TREK Liquid Lock

By: Patrick Oliver, Senior Sales Engineer
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The TREK Liquid Lock is an integrated resource management system for conveyorized inline cleaning systems. TREK's Liquid Lock reduces operating cost of the cleaning process by saving cleaning agent, water and power. The TREK Liquid Lock also minimizes the environmental impact of the cleaning process.

Background

Inline conveyor cleaners provide high throughput precision cleaning of various parts including electronics, optics, stampings, castings, etc. High-pressure spray is frequently used to introduce energy to the cleaning process for the mechanical removal of tenacious soils. In addition to mechanical energy, the cleaning process often requires the use of a cleaning agent to dissolve contaminants or to enable penetration of small spaces by reducing surface tension.

Cleaning agents can add significant cost to a cleaning process, especially in-line processes, which tend to consume larger volumes of chemistry due to inherent design features of this equipment, such as:

Exhaust

High-pressure spray atomizes cleaning agent in the wash stage. To prevent atomized cleaning agent entering the room where the cleaner is installed, negative pressure exhaust is required. Exhaust helps isolate the wash and rinse stages by preventing unwanted migration of cleaning agent aerosol within the cleaner. Exhausting atomized cleaning agent leads to loss. And, as the cleaning agent solution is exhausted from the cleaner, it is released into the environment.

Dragout

Dragout refers to cleaning agent that leaves the wash stage of the inline cleaning process on the parts being cleaned as well as the conveyor belt. Dragout accounts for cleaning agent losses not related to exhaust. Dragged out cleaning agent typically ends up in a subsequent rinse stage if the cleaner is so configured. In that case, the cleaning agent becomes dissolved in the rinse water and will increase in concentration as the process runs. Dragout is an inevitable factor of most cleaning processes which contributes to chemical consumption.

Evaporation

Most cleaning agents used in inline cleaners are in an aqueous solution, so the atomization and evaporation of water follows. The cleaning agent solution is typically heated, so as the hot cleaning agent solution vapors escape the cleaner, power is required to operate the electric resistance heaters that attempt to maintain the solution temperature. Psychrometrics compound the problem as hotter air holds more moisture, thus losses of cleaning agent, water and power are directly proportional to the temperature of the spray process.

Cleaning equipment manufacturers, over the years, have introduced various chemistry conservation techniques to help with the consumption problem, such as exhaust demisters that capture and reclaim chemistry or air isolation knives that strip and reclaim chemistry from the product and conveyor. None of these techniques have drastically reduced the chemical consumption problem that is inherent to in-line cleaning equipment**. Liquid Lock does**.

Liquid Lock

The Liquid Lock technology was originally developed by Trek for their semi-aqueous inline cleaning process that uses terpenes or aliphatic hydrocarbon cleaning agents to remove rosin-based flux from printed circuit boards. Normally semi-aqueous inline cleaners require spray under immersion wash stages that increase footprint, complicate material handling, may create part movement and typically require larger spray pumps. The Liquid Lock technology allows hydrocarbon cleaning agents to be sprayed in air without creating a combustion atmosphere, thus eliminating the need for nitrogen inerting or other complex means to reduce direct sources of ignition typically associated with spraying hydrocarbons. Trek then began experimenting with the Liquid Lock technology in their line of aqueous cleaners and soon discovered that Liquid Lock drastically reduced chemical consumption in the wash and, at the same time, conserved water and power.

How Does Liquid Lock Work?

The Liquid Lock encloses the spray stage of an inline cleaner within a laminar flow that effectively "locks" the atomized and aerosoled cleaning agent within the confines of the locked wash zone. The liquid that comprises the locks is the same fluid being sprayed in the wash stage, which is pumped from the wash stage reservoir and cascades over specially designed weirs to enclose the entire spray zone. The laminar liquid locks are located at the entrance and exit of the wash stage. The spray zone is fully enclosed, with the only way in and out being through the liquid lock. Atomized and aerosoled cleaning agent solution drawn into the laminar flow of the liquid locks rejoins the rest of the fluid in the wash stage reservoir. This locking process drastically reduces the exhaust requirement for the cleaning system, and thus reduces emissions of cleaning agent and water while minimizing the environmental impact of the cleaning process. Cleaning agent solution consumption, and the power required to heat it, is directly proportional to the volume of cleaning agent flowing through the spray nozzles. It should be noted that the conservation benefits of Liquid Lock increase in direct proportion to the length of the spray zone and the number of nozzles within that zone. Cleaning agent conservation can be up to 75% in certain applications as compared to conventional designs. The reduced exhaust requirement also minimizes the consumption of facility-conditioned air and thus reduces the heating, cooling and filtration costs of the room in which the cleaner is located. Facility related reduction of operating cost is especially significant if the cleaning system is located in a clean room environment. Reduced exhaust volume also minimizes the capital requirement for costly mist eliminators in the exhaust system, and eliminates the maintenance cost associated with those devices. Diminished consumption of cleaning agent reduces operator exposure to cleaning agents by lowering the volume of makeup cleaning agent that must be added to maintain the required operating concentration. Reducing the consumption of cleaning agent creates a more stable cleaning process because the concentrations of cleaning agent and water are less dynamic. Results of the cleaning process are therefore more repeatable and predictable. Reduction of exhausted cleaning agent can also mean less impact on the building in which the cleaner is located. For instance, if the cleaner's exhaust stack exits through the facility roof, cleaning agent residue can damage the roof: hydrocarbon-based cleaning agents can damage asphalt roofing surfaces, and alkaline-based cleaning agents can damage aluminum, galvanized or painted surfaces. The emission of cleaning agents also has an ecological impact with possible detrimental effects to terrestrial and aquatic life.

Conclusion: The return on investment for a Liquid Lock inline cleaner is obviously most attractive for containment of cleaning agents that are relatively expensive or used in higher concentrations. As an example, a modest savings of 7.5 gallons per day in an actual application provided an annual chemical cost saving of about $70,000.

The heating requirements for maintaining spray temperature of 120^{O}F would normally be about 30 kW. This requirement can be reduced by 75% to about 7.5 kW. For an energy savings of 22.5 kW at 7 cents/ kW Hr as an example, the annual energy savings would be about $14,750 operating on a 24/7 basis. It would be $3,300 operating single shift, weekends off.

For More Information:
Stoelting
502 Highway 67
Kiel, WI 53042-1600
www.stoeltingcleaning.com
www.trekindustries.com

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