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Pollution Prevention Assessment for an Oil Extraction and Soap Manufacturing Facility

CASE STUDY

What is EP3?

The amount of pollutants and waste generated by industrial facilities has become an increasingly costly problem for manufacturers and a significant stress on the environment. Companies, therefore, are looking for ways to reduce pollution at the source as a way of avoiding costly treatment and reducing environmental liability and compliance costs.

The United States Agency for International Development (USAID) is sponsoring the Environmental Pollution Prevention Project (EP3) to establish sustainable programs in developing countries, transfer urban and industrial pollution prevention expertise and information, and support efforts to improve environmental quality. These objectives are achieved through technical assistance to industry and urban institutions, development and delivery of training and outreach programs, and operation of an information clearinghouse.

EP3's Assessment Process

EP3 pollution prevention diagnostic assessments consist of three phases: *pre-assessment*, *assessment*, and *post-assessment*. During *pre-assessment*, EP3 in-country representatives determine a facility's suitability for a pollution prevention assessment, sign memoranda of agreement with each facility selected, and collect preliminary data. During *assessment*, a team comprised of U.S. and in-country experts in both pollution prevention and the facility's industrial processes gathers more detailed information on the sources of pollution, and identifies and analyzes opportunities for reducing this pollution. Finally, the team prepares a report for the facility's management detailing its findings and recommendations (including cost savings, implementation costs, and payback times). During *post-assessment*, the EP3 in-country representative works with the facility to implement the actions recommended in the report.

Summary

This assessment evaluated an oil extraction and soap manufacturing facility. The objective of the assessment was to identify actions that would: (1) reduce the quantity of toxics, raw materials, and energy used in the manufacturing process, thereby reducing pollution and worker exposure, (2) demonstrate the environmental and economic value of pollution prevention methods to the soap industry, and (3) improve operating efficiency and product quality.

The assessment was performed by an EP3 team comprised of an expert in oil extraction and soap manufacturing and a pollution prevention specialist.

Overall, the assessment identified two pollution prevention opportunities that could provide annual savings of at least $6,000 for a one time investment of $23,000. If implemented, these changes could reduce energy and water use per unit output, reduce contaminated wastewater, and improve product quality.

Facility Background

This facility refines olive oil and soybean oil for consumption. The facility also makes soap from high acid oils and other fat sources. The plant operates three eight-hour shifts, employing 37 permanent workers and 20 seasonal workers.

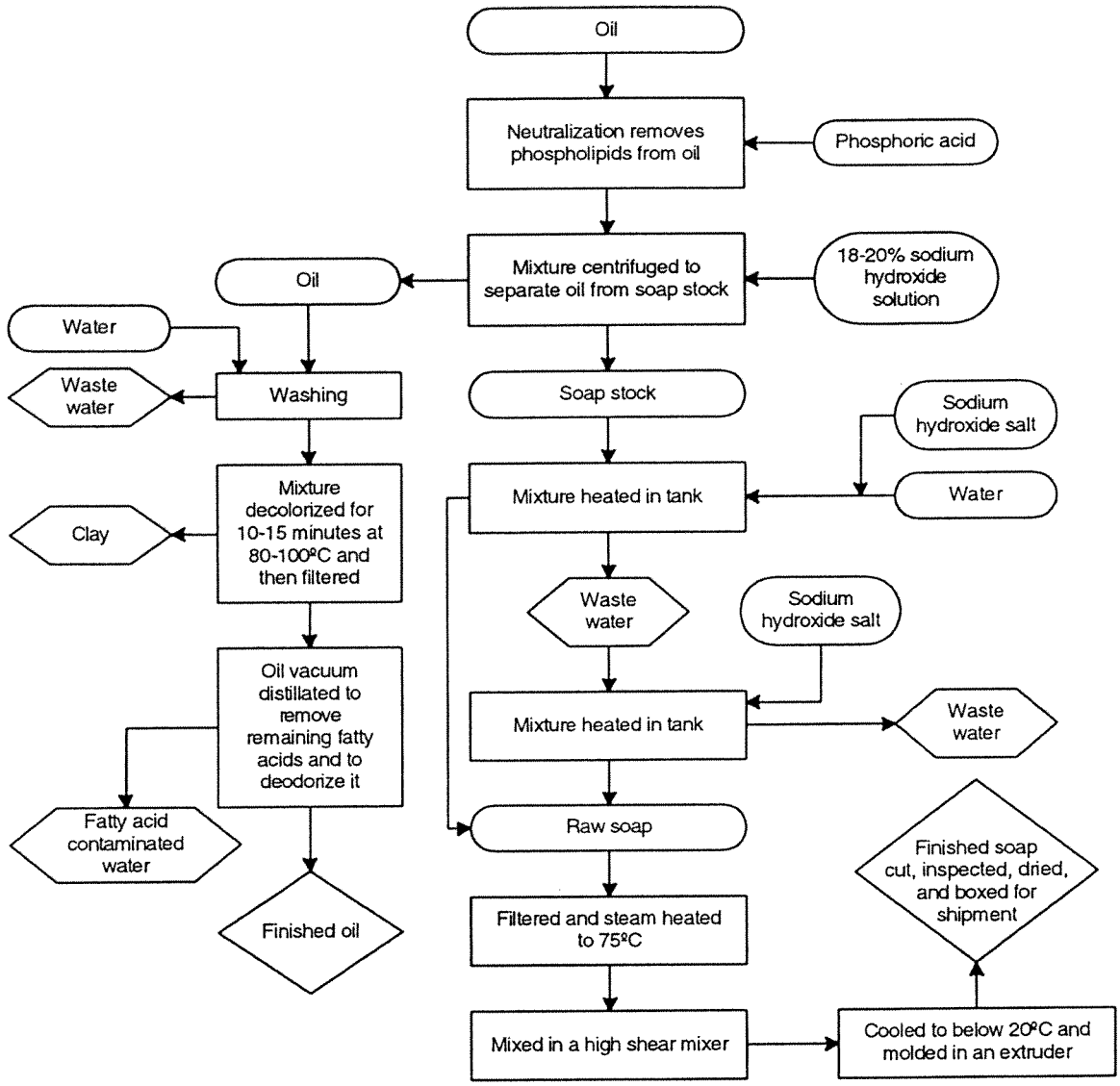
Manufacturing Process

The plant has two main unit operations: oil refining and soap making, as shown in **Figure 1**.

The refinery process removes phospholipids, neutralizes the oil's acidity, and decolorizes and deodorizes the oil. Phosphoric acid is added to the heated crude oil to eliminate the phospholipids. An 18-20 percent solution of sodium hydroxide is mixed with the oil and then centrifuged to separate the oil and soap waste. The oil is mixed with water for washing in a second centrifuge. The effluent is waste water.

EP3 is sponsored by the U.S. Agency for International Development.

Figure 1: Overview of Facility's Oil Extraction and Soap Manufacturing Process



The oil is decolorized by mixing bentonite clay with the oil at 80-100 degrees C for 10-15 minutes, then filter pressing. Deodorization is accomplished through the use of superheated steam in a vessel installed in 1933. This refined oil is sold for consumption.

Oil of insufficient quality for refining (as well as the soap stock from the neutralizing step in refining) is used as feed for soap making. In large, steam heated cylindrical tanks, oil and/or soap stock mix with sodium hydroxide, salt, and a variable amount of water, reacting to form soap that floats on top of the tank. The waste water from the bottom is diverted to another tank where it again mixes with sodium hydroxide and salt to make more soap stock. Subsequent steps include salt washing and multiple rinsing.

The wet soap feeds by gravity to a small holding reservoir. From there it is filtered, steam heated, and vacuum dried. The soap, now with a lower moisture

Table 1: Summary of Recommended Pollution Prevention Opportunities

Unit Operation	Pollution Prevention Action and Environmental/ Product Quality Benefit	Cost	Financial Benefit	Payback Period
Refining Oil: Neutralization Pre-Treatment, First Centrifuge	Purchase oil, acid, and caustic flow controllers and flow meters - reduces oil losses to water stream.	$19,000	Measurable once equipment is installed and used	Measurable once equipment is installed and used
Refining Oil: Neutralization Wash Water, Second Centrifuge	Reduce water flow to no more than 10 percent of oil flow rate and use mixer; purchase flow meter and flow controller for wash water - reduces waste water.	$4,000	$6,000 per year	8 months
TOTALS		$23,000	$6,000 per year plus 1 unquantified opportunity	

content, passes through a high-shear mixing machine to where it is cooled and molded into a continuous rectangular solid. The continuous soap bar is cut, inspected, and placed onto the dryer. The finished soap bars are boxed for shipment.

Existing Pollution Problems

At the time of the assessment, there were a number of pollution problems at the facility, including (1) excessive waste water, and (2) oil loss to the water stream.

Pollution Prevention Opportunities

The assessment identified two pollution prevention opportunities. One could save the facility $6,000 per year for an investment of $4,000, while the other could save the facility an undetermined amount for an investment of $19,000. If implemented, these pollution prevention changes can reduce the loss of high value oil to lower value soap stock, reduce the generation of waste water, and improve productivity and product quality. **Table 1** presents the assessment's findings in order of unit operation processes.

The recommendations also could help the facility produce superior oil and soap by (1) purchasing instruments to correctly and precisely meter chemical additions to the refinery process and (2) increasing the backpressure on the refinery washing centrifuge.

The ability to precisely mix the raw materials for neutralization (oil, phosphoric acid, sodium hydroxide, and water) greatly impacts the resultant oil quality, profitability, and waste generated. Oil, acid, caustic, and wash water flow controllers and meters could enhance the facility's precision. A sufficiently high backpressure on the centrifuge exit is needed to assure proper separation of the oil and wash water; the current backpressure is too low to properly separate the phases.

These recommendations will improve the facility's competitiveness in a market that is likely to become more competitive in the future.

Effect on the Environment

If implemented, these pollution prevention improvements will reduce the volume of waste water and its BOD and COD levels, and the amount of solids in the waste water.

Evaluating Performance

EP3 is developing a methodology for measuring and tracking pollution prevention performance. The approach uses simple but critical ratios to compare data among facilities in the same industrial sector.

This assessment identified two critical ratios, as shown in **Table 2**: (1) cubic meters of refinery water per ton of crude oil processed, and (2) kilograms of caustic soda per ton of crude oil processed. Based on its knowl-

Table 2: Critical Performance Ratios for Oil Refining

Ratio	BIP	Current Ratio at Facility
Cubic meters of refinery water per ton of crude oil processed	2	8
Kilograms of caustic soda per ton of crude oil processed	10	20

edge of the olive oil refining/soap manufacturing process, the Assessment Team developed best industrial performance (BIP) values for these ratios, and found that this facility's current values were significantly higher than the BIP values. The facility should be able to reduce its ratios and come closer to the BIPs by implementing the pollution prevention options listed in **Table 1**.

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 apenderg@habaco.com.