Safety valves provide zero leakage

Y-shaped valves save operating costs in ethylene copolymer unit

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The Orange, TX-based Sabine River Ethylene/Ethylene Copolymers Complex, operated by E.I. DuPont de Nemours & Co.'s Packaging and Industrial Polymers Div. produces ethylene copolymer intermediate product used in the manufacture of various consumer items.

Three fire-protection vent valves on each process unit became coated with the waxy polymers produced in the reactors. The valves were not providing tight shut-offs causing leakage that resulted in unit outages to repair the leaks. DuPont personnel repaired these valves so many times that the bodies were thin and became warped during operation, further hindering their performance.

Y-conduit valves provide soft-seat, bubble-tight shutoff at pressures to 8,000 psi in fire protection vent application.

The plant solved the problem using custom-designed safety valves. The bubble-tight valves reduce outage time because they can be used when depressurizing with nitrogen. In emergencies the valves evacuate the systems in 2 sec.

In addition to solving the intended problem, the new valves save 5 hr of run time for the unit, saving considerable operating costs.

Sticky polymer coats valves

DuPont's Sabine River plant produces ethylene copolymer pellets in a process that includes three high-pressure auto-clave units by mixing high-pressure gaseous ethylene, which is highly reactive, with other chemicals.

The heated mixture reacts to form the waxy polymer that is separated from unreacted material and made into pellets. Leftover ethylene material is recycled back through the system. As a result of this process, the interior of the unit becomes glazed with a hard, sticky polymer coating.

Within the gas-process piping on each of the ethylene units are three Y-shaped "Y-conduit" fire-protection vent valves, which are used to release ethylene from the system in an emergency. There was much concern to safely release the ethylene as quickly as possible because of the potential for a catastrophic event. The shape of the valve allowed full-port venting in a few seconds.

Each unit has two low-pressure (3,000 psi) valves and a high-pressure (8,000 psi) valve for a total of nine 1 1-2-in valves on the three units and one spare for each pressure range.

Polymer buildup on the walls ages after several weeks to form a hard, black, brittle coating. When the valve dumps, the extremely high velocity caused by the rapid venting allows particles to break off the walls of the vessel and travel out, some getting caught on the valve seat.

"We require zero-leakage valves to meet our safety requirements, as well as those of the regulatory agencies," says DuPont's Senior Area Engineer Lou Trahan. "The copolymer residue collected inside these valves presented a leakage problem by preventing a positive shutoff on these valves once they were opened. We were concerned with the environmental and safety impact of the leakage."

Excess cost/low reliability

"High maintenance costs and low reliability were the big problems with these valves," Trahan continues. "We would have to shut the autoclave unit down to remove the leaking 300-lb valve for repair. After replacing the valve with a spare, it would take a crew of two technicians and one engineer about two weeks to rebuild the valve. Concerned about completing the repair before another emergency, we scheduled two crews, each working 8-hr to 12-hr shifts to get the failed valve back to a ready, standby condition. Fortunately, we never had two units down at once.

Shop personnel rebuilt the valves during biennial overhauls, whether used or not. The frequent repair on the 25-year-old valves took its toll on safety and dependability.

"We got to the point where we had machined on the valves so much to make them seal that we reduced the structural support for the seal area, so there was nothing to seat against. We needed to look

to an outside source for a solution." Trahan says. In September 1992. Duponts valve-shop personnel developed a list of items to be addressed in a new Y-conduit valve design.

"First item on the list was an improved valve-body design. In addition to the shut-off problems, the metallurgical technology of valves had improved over the past decade, and stronger materials and improved forgings were now available," Trahan says.

The original valve design was also difficult to maintain and repair because it had a tendency to leak in more than one area. Trahan explained that finding the leaking area in the valve was often time-consuming. Each attempt to do so made other areas prone to problems. The sealing area was on a 90° corner, making it difficult to access. Over the years, machining this corner had weakened it, causing mechanics to damage it more every time they worked on it.

"The stem (or spindle), another point of difficulty of the original design, was comprised of multiple components. This caused us to machine, stock and maintain a whole complement of spare parts to keep on hand for replacement. For example, if this area needed repair, we had to machine and assemble four or five pieces before we could attach the seat ring, because the seat ring was not built directly onto the spindle. To save time, we would machine extra parts to use the next time, because we knew there would be a next time." Trahan says.

By December 1992, time was also running short. DuPont scheduled a major shutdown for a unit in May 1993 and Trahan wanted the replacement valve installed during that time. The scope of the original request for four valves was reduced to one, considering this first valve a test unit before committing to replace all 11 valves.

New valve design

The valve manufacturer was able to redesign the valve to meet DuPont's requirements within its mandated time frame.

The newly designed valves have the same face-to-face dimensions but weigh about 750 lb. The manufacturer delivered the valve as promised, one week before DuPont's scheduled outage.

The new valve design includes advanced metallurgy for the body and trim, made from 15-5 precipitate hardness stainless steel to strengthen the assembly; a new plug and actuator assembly, with general improvements to meet both operational and maintenance requirements; and an improved seat design, made from a high-strength, corrosion-resistant alloy steel.

The manufacturer specified the high-pressure valves at 10,000 psi, modifying the internal design to meet requirements. The maximum pressure range of these conventional soft-seat, bubble-tight designs were previously 4,000-6,000 psi. The design team developed a high-pressure unsupported dynamic seal, made from poly ether ether ketone (PEEK), for service to 10,000 psi.

The valve has more clamping or closing force because the actuator is bigger, designed to crush any polymer that might be present on the seating area.

Repeatable, positive shutoff

"As ethylene is extremely flammable, getting the potential fuel out of the system quickly becomes a big priority. With the new valves, the safety requirement is met by its ability to vent ethylene from the system quickly—about 2 sec—and the environmental advantage is that they provide zero leakage," Trahan says.

"The new valve gives us a repeatable, positive shutoff. The regulatory agencies permit only a limited amount of release to the atmosphere, and if these valves were to leak, we would creep up on that limit. Our own policy is to put no ethylene into the environment, hence the importance of zero leakage in this application. We can now use the valve without worrying if it will shut tight again after opening."

Based on the success of the first valve, DuPont ordered the remaining 10 valves in September 1993.

Trahan says the ability to vent quickly has given DuPont an additional, unexpected benefit.

Oxygen contaminates the ethylene reaction, so if the unit is exposed to oxygen, it must be purged before starting again. Nitrogen displaces oxygen during the purge of the closed-loop system. Previously, DuPont used a different by-pass valve arrangement around the Y-conduit valves, and the purge process took 5-6 hr to complete.

With the new valve design, this process takes only 20 min. This translates to increased production for the plant, coming back on-stream quicker.

Reduced Maintenance

Recently, Trahan says, some valves were rebuilt during a turnaround after 1½ years of service in less than one 8-hr shift. The valves were cleaned, their seals were replaced and the valves were tested at maximum pressure without problems.

"Because the new valves are so reliable, we also can reduce our maintenance costs. Unit downtime caused by the old valves has been eliminated. We can now use our maintenance crews more effectively in other areas of the plant. Our bot-tom-line production has increased by our being able to cycle and bring the units back on-line more quickly. All of this translates directly to increased revenues for our plant," Trahan concludes.

- Y-Conduit Valves—
  Control Components Inc.,
  Rancho Santa Margarita, CA.