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Cranston Print Works Co.
Toxics Use Reduction Case Study
Carbon Dioxide Replaces Sulfuric Acid for pH Adjustment

Summary

Spurred by a desire to meet the goals of the Massachusetts Toxics Use Reduction Act, the managers of Cranston Print Works altered their wastewater pH adjustment process to eliminate the use of sulfuric acid. The company installed a jet aeration system with injected liquid carbon dioxide to replace the two 4,300-gallon sumps in which wastewater neutralization had previously taken place. This $115,000 project eliminated the annual use of 2.66 million pounds of sulfuric acid. Although financial profit was not the main goal of the project, the company saved about $80,000 per year in chemical purchase and maintenance costs.

Background

The Webster, Massachusetts, division of Cranston Print Works (CPW) prepares, prints and finishes cotton and blended fabrics, which are used to make clothing and other goods. The facility employs approximately 420 people in its three-shift-a-day, six-day-a-week operations. Cranston considers acting as a "green company" to be an integral part of the company commitment to continuous quality improvement, and it has been recognized by the Massachusetts Audubon Society, the Worcester Business Journal and the American Textile Manufacturers Institute for its environmental achievements.

Cranston processes 65 million yards of fabric each year. In order to improve color yield in the printing process, raw cotton and other fabrics are bleached, then ‘‘mercerized’’ in a 22 % caustic soda solution. These steps generate highly alkaline wastewater (11.4 pH average) which must be neutralized in the company’s treatment facility before it can be discharged. Cranston formerly used sulfuric acid for neutralization. Sulfuric acid accounted for 80 % of the toxics usage reported by Cranston under the Massachusetts Toxics Use Reduction Act (TURA).

Alkaline wastewater was neutralized in two 4300 gallon sumps. The acid was mixed into the wastewater in the first sump for rough pH control, while the second sump was used for fine-tuning of pH levels. Fully neutralized wastewater was pumped into a 600,000 gallon holding basin for organic equalization and seven day discharge to Webster’s publicly owned treatment works (POTW).

Cranston became interested in eliminating its use of sulfuric acid because it wished to end its use of substances listed as toxic under TURA. The company also hoped to enhance the safety of employees both at Cranston and at the POTW. Easier pH control was a final, though less important, goal. Cost was not a driving factor.

Toxics Use Reduction Planning

Cranston Print Works decided to find an alternative to sulfuric acid in 1991. Liquid carbon dioxide was chosen as the replacement, since it performs the same job as sulfuric acid and it is not a toxic material. Liquid carbon dioxide systems also typically offer greater safety, more precise pH control and lower operating costs than sulfuric acid neutralization systems.

Once the decision was reached, the company's management teamed with plant operators, three consultants, a liquid CO2 vendor and an aeration equipment vendor to lay plans for the change. The team spent approximately 150 hours devising the innovative system that eventually replaced the old acid neutralization sumps.

Cranston officials worked with the liquid carbon dioxide supplier to run laboratory tests which traced the alkalinity levels of specific waste streams. These tests permitted the development of titration curves, which were used in turn to determine the CO2 requirements of the new neutralization system. These tests had the added benefit of improving the company's technical understanding of day-to-day operations.

Toxics Use Reduction Modifications

The two existing 600,000-gallon basins, now operating in series, were equipped with jet aeration systems designed to feed the liquid carbon dioxide into the wastewater. All plant wastewater is now pumped into the two basins, where liquid CO2 is injected into the aeration liquid header to provide complete mixing with the wastewater. As the CO2 mixes with the water it makes carbonic acid, which is weaker and much easier to monitor and control than sulfuric acid. The carbonic acid dissociates into bicarbonates, carbonates and hydrogen ions, and the hydrogen ions reduce the pH. Using this process, it has become easier for Cranston employees to keep wastewater effluents within the required pH range of 6.5 to 9.0.

Implementation of the complete pretreatment system upgrade took approximately 450 man-hours over an eight-month period. Employees whose work requires knowledge of the waste treatment system, including all maintenance workers and waste treatment operators, were given appropriate training by the CO2 vendor and by Cranston's waste treatment supervisor. The new system is generally safer and easier to operate than the old one, since employees no longer require special training in acid handling, spill monitoring and emergency spill response.

Since the new system was installed, Cranston has made further changes to equipment and manufacturing controls that have drastically reduced the amount of caustic wastewater generated by its bleaching and mercerizing processes.

Results

Reductions: Cranston's replacement of sulfuric acid with liquid carbon dioxide has eliminated the annual purchase of more than 2.66 million pounds of sulfuric acid. The change has also freed the company from a series of onerous requirements associated with the safe use of sulfuric acid. These requirements include special protective equipment to handle the acid, training on acid handling and emergency spill response, and special monitoring of deliveries to detect spills and leaks. (The new system has not reduced the company's emissions of toxic substances, since the sulfuric acid was consumed in the pH adjustment procedure. Neither pH adjustment system produces toxic byproducts.)

Economics: Installation of the new pH adjustment system cost $115,000. This figure includes the purchase of a used liquid CO2 holding tank. Cranston estimates that it saves approximately $60,000 per year in chemical purchase costs, and another $20,000 in system maintenance. This latter figure includes the annual cost of maintaining the sulfuric acid piping system, valves and pumps, together with an additional $5,000 for an annual recoating of neutralization sumps. These figures indicate that the payback period on the new system is slightly less than 1.5 years.

This case study is one in a series prepared by the Office of Technical Assistance (OTA), a branch of the Massachusetts Executive Office of Environmental Affairs. OTA's mission is to assist Massachusetts facilities with reducing their use of toxic chemicals and/or the generation of toxic manufacturing byproducts. Mention of any particular equipment or proprietary technology does not represent an endorsement of these products by the Commonwealth of Massachusetts. This information is available in alternate formats upon request. OTA's **non-regulatory** services are available at **no charge** to Massachusetts businesses and institutions that use toxics. For further information about this or other case studies, or about OTA's technical assistance services, contact:

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