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Environmental Pollution Prevention Project

CASE STUDY

Pollution Prevention Assessment for a Sugar Refinery

Executive Summary

This assessment evaluated a sugar refining facility. The objectives of the assessment were to identify pollution prevention options that would: reduce the quantity of toxics, raw materials, and energy used in the manufacturing process, which reduces industrial pollution and worker exposure to toxic chemicals; demonstrate the environmental and economic value of a focused pollution prevention assessment; improve manufacturing competitiveness and product quality; and provide the foundation for a sustainable pollution prevention program at the facility. The assessment team was comprised of experts from the US, the local EP3 office, and local implementing agencies

The assessment team identified seven pollution prevention options that will save the facility US$836,400 annually, with a first year cost of US$266,100. These include repairing steam leaks, recycling waste water, and improving process techniques. These options will help to: 1) increase sugar yield; 2) reduce on-site fuel consumption by 2,500 tons, 3) reduce water consumption by 100,000 m^3; and 4) reduce solid waste generation.

Implementing the pollution prevention opportunities will significantly improve production efficiency at this plant. The facility consumes and discharges a large quantity of water in the refining process, and must review its water use practices in order to comply with environmental regulations. The pollution prevention options provide a way to reduce water consumption at low or no-cost. Furthermore, these options will help to reduce the cost of installing and operating the waste water treatment plant being considered.

Facility Background

The facility is a sugar refinery with a production capacity of 336,000 tons of refined sugar per year. It runs 330 days per year.

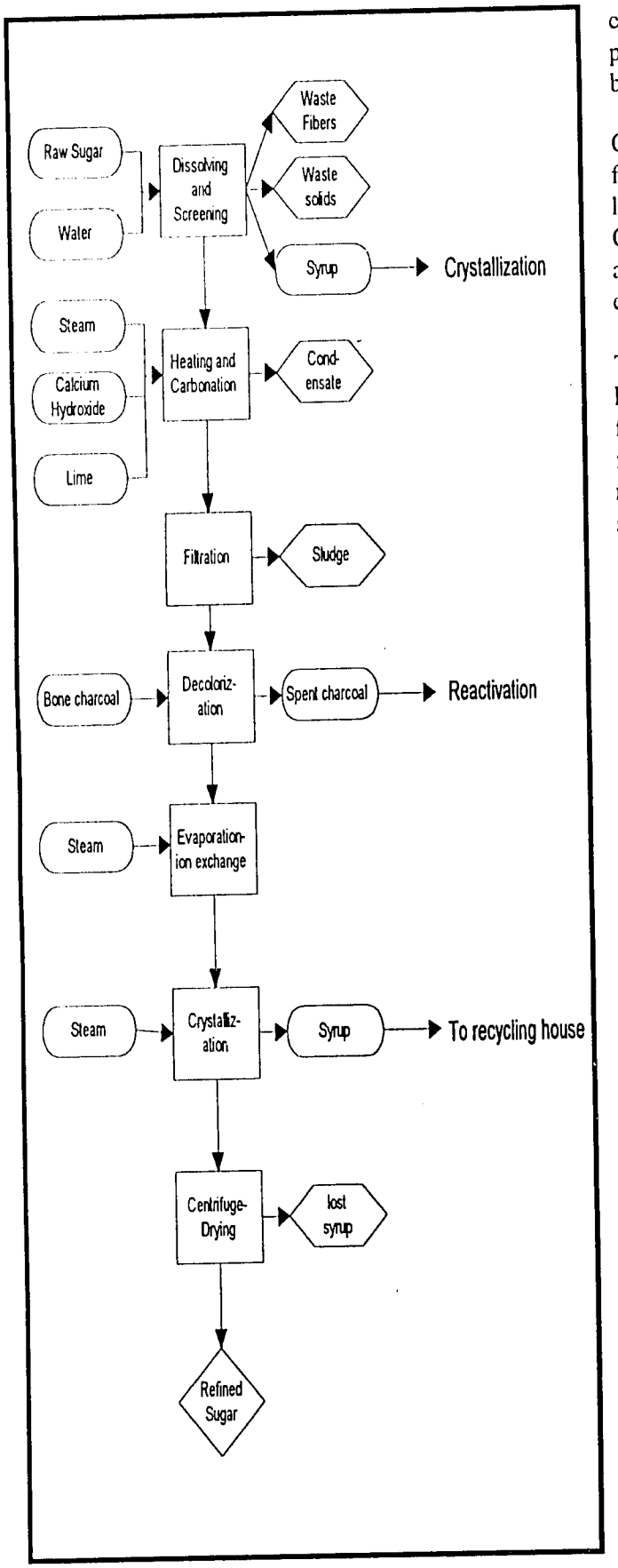
Manufacturing Process

This facility has nine unit operations: 1) raw sugar receiving; 2) dissolving and screening; 3) heating-carbonation-reheat; 4) filtration; 5) decoloration; 6) evaporation-ion exchange; 7) crystallizatien; 8) centrifugal-drying; and 9) final product packaging. **Figure** 1 outlines this process.

Raw sugar is received at the plant, where it is mixed with water to form a solution which is filtered and then processed in a centrifugal unit where hot water is added to reach a temperature of 70°C. Clear liquor is extracted and the sweet water returns to the raw sugar/syrup processing unit.

The resulting liquor is heated to 85°C and lime is added, followed by carbon dioxide. This mixture is then filtered to separate the clear liquor from the sludge which still contains sweet liquor. The residual sweet liquor is recovered by further processing and is transferred to melting tanks where it is mixed with bone charcoal at 85°C to remove color and minor impurities. For cubed sugar, the liquor must go through ion exchange tube before decolorization and evaporation. For granular sugar, the liquor is evaporated in two stages, first to 58% and then to 66% before crystallization.

Figure I: Overview of Facility's Printing Process



A major consumer of water is the charcoal reactivation process. The charcoal is first washed to remove sweet liquor and second to remove salts. The rate of water consumption for both washes is 18 m^3/hour. Compressed air is then used to remove moisture before baking the charcoal. **Figure 2** outlines this process.

Crystallization uses build-up/grow-up units for crystal formation and is repeated several times, producing lower grades of sugar with each subsequent step. Crystals are separated from the syrup by centrifuging and move on to drying while the syrup is returned to the crystallization step.

The final product ships in either 1 kg paper bags or 100 kg jute bags. Paper packages are produced at the facility and after automated filling, the seam is inspected for quality. Jute bags are automatically filled and manually transferred to a closure sewing machine, sealed and transferred for shipping.

Existing Pollution Problems

The environmental problems associated with sugar refining are: consumption of large amounts of water and fuel; generation of waste water; generation of solid waste; and emissions produced from heavy fuel oil combustion.

Pollution Prevention Options

Seven pollution prevention opportunities were recommended from this assessment. **Table 1** lists the recommendations and presents the environmental benefits and first year cost for each recommendation.

Repair steam leaks and insulate pipes: Repairing leaks at the plant could save 1,500 tons of fuel each year. The cost of implementing this option is US$900; the yearly savings is US$68,200.

Repair and replace fittings on filter machines: Leaking sweet liquor increases the cost of producing sugar because it must be re-cycled back into the production process. Preventing these leaks could save up to US$143,900 per year. The cost of repairing leaks is US$16,700.

Seal doors and lids on the centrifuge and dryer: Spillage must re-enter the production process, adding additional steps and increasing production costs. Sealing lids and doors and could reduce the amount of spillage

Table I: Summary of Recommended Pollution Prevention Opportunities

Operation	Pollution Prevention Option	Environmental and Health Benefits	First Year Cost (US$)	Annual Financial Benefits US$/yr	Payback Period
Plant Maintenance	Repair steam leaks and insulate pipes	Reduction in fuel consumed; reduction in emissions	US$900	US$68,200	5 days
Plant Maintenance	Repair and replace fittings on filter machines	Reduction in product loss; reduction in energy consumption; reduction in water consumption	US$16,700	US$143,900	2 months
Plant Maintenance	Seal doors and lids on centrifuge and dryers	Reduction in product loss	US$21,200	US$15,800	16 months
Materials Handling	Re-use jute and plastic bags	Reduction in solid waste	US$51,500	US$500,000	1 month
Filtration	Adjust filter cleaning process	Reduction in waste water contamination	US$0	US$15,200	Immediate
Decolorization	Recycle wash water	Reduction in waste water generated	US$45,500	US$14,500	N/A
Crystallization	Install super-saturation detectors	Reduction in energy consumption; increased product yield.	US$30,300	US$80,300	5 months
TOTAL			**US$266,100**	**US$836,400**	

in both the centrifuge and drying processes by almost 500 tons. The cost of sealing the centrifuges and dryers is US$21,200; annual savings in value added is US$15,800 per year.

Re-use jute and plastic bags: The jute bags that hold raw material are used twice while the plastic bags are used once. Increasing the number of times that jute bags are used reduces the quantity of bags purchased by approximately 865,000 jute bags. Plastic bags can be re-used, but are filled to half their original capacity, saving 30% on annual purchases. The cost of installing equipment or modifications could be as much as US$151,500; the annual savings is US$500,000 per year.

Adjust process during filtration: The contact time between hot water and mud in the filter units should be increased. More residual sugar will be dissolved, increasing syrup recovery and thus the amount of sugar produced. There is no cost associated with implementing this option; the annual savings is US$15,200.

Recycle wash water from decolorizing charcoal: Waste water generated in washing decolorizing charcoal can be re-used several times for the second wash stage after it has been treated. The one-time cost to purchase water treatment equipment is approximately US$30,300; the annual cost for chemicals required for water treatment is US$15,200. While the annual savings would be US$14,500, the decrease in waste water generated is critical because it helps the facility comply with environmental regulation.

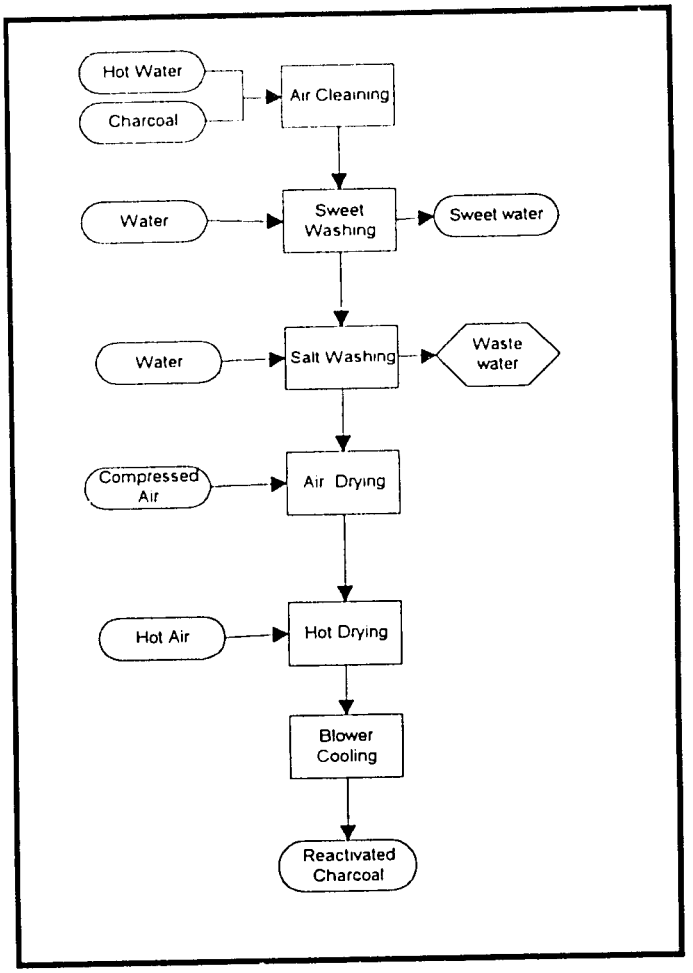
Install super-saturation detectors: Using super-saturation detectors during the crystallization stage

improves the efficiency of the process resulting in a 12.5% reduction in energy use. The cost of purchasing equipment for this option is US$30,300; the annual savings is approximately US$80,300.

Conclusion

During the shut-down period (May 15-30) the plant management implemented the following options as part of a major maintenance plan: repairing steam leaks and insulating pipes; repairing and replacing fittings on filler machines; and sealing doors and bids on the centrifuge and dryer. Measures taken include repairing steam leaks and seals on filter machines and centrifuge equipment. The total cost of implementing the maintenance plan was US$121,200 with a payback period of less than 15 days.

Figure 2: Charcoal Reactivation



For Further Information

For futher 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