storing the cylinders used in the printing process. Improving this process to reduce rejects will significantly improve the quality of the product, save the facility a substantial amount of money each year, and reduce the impact of this facility on the environment.

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