Turning Back the Clock—and Looking Ahead

Saluting Our 2015 New Product of the Year Winners

How Thermal Oxidation Can Increase the Sustainability of a Chemical Plant
This month, we’ve included the winning products from the 2015 Environmental Protection New Product of the Year contest and a case study about a company’s use of a centralized direct fired thermal oxidizer to handle liquid and gaseous waste streams.

By Jerry Laws

This special section in OH&S’ April 2016 issue is our homage to Environmental Protection, a monthly print magazine published by our predecessor company for more than 15 years. Our publishing company, 1105 Media Inc., maintains its www.eponline.com website, and we’re committed to providing top-notch content there—feature articles, new products, webinars, videos, and more—to help EHS professionals stay abreast of developments in this all-important regulatory arena.

We plan to publish a second EP special section in November 2016 with more articles, including an analysis of the leading presidential candidates’ environmental platforms.

Stay tuned, and do send me your new products, articles, and tips for what we should feature in this November 2016 section. Meanwhile, visit www.eponline.com for news about EPA’s upcoming enforcement initiatives and state environmental agencies’ activities, articles about solving data centers’ EHS challenges and managing commercial chemical products efficiently, and much more.

Jerry Laws (jlaws@1105media.com) is the editorial director of Environmental Protection.
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BY JERRY LAWS

Many readers of OH&ES will remember our Environmental Protection magazine, and many of you make use of the information and articles available on its www.eponline.com website and in our Environmental Protection and Water & Wastewater News e-newsletters. But you may not be aware of the annual New Product of the Year contest, launched several years ago to highlight the environmental industry’s latest and greatest product offerings.

We recently recognized six companies, including multiple-category winners ParkUSA and New Pig Corp., for winning categories in Environmental Protection’s annual contest. Our 2015 contest attracted high-quality, innovative entries in every category, which is one more encouraging sign that the environmental marketplace is dynamic and growing. The competition was especially keen in categories such as health & safety/cleanup and wastewater. An independent panel of three highly qualified judges chose the winners.


I congratulate all of the entrants on their fine work and thank them for participating. We hope they’ll enter our 2016 contest, as well.

To be eligible for the 2015 awards, products must have been introduced to the market during the 2015 calendar year. Serving as judges in the contest were:

- Angela Neville, JD, energy law reporter for the Texas Lawyer newspaper and former editor of Environmental Protection
- Christopher Pai, a safety management consultant with ME-MIC (Maine Employers’ Mutual Insurance Company)
- Fred Elliott, a freelance author in Austin, Texas, who writes frequently on occupational safety and environmental protection issues for OH&ES EP


RECYCLING

The Bulb Eater 3 with Intelli Technology is the next generation of the Bulb Eater lamp crushing system. Crush straight fluorescent lamps of any length, CFLs, and u-tube lamps into 100% recyclable material while capturing over 99.99% of vapors released. In addition to providing OSHA and ACGIH compliance, the Bulb Eater 3 will reduce labor costs, minimize storage space by up to 80%, and saves up to 50% on recycling costs. Ensure facility compliance, worker safety and protect the environment by crushing your spent lamps. Air Cycle Corporation. CIRCLE 300 ON CARD

SOFTWARE/SAAS

WebInsight 9.0 saves EH&S professionals valuable time, eliminating the need to research and reference regulations from multiple sources scattered across numerous websites and/or published in a variety of formats. The intuitive user interface puts global EH&S compliance information at customers’ fingertips and gives them robust search, navigation, visualization, analytics, and regulation tracking capabilities, as well as the most current and relevant industry-specific regulatory content. 3E Company. CIRCLE 301 ON CARD

WASTEWATER

Flocculation of sludge in the dewatering process is required for efficient wastewater processing. The PolyCat™ is an improved batch-type blending and injection system compared to traditional polymer mixing systems. The PolyCat’s green design uses less energy and less polymer per pound of sludge treated. More efficient dewatering with the PolyCat also means less emissions inherent to solid waste transportation and disposal, which saves valuable landfill space. ParkUSA. CIRCLE 302 ON CARD
AIR QUALITY AND CLIMATE
The OdorTrooper™ Interceptor is an exhaust air treatment system designed for use with wastewater treatment equipment that emits hydrogen sulfide, VOCs, and other noxious gases. The OdorTrooper was developed to fill the need for an invisible, aesthetically pleasing solution. Common applications include pump stations and wastewater treatment plants. The pre-packaged system is placed underground adjacent to the odor-producing equipment. Exhausted air is piped through the OdorTrooper’s activated carbon canisters, absorbing organic impurities. The resulting air vented into the environment is safe, clean, and free from odor. ParkUSA.

WATER
Onset announced the HOBO MX2001, the industry’s first water level data logger designed for convenient wireless setup and download from mobile devices via Bluetooth Low Energy. The MX2001 dramatically simplifies and lowers the cost of field data collection by providing wireless access to high-accuracy water level and temperature measurements right from a mobile phone or tablet. Researchers no longer need to take a laptop computer out to the field or pull data loggers out of a well to download data. And, no Internet access is necessary; the logger and mobile device are all that’s required. Onset Computer Corporation.

HEALTH & SAFETY/CLEANUP
EXAIR’s High Lift Reversible Drum Vac is ideal for the recovery of fluids like: coolant, hydraulic oils, sludge and chips, wastewater, tramp oil, and liquid spills. The High Lift Reversible Drum Vac has been engineered to recover liquids found within below-grade sumps, wells, underground tanks, pits, and drains with up to 15’ of lift. The powerful vacuum can fill a 55-gallon drum in just 85 seconds from 15’ and, with the turn of a knob, the same stainless steel pump can quickly empty the drum. High Lift Reversible Drum Vac Systems include the two-way pump assembly, 20’ (3m) flexible vacuum hose (1-1/2”/38mm I.D.) with 90-degree quick release elbow connection and one aluminum wand. EXAIR Corporation.

NEW TECHNOLOGY - INDUSTRY
New Pig’s Battery Acid Spill Kit in Cart is prepacked with everything needed to respond to a battery acid spill: PIG Battery Acid Encapsulating and Neutralizing Mats, Loose and Socks; PIG Battery Acid Cleaner and Neutralizer Wipes; disposal bags and cleanup tools; gloves, goggles, faceshield/keadgear; instructions. The cart is highly portable with 8-inch wheels and is high-visibility yellow for easy locating in the event of a spill. The cart features swing-out doors, prepacked shelves, and compartments that allow for easy access to all materials. The cart is also lockable for security. New Pig.

WASTE
The ZooTrooper™ Interceptor is a wastewater solids separator specifically designed for animal habitats such as zoo enclosures, livestock barns, and pet kennels. The ZooTrooper unit features a compact and efficient design that separates organic solid wastes from the sewer-bound wastewater. The unique, robust design allows for easy end-user maintenance and reduces expensive third-party pump-out costs. The ZooTrooper’s green design alleviates emissions inherent to waste transportation and disposal, saving valuable landfill space. The organic solids are simply collected and composted for on-site landscaping use. ParkUSA.

ENVIRONMENTAL MANAGEMENT
New Pig introduces the PIG Spill Response Tactics Training DVD. The film allows for spill control training straight from the experts. The original content is presented in easy-to-understand ways. The language is plain and allows the learner to remember content in high-pressure situations. The disc includes 15 modules lasting from two to six minutes each. The fast-paced training is informative, educational, and entertaining. The content is focused on incidental spills of 55 gallons or less, but the tactics and practices could be applied to spills of any size. New Pig.
Installing new production processes or upgrading and expanding existing lines requires a review of the expected emissions. The right emission control system for Hazardous Air Pollutants (HAPs) and Volatile Organic Compounds (VOCs) can help efficiently and economically dispose of these environmentally hazardous wastes. Over the last 20 years, as emission limits have tightened and authorities have taken a more “holistic” plant-wide approach to air permits, the trend in the chemical processing industry has been to collect multiple waste streams plant wide for control in a single thermal oxidation system, despite the required additional source ducting and piping. This trend has been driven by an array of factors, including:

- Rising fossil fuel prices
- Tightening of emission limits for VOCs, HAPs, NOx, and CO
- Goals for the reduction of a plant’s carbon footprint
- Increasing cost for disposal of organic waste liquids
- Minimizing the number of control systems to be maintained and points of emission monitoring and testing

All of these are key for companies increasingly committed to energy-efficient, sustainable production. The benefits of a single, centralized thermal oxidation system can be best illustrated with a case study on the experience of a plant that recently added emission controls to many existing production processes.

Two types of thermal oxidizers are most frequently applied in the chemical processing industry: regenerative thermal oxidizers (RTOs) and direct fired thermal oxidizers (DFTOs), also known as afterburners. RTOs offer high thermal efficiency and very low fuel requirements for plants that generate dilute air streams contaminated with low concentrations of VOCs and HAPs. However, a DFTO is the best choice when:

- Production processes demand steam energy
- Required destruction efficiency is greater than 99.5 percent
- Highly caloric off gases with low oxygen must be handled
- High loading of halogenated or sulfurous compounds are expected (acid generators)
- Destruction of waste liquids is needed

Many excellent guides and articles address the selection process between different types of oxidizers. This paper focuses on the DFTO exclusively.

A company manufacturing organic intermediates for the pharmaceutical and fertilizer industry decided to install a direct fired thermal oxidizer system to handle all liquid and gaseous waste streams from their many small to mid-size process reactors and storage tank vents. The DFTO is designed to handle a wide range of wastes, including organic compounds containing halogens, sulfur, and nitrogen. The system consists of the required liquid pipe trains and storage tanks, process off gas pipe trains including explosion protection equipment, oxidation chamber, fire tube waste heat steam boiler, economizer, scrubber for acid gas removal, selective catalytic reduction (SCR) system for NOx removal, an induced draft system fan, and stack including emission monitoring system.

Components in a modular DFTO system can be selected based upon the waste stream contaminants.

**Waste Liquids and Off Gas Sources**

The liquid wastes are accumulated from a number of sources across the plant and collected in a storage tank. The small storage tank was sized to accommodate the effluents from periodic tank cleaning processes. At this particular plant, all of the waste liquids are purely organic and have a consistent high caloric value, which allows them to be fired directly through the thermal oxidizer’s dual fuel burner system. After start-up, these systems can run entirely on the waste liquid fuel. Although not needed at this facility, a second system is sometimes used to collect liquid wastes with low or inconsistent caloric value or high water...
content. These wastes are atomized into the oxidation chamber adjacent to the burner through secondary injection lances.

In addition to the liquid wastes, a total of six process off gas streams are controlled by the thermal oxidizer system. Each off gas is handled by an independent control train and injected separately into the oxidation chamber. One stream is drawn from nitrogen-blanketed storage tanks using a blower, designed to handle potentially explosive gases, to maintain a slight negative pressure. The remaining streams come from process reactors under pressure and can be routed to the oxidation chamber without blowers. The volume of off gas and VOC caloric content of each stream is highly variable, especially for several batch reactors and for the storage tanks that vent the most VOC during filling operations. These large variations of flow and loading lead to the first major benefit of a single, centralized DFTO system.

Multiple skid-mounted off gas piping control trains.

During preliminary engineering of the emission controls, consideration was given to multiple, smaller DFTO systems installed local to each process gas source. This arrangement has the advantage of minimizing the cost of the off gas collection system duct work and keeping each process fully independent. However, as the off gas sources were analyzed, it was determined that each DFTO would need to be designed for the peak off gas volume and caloric content required for that source under start-up or upset conditions, resulting in large oxidizer size. Furthermore, the much lower “normal” off gas flow is then difficult to handle efficiently in the large oxidizer. Designing for this high turndown is especially challenging for the several batch reactor processes.

Bringing all of these off gas streams to a single, centralized DFTO makes it possible to design for the peak VOC loading on several, but not necessarily all, processes simultaneously. This reduces overall system size and capital cost, while improving turndown and DFTO efficiency under normal operation. The availability of the organic waste liquids to the centralized DFTO also has a stabilizing effect on operation as the storage tank allows injection of liquids to cease during periods of maximum off gas loading (while collection in the tank continues) and to resume providing supplemental heat during periods of low off gas loading.

The overall impact of the centralized DFTO is a significant reduction in natural gas (or other supplemental fuel) usage and thus the plant’s utility budget. By minimizing supplemental fuel usage, a corresponding reduction in the plant’s carbon footprint is achieved. Whether greenhouse gas (GHG) emission reductions are mandated, as they are in Europe, or whether they are voluntary, this is an increasingly important consideration for many companies.

Process Steam

Many chemical plants generate and use steam on site for various process and heating requirements. The flue gas from a DFTO oxidation chamber is a source of high-quality waste heat at 1,600 to 2,200 degrees F that is easily convertible to saturated or superheated steam to supplement the facility’s gas, oil, or coal-fired boilers and reduce their fossil fuel usage. To do this, the refractory lined oxidation chamber of the DFTO is simply transitioned to mate with the boiler inlet.

Numerous considerations affect the boiler design and selection, including:

- The desired steam pressure
- Requirement for superheated steam
- Presence of halogens or sulfur that generate acid gases
- The presence of silicon, phosphorous, metals, and other dust-forming compounds

In this case, the system includes a fire tube waste heat boiler to generate medium-pressure saturated steam, followed by a super-heater and an economizer for preheat of boiler feed water. High concentrations of hydrochloric and hydrobromic acid in the oxidizer flue gas result in a design that limits the heat recovery in the economizer to keep the outlet temperature above acid dew point under all operating scenarios. In addition, due to the distance from the facility’s main boiler house, the system included a boiler feed water tank with redundant pumps and a deaerator for returning condensate.

Once again, a single, centralized DFTO when compared to multiple local units is significantly more beneficial. To achieve the same steam production, the capital cost is much lower for a single waste heat boiler system with high utilization than for multiple boilers connected to localized DFTOs. Waste heat boilers for localized DFTOs must be designed and sized for the peak flow and heat load from each oxidizer but will normally operate at just a fraction of that design capacity. It is obvious that the boilers themselves are capital intensive, but a single centralized waste heat boiler also minimizes installation costs associated with piping for boiler feed water, steam supply, and blow down. The number of boiler start-up and shutdown cycles is reduced, increasing the longevity of the equipment and minimizing the time demands on boiler operators. The net effect is an improvement in the payback that justifies waste heat recovery as steam. By choosing to recover waste heat, the plant further reduced its overall fossil fuel consumption and carbon footprint.

Acid Scrubber

After exiting the economizer, the flue gas is directed to a quench and acid scrubber. The quench cools and saturates the flue gas stream with water spray nozzles and flooded walls. The quench discharges the flue gas and water into the base of a vertical flow, packed column scrubber where HCl, Cl2, HBr, Br2, HF, and SO2 are absorbed and neutralized with NaOH solution. The scrubber removes over 99 percent of these contaminants; however, taller columns and multiple stages can be used to achieve greater than 99.9 percent removal. Fifty percent NaOH is available as a utility at this facility and feeds a day-tank from which redundant pumps dose it into the recirculated scrubber wash water to control the pH.

The waste liquid and three of the six off gas streams currently contain halogens requiring scrubbing downstream of the oxidizer, with the vast majority coming from methylene chloride in the waste liquid. Prior to installation of the new DFTO system, these halogenated liquids were transferred to tanker trucks and disposed of off site at significant expense ($0.20 to $0.50 per gallon). As with the waste heat boiler, adding a scrubber to the single centralized DFTO system has a significant capital cost advantage.
Selective Catalytic Reduction of NOx

In recent years, regulatory authorities have focused more and more on reducing NOx emissions from combustion processes, and oxidizers are no exception. In the case of a boiler or process heater, the majority of NOx emissions form as “thermal NOx” from N2 in the flame front of gas- and oil-fired burners. In the case under study here, the vast majority of the expected NOx comes from the oxidation of amines and other VOCs containing nitrogen in the plant’s off gases and waste liquids. Several alternative approaches for NOx reduction were evaluated, including non-catalytic reduction in the oxidation chamber, before selective catalytic reduction (SCR) was chosen based on the high conversion efficiency required to meet the very low emission targets. SCR also offers the advantage that the catalyst used to reduce NOx also favors the destruction of trace dioxins and furans formed during the oxidation of chlorinated compounds.

Because the flue gas exiting the scrubber is saturated and contains trace acids, the SCR system begins with a pre-heater module to raise the flue gas temperature above its dew point by mixing a small volume of hot air recirculated from downstream. This module is constructed in alloys resistant to chloride corrosion. The DFTO system’s redundant draft fans follow the pre-heater and are operated on variable frequency drives to maintain a pressure in the oxidation chamber slightly negative to atmosphere. The flue gas then enters a recuperative heat exchanger that recovers heat from the SCR outlet (the reduction process is exothermic) to bring the flue gas up to reduction temperature. Finally, an aqueous ammonia reducing agent is sprayed into the stream, metered precisely to match the measured incoming NOx, before the flue gas enters the catalyst beds, where greater than 95 percent of the NOx is converted to N2 and H2O. The flue gas then passes through the other side of the heat exchanger on its way to the system stack, where it exhausts to atmosphere at about 200 degrees F. Continuous emissions monitoring equipment in the stack, as required by the plant’s air permit, tracks exhaust concentrations of total hydrocarbon, hydrochloric acid, and NOx to confirm proper operation of the system.

The low NOx emission required for this system was another factor in the selection of a single, centralized DFTO system; the SCR system is capital intensive, including expensive precious metal catalyst, heat exchanger, and flue gas analyzers. The DFTO system benefited the company by:

- Maximizing the destruction efficiency of VOCs and HAPs
- Reducing NOx emissions well below the permit limits
- Eliminating expenses for off-site waste liquid disposal
- Reducing fuel demand by using wastes to generate steam
- Minimizing maintenance costs by installing one system

Jon Hommes was an Engineer in the Clean Technology Systems business unit of Dürr Systems, Inc. in Southfield, Mich., for more than 19 years. Contact Dürr Systems at 248-450-2000, email CTSales@durrusa.com, or www.durr-cleantechnology.com.
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