Kyle Hankinson is the President of KCH Engineered Systems, a national leader in the design and manufacture of industrial ventilation systems and wet process lines for the surface finishing industry. He has authored various articles of energy conservation techniques on wet process lines and has over 20 years of experience in our industry, traveling to many job and captive shops within North America.

Designing Process Lines to Minimize Energy Costs and Risk

by Kyle Hankinson, khankinson@kchservices.com

Many surface finishing companies have seen their power bills increase more dramatically in recent years. Some of these increases are due to recent environmental and economic conditions. A multi-billion-dollar ash cleanup process for coal power plants will likely be offset to customers in the coming years. A recent cancellation of a US regional nuclear facility under construction, has costed billions of dollars with nothing to show, and will likely be offset to customers over many years. For finishers, the operational cost of heating, cooling, and ventilating buildings and processes can add up to a significant dollar amount.

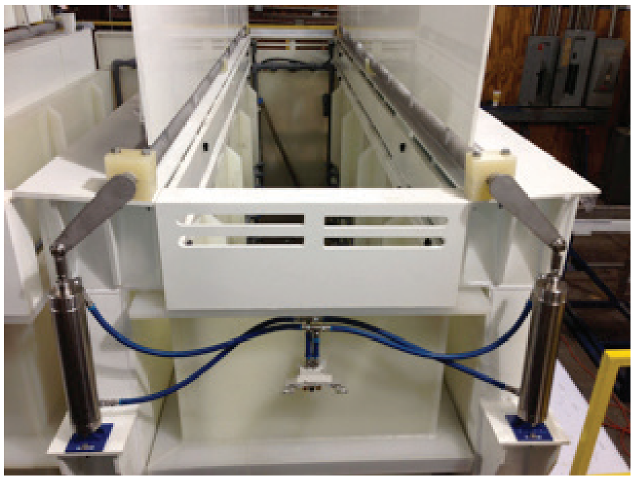

Figure 1: Tank with cover open.

The use of mechanical covers in process lines can save heating and cooling losses, as compared to a typical open surfaced process line. Integrating the covers with a well-engineered ventilation system will conserve tremendous amounts of energy required to properly control tank emissions.

For controlling airborne contaminant exposure to employees, the concept is simple. Covering a tank reduces the open surface area, thus limiting employee exposure to the contaminants evolving from the liquid surface of the tank.

Covering a Tank

Traditional metal finishing lines have open surface tanks. Calculating surface area is a main component of sizing a local exhaust ventilation system. Covering a tank will reduce the exposed liquid surface, reducing the calculated area necessary for properly sizing a ventilation system to control tank emissions.

Figure 2: Tank with cover closed.

A lower surface area requires smaller hoods, duct, control device, exhaust fan, and therefore, a decrease in capital and operational costs.

Many companies have tried the use of basic covers over their tanks. This undoubtedly can help, but the number one problem with a simple cover is that it is removable. Removable covers are cumbersome and a hassle for operators to handle.

Chemistry will drip on the floor from where it is taken off the tank to where it is stored. Usually, after about a couple messy weeks of this practice, the covers will remain in storage and never be used again. That very reason is why mechanical covers should be designed integral to the process line.

Mechanical Covers

A mechanical cover is permanently mounted on the sides or back of a tank. Depending upon space constraints, it can be single hinged, double hinged, or double covers, similar to a horizontally mounted bedroom closet, or French doors. Connected to the cover and mounted to a side wall bracket on the tank is an actuator. The actuator raises and lowers the cover, and can be electromechanical, pneumatic, or hydraulically powered.

Most are linear motion, but other types are available. When an operator needs to add or remove a part to be processed, he or she simply presses the up/down push button control mounted on the operator side of the tank, which triggers the actuator to open or close the cover.

Many existing tanks were designed without the idea of being able to cover the process. Therefore, bussing, fixtures, and utilities can make covering a tank very difficult. “Cluster bussing” is popular in some chrome plating shops.

A tank can be retrofitted, though, by “cleaning up” the bussing, fixture, and piping configurations. A taller side wall and rim can be welded on top of the existing rim, extending the overall height of the tank, and the freeboard inside the tank. After extending the sidewall, the bussing and utilities can be installed through the new sidewall just below the rim. Now a new cover can be mounted over the new rim along with the exhaust hoods.

An alternative to raising the sidewall of an existing tank is to design a cover with enough depth or height to clear the bussing, fixtures, and utilities. It may need to be notched in certain areas, but the main key is reducing the majority of exposed surface area. Figure 1 shows a tank with the covers open. Figure 2 shows the same tank with the covers closed.

Integrating Covers with LEV Systems

If properly designed, incorporating a local exhaust ventilation (LEV) system with the use of covers can yield significant operational cost savings versus exhausting a line without covers. Tanks with covers incorporate a lateral, low-profile-type exhaust hood for contaminant control and removal. When a tank cover is in the closed position, the amount of exhaust required to control tank emissions is only a fraction of that when the cover is in the open position.

Figure 3: Automatic line and smart tank covers integrated into the exhaust system.

A volume damper in the exhaust hood is interlocked with the cover. When the cover is in the open position, the volume damper is open, increasing the capture velocity through the exhaust hood to properly control contaminants from the open tank surface.

When the cover closes, the volume damper closes, only allowing minimal exhaust at the lateral hood to prevent fugitive emissions from escaping the enclosed tank area. A slightly negative air pressure is maintained inside the enclosed tank area. This also eliminates the risk of hydrogen or other combustible gas explosions, which can form during a plating process.

Automatic Hoist Lines

Most automatic lines have one hoist transporting parts from station to station over open surface tanks. Automated mechanical covers with lateral exhaust hoods can be installed to cut down on the total volume of air that is exhausted from the line. As mentioned earlier, the covers are linked to an automatic volume damper in the exhaust hood, which will open and close in tandem with the cover. All covers on the line will be closed, except when parts are being lowered into or lifted from the tank.

Therefore, a ventilation system on a one-hoist automatic line with 10 covered tanks will be sized based on only one cover being open at any one time. That one open tank will be exhausting at full ventilation rate, while the other nine covered tanks are exhausting at a percentage (i.e., 10%) of the full rate. For example, the open tank will be exhausting at 1,000 CFM while the other closed tanks are exhausting at 100 CFM each (10% of the open tank).

The total CFM requirement is calculated below:

Nine closed tanks x 100 CFM each = 900 CFM
900 CFM + 1,000 CFM for the open tank = 1,900 Total CFM. The same automatic line without the covers would have the following exhaust system size calculation: 10 open tanks x 1,000 CFM each = 10,000 CFM

In this very basic example, the total net savings of using covers is 8,100 CFM, or approximately an 80% reduction in system sizing. This is very significant in terms of energy and initial cost savings. Figure 3 shows automatic lines with covered tanks incorporated with the exhaust and makeup air system.

A Case Study of Operational Cost Savings

The U.S. Environmental Protection Agency (EPA) assessed the performance characteristics of environmental technologies such as Automatic Covered Tanks.

A semi-automatic chemical etch line utilizing covered tanks integrated with local exhaust ventilation was evaluated by an independent contractor in cooperation with the EPA. The evaluation was to verify the performance of the installation and compare the capital and operational costs with that of a traditional finishing line without covers.

The test results reveal that utilizing covers result in an operational cost savings of $62,978 per year2. The total operational cost savings are a sum of individual components measured in the test. The components include a reduction in tank heating requirements, air volume, and pump and fan horsepower. Also included is a reduction in operation and maintenance costs due to reduced chemicals, water treatment, scrubber media replacement, and labor. These operational savings add up to greater than $1 Million Dollars in electrical cost savings over a mere 15 years of operating the process line.

An additional $61,283 was also saved in initial capital costs due to the smaller sizing of the fume scrubber, scrubber pump, ducting, exhaust fan, and installation cost.

The covered tank system was verified by the EPA/ETV program to be a proven method for energy conservation. Further information on this study can be accessed on the KCH website at http://kchservices.com/products/process-tanks

Regulatory Considerations

As many know, the Department of Labor's Occupational Safety and Health Administration (OSHA) has strict standards for occupational exposure to hexavalent chromium. The current permissible exposure limit (PEL) is 5 µg/m3 based on an eight-hour time weighted average.
Over the past year, the State of California's South Coast Air Quality Management District (SCAQMD) has ordered multiple finishers to temporarily shut down their chromium processes3. These operational suspensions are due to exceedances of the agency's recently enforced limit of 1 nanogram of hexavalent chromium per cubic meter, at the property line. The agency is concerned that fugitive emissions are escaping the facilities and creating a danger to neighboring businesses and residents. The implementation of mechanical process covers on new and existing lines will allow companies to take proactive steps to prevent these business interruptions. Covering an open process tank can drastically cut down on cross drafts, poor ventilation rates, and other causes of fugitive emissions. The SCAQMD Proposed Rule 1469 recommends the use of tank covers to reduce hexavalent chromium emissions from a tank. The US EPA Plating and Polishing rule, finalized in 2008, also recommends the use of process covers for compliance, whenever possible.

The American National Standards Institute (ANSI) and American Society of Safety Professionals (ASSP) are organizations that publish national design standards. ANSI/ASSP Standard Z9.1 establishes design criteria for Ventilation and Control of Airborne Contaminants During Open-Surface Tank Operations4. This standard was recently updated to include the recommended use of process covers to help protect the health of personnel engaged in open surface tank operations.

Sustainable Benefits

Sustainable design has a significant presence in large corporate operations and is beginning to trickle down to design requirements in smaller operations. There are multiple sustainability benefits of designing process covers into a surface finishing line. **A reduction in all of the following is expected:**

- Employee Exposure to Airborne Tank Emissions
- Fall Hazards into open top tanks
- Employer Exposure (lawsuits)
- Tank Heat Loss – by covering
- Water Consumption – due to condensation recovery of evaporative losses

- Humidity in the finishing plant
- Building and Equipment Corrosion
- Exhaust Airflow Volume
- Tempered Makeup Air Volume
- Ventilation Equipment Cost/Footprint
- Operational Cost
- Overall Energy Consumption

Summary

The importance of protecting the worker from hazardous chemical exposure outweighs all other factors when designing an industrial ventilation system for wet process lines. A complete understanding of airflow and controlling tank emissions is required. Incorporating a properly designed exhaust system, with automatic covers and volume dampers operating in tandem, can create tremendous pollution prevention and energy savings, especially today, where energy costs alone could make the difference between profit and peril. Regulatory agencies and standards organizations are both incorporating language recommending or even requiring the use of process covers on open tanks.

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About the Author

Kyle Hankinson is the President of KCH Engineered Systems, a national leader in the design and manufacture of industrial ventilation systems and wet process lines for the surface finishing industry. He has authored various articles of energy conservation techniques on wet process lines and has over 20 years of experience in our industry, traveling to many job and captive shops within North America.

Kyle holds a Bachelor's of Science Degree from North Carolina State University, along with Commercial and Airline Transport Pilot Ratings in Helicopters and Airplanes with the FAA. He also recently earned the US Coast Guard Captain's License to operate marine vessels up to 100 Tons.

Kyle is very active within the Surface Finishing Industry and is a Certified Electroplater Finisher (CEF). He has previously served on the local level as an AESF Branch President, has served on NASF Board of Directors for the past 5 years. Kyle has served on the NASF SUR/FIN Steering Committee for 8 years and also represents the industry on the American Society of Safety Professionals, Z9 Committee for Industrial Ventilation Standards.

Kyle served in the Army for nearly 10 years as a Chief Warrant Officer and Pilot in Command of the AH-64D Gunship. He is currently in the Inactive Ready Reserves.