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POLLUTION PREVENTION CASE STUDY

BOC EDWARDS IMPLEMENTS ZERO WATER DISCHARGE AND OTHER IMPROVEMENTS

SUMMARY

To improve quality of service and environmental, health and safety performance, BOC Edwards installed an enclosed, automated wash system and closed-loop wastewater treatment unit at its pump remanufacturing center in Wilmington, MA. The new system recycles nearly 100% of the process water used to clean pump components and decreases waste sludge by approximately 80% compared to previous operations.

As part of BOC Edwards' commitment to continuous environmental, health and safety improvement, the company will use the retrofit at its Wilmington facility as a performance standard for similar operations at other BOC Edwards facilities worldwide.

BACKGROUND

BOC Edwards, a division of the multi-national BOC Group, provides high-performance vacuum pump manufacturing and support services to the semiconductor industry. The corporation places a strong emphasis on environmental, health and safety performance; it maintains a centralized database on each facility's performance, shares best management practices between facilities (often with other industry members), and strives to ensure that subcontractors and vendors meet specified standards. Senior management strongly supports the incorporation of environmental, health and safety standards into the company's business strategy, and has committed the company to achieving ISO-14001 certification within the next few years.

Operations at the company's 11-year-old Wilmington, MA facility, which serves as BOC Edwards' North American headquarters, include the cleaning, repairing, and rebuilding of vacuum pumps. The first step of this process is the preparation of incoming pumps for re-manufacture, specified as Disassemble, Clean, Inspect (DCI). DCI is critical to ensuring both the quality of the re-manufactured product and the proper management of various potentially hazardous pump contaminants. Within the DCI area, pumps are torn down to their basic components and cleaned of all contaminants, oils, and process build-up. The individual parts are then inspected for condition to ensure they are acceptable for reuse. A number of operational, product quality, environmental, health and safety concerns prompted BOC Edwards to undertake a comprehensive redesign of the DCI area.

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Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs

Prior to this effort, disassembled pump components were cleaned by hand in an enclosed cabinet with a high-pressure steam gun. Components with particularly resilient contaminants were transferred to a similar apparatus and sprayed with an abrasive blast of glass beads and water, then sent back to the steam cleaner to remove any remaining abrasive media. This cycle was repeated, if necessary, until all contaminants were removed. The process was fully manual, requiring considerable operator time.

All DCI wash water was run through a treatment system and re-circulated. However, age and disrepair made this system increasingly difficult to maintain. Breakdowns were frequent, wash water quality unreliable, and odor problems from bacterial growth serious enough to render the DCI area "sewer-like" at times. Increasing production levels at the facility placed a strain on the treatment system's limited capacity – a problem exacerbated by the frequent breakdowns.

IMPLEMENTATION

Intent on stabilizing performance, improving working conditions, preventing environmental impacts and meeting the company's growing production needs, BOC Edwards began researching options for redesigning the DCI area. A project team encompassing senior management, engineering, operations and production was established to guide the process. Based on their recommendation, the company replaced the existing DCI equipment with a new automated wash system and an accompanying wastewater treatment and recirculation unit.

Similar in concept to a dishwasher, the wash system is entirely enclosed and automated. Components are scrubbed with a proprietary cleaning agent and then rinsed. Because many of the pump components are constructed from materials susceptible to oxidation, a rust inhibitor is also applied. Clean components are inspected and then sent on to the re-manufacturing stage. An abrasive-blasting unit similar to the original glass-bead system is still used to remove resilient contaminants, although process engineers have steadily reduced reliance on this secondary cleaning step. Being automated, the new washing machine is faster and more consistent than the previous system, significantly increasing production efficiency. Worker ergonomics and other health and safety concerns associated with the previous system are resolved.

Complementing the new washer is a wastewater treatment and recirculation system manufactured by CASTion Corporation of Ludlow, MA. Water discharged from the washing machine contains trace metals, contaminants and other solids, as well as used cleaning solution, soluble contaminants and oil. The treatment unit sends the wastewater stream through an evaporative condenser that extracts nearly 100% of the water and concentrates the contaminants in a compact waste sludge. The relatively clean water is fortified with fresh make-up water as necessary and recirculated back to the wash system. The accumulated waste sludge (roughly 30% water) is disposed of quarterly as hazardous waste.

In addition to these new technologies, BOC Edwards implemented a number of other changes to the DCI process to improve efficiency and overall environmental, health and safety performance. Customers are asked to complete a health and safety assessment form prior to sending pumps for re-manufacture. As pumps arrive, they are tagged as hazardous or non-hazardous as necessary. Customers are also requested to clearly stipulate the nature of the pump's operation (e.g. what gases, vapors were involved) and how it malfunctioned, thereby helping to negate possible worker exposure to contaminants. The disassembly benches are now equipped with a drainage system for quick and safe removal of wastes from the pumps as they are broken down; the workbenches themselves are ventilated, generating downdraft airflow to protect the technicians from vapor exposure.

Installation and start-up of the new DCI process took BOC Edwards approximately six months to complete. Worker training was conducted to orient

DCI technicians to the new equipment and procedures. Refresher training is provided on an ongoing basis, as needed. Following start-up, the company utilized some degree of trial and error to optimize wash cycle times and detergent levels. Process engineers monitor the new system's performance to ensure product quality, increase efficiency and facilitate waste reduction efforts.

RESULTS

Reductions: Without treatment and recirculation, the DCI process would generate upwards of 60,000 gallons/year of contaminated wastewater. The water treatment unit allows the facility to recycle nearly 100% of the process water, with only minimal amounts of make-up water added periodically to account for losses and evaporation.

The contaminant sludge removed from the wash water amounts to less than 10,000 gallons per year, a decrease in volume of approximately 80% compared to the original process. BOC Edwards' engineers continue to seek opportunities to reduce this volume further.

Compliance: Because it meets the federal criteria for a totally-enclosed treatment system, the CASTion wastewater treatment unit has been approved by Massachusetts Department of Environmental Protection (DEP) and federal U.S. Environmental Protection Agency (EPA) officials as a permitted exemption to hazardous waste provisions[1] that prohibit treatment at non-licensed facilities.

Economics: The entire DCI retrofit cost BOC Edwards approximately $700,000. Roughly $85,000 of this amount went toward purchase and installation of the new water treatment system. While the upgrade for the DCI process overall represented greater up-front capital costs than repair or in-kind replacement of the previous equipment, savings from increased efficiency and production capacity yielded a payback period of roughly 10 months. The company estimates that the savings from reduced hazardous waste generation and reduction in use, replacement and disposal of filters exceeds $80,000 per year.

1 Under the Resource Conservation and Recovery Act (RCRA), Public Law 94-580

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