Chemical Milling Process Line Improvements

KCH SURFACE FINISHING
AN ECS COMPANY

Case Study Project Details

Client: Confidential designer and supplier of components for United States government programs.
Chemistry: Licensed to process radioactive materials.
Applications: This client site is also skilled in radioactive material blending applications.

Background

The facility currently utilizes a manual chemical milling process line with an open tank design. This process line is used to etch different sizes and configurations of ingots, within very specific tolerances, to be used in nuclear plate-type reactors. Chemical milling processing is an efficient and economical step in the manufacturing of these critical components, achieved by immersing intricate components in a series of chemical baths, covering the complex profile. The material is reduced evenly in all dimensions. This alleviates some or all of the need for designing special tooling, to get into awkward corners.

Control parameters in such an operation are critical. There are five key criteria: the concentration of the solution, its temperature, additive dosing volumes, the time the parts are in process and the agitation of the solution. In this particular case, the chemical process is already specified and proven. Our goal was to create a process line that is mechanically more efficient and environmentally friendly, without compromising these set standards.

The existing process line relies heavily on human interaction which causes several problematic scenarios. Our objective with this project was to design a new chemical milling process line that incorporates personnel safety, environmental compliance, product standardization and energy conservation.

Situational Challenges: Personnel Safety

All personnel are held to OSHA standards as well as more stringent in house regulations when it comes to safety. The chemical milling process consists of highly dangerous chemistries including but not limited to Hydrofluoric Acid, Hydrochloric Acid, Nitric Acid, Sodium Hydroxide and Deionized water at boiling temperatures. This chemical makeup requires an abundance of Personal Protective Equipment (PPE) including respirators, rubber boots, aprons, safety glasses and splash shields.

Process technicians are also working on elevated platforms placing them in close proximity to the large open process tanks. All OSHA standards and practices must be followed including safety showers/eye washes, hand rails, toe plates, stair design and pinch points.

Environmental Compliance

The current process line utilizes a typical wet scrubber ventilation system with exhaust hoods located on the rim of the tanks. Since the process tanks have a large open surface area, fugitive emissions were putting personnel at risk to exposure, thus requiring additional PPE (respirators) as well as damaging nearby equipment such as overhead hoists and steel structural components. The emissions that are captured within the hoods, travel through the duct system into the existing wet scrubber (designed to neutralize the acidic gas stream) through the exhaust fan and exiting the stack. During certain processes a dark plume would become visible. This is potentially problematic due to regulations requiring the customer to maintain a certain opacity limit as well as maintaining a healthy outside environment.

Product Standardization

The client currently has a specified chemical process which is held to tight standards with little or no deviation allowed. To change components of the actual chemical process would command a complete engineering review, test parts evaluated, and a full report of the findings must be finalized and approved by multiple in-house departments. This process takes several months and would not be feasible in this case. That is not to say that the process equipment could not be designed to stabilize the chemical environment as well as improve the efficiency of the process chemistry.

Energy Conservation

The current process line is designed to utilize all components at maximum capacity (fans, pumps, tank heaters, ventilation & solution agitation) at all times with the exception of a shutdown. This creates wasted energy and resources while production runs in shifts, and can be dictated by demand. It is not economical to power down these major components during an off shift due to the time and energy required to bring the process line back up to operational parameters.

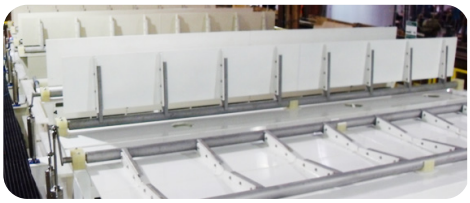
Solution

KCH approached this project in a joint venture with the clients engineering group to combine our knowledge in our respective fields. KCH provided the complete design of a semi-automated chemical milling process line (following the set specifications initially provided by the customer) complete with ventilation, environmental controls and covered tanks. The client was then able to determine that the chemical process would not change and the line could be implemented without further product testing during the design phase of this project. To get to this point we had to evaluate each of our 4 problematic scenarios and incorporate the appropriate components needed.

Personnel Safety

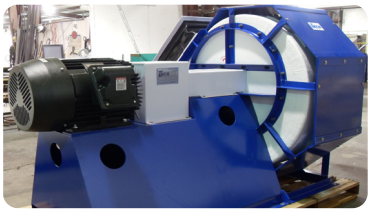
The new process line incorporated all OSHA and internal regulations: This included properly designed catwalks, stairs, handrails, toe plates, safety shower/eye wash stations, splash guards, automated covers and KCH engineered ventilation system, designed and built in house at KCH in Forest City, NC.

The new process line incorporated covered tanks specifically engineered for this project. *The covered tank design considerably reduces exposure to the hazardous chemistry by the process technicians as well as reduces the overall need for ventilation and make-up air.*



Along with this covered tank design we incorporated a two hand chemical resistant optical relay to insure the safety of any associated personnel. This system requires the technician to contact both finger sensors at the same time in order to close the covers. If either contact is broken the covers stop all movement immediately.

Two hand, finger sensors address any possible dangerous situations which may involve pinch points around the tank covers. Guards were also added to enclose any moving components as well as clear Lexan splash shields on all open tank surfaces accessible by personnel.



Since personnel safety is the highest priority, the KCH Engineering Department went one step further when designing the exhaust ventilation fans. *These direct drive fans are not only highly efficient with programmable variable frequency drive motors they were also designed to contain any foreign debris that may result in a catastrophic failure.*

Environmental Compliance and Energy Conservation

We designed a state of the art ventilation system that not only exceeded all expectations during testing, but was 65% more efficient than the existing process line. By designing a covered tank system, the ventilation capacity was reduced from 29,000 cfm to 11,000 cfm, further aided by the energy savings produced by the programmable variable frequency drives on the exhaust fans, which ramp up and down as the associated covers are opened or closed. The make-up air was also reduced respectively and with covered tanks the heat loss is minimized.

Product Standardization

With design upgrades, concentration and temperature of the solution is now aided by the covers on the tanks. We have considerably less solution evaporation as compared to an open tank, as well as tighter controls on the temperature, with less heat loss to the atmosphere. Smaller heaters provided more energy savings, while additive dosing volumes were automated to allow tighter control of chemical makeup in the tank. The solution agitation was upgraded to a highly efficient eductor system, as opposed to air agitation which not only provided an improved solution coverage of the part- but also reduces emissions from the tank. With these tighter controls of the chemistries in each tank, the operational range required before a part can be processed, in less processing time.