A PUTMAN PUBLICATION FEBRUARY 2000

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FLUID HANDLING SYSTEMS

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AI technology renders standard pumping arrangements obsolete

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LESS IS MORE

Trading hardware for artificial intelligence proves the adage is true

Russ Kratowicz
Executive Editor

You can't find a molecule with fewer components than what is found in hydrogen. Its simplicity is a thing of natural beauty. On the other hand, the equipment needed to process this atomic wonder rarely mimics that uncomplicated configuration.

Air Products and Chemicals, Inc. completed and commissioned a new hydrogen purification plant in Geismar, La. in July 1999, taking only eight months to bring it from concept to commissioning. The facility, known as Satellite Plant No. 4, is one of several the company owns and operates. Running automatically and unattended, the facility purifies a crude hydrogen feedstock and puts the enriched hydrogen into a pipeline, feeding users situated between New Orleans and Baton Rouge.

Despite its relatively small, 200- by 200-ft. size, the hydrogen facility needed a cooling tower. Each of two 100-hp cooling water pumps—one an installed spare—are sized to supply 2,810 gpm at 90 ft. total discharge head to the cooling water header serving the plant.

To get a better grasp of the design constraint that Air Products faced in a small space, imagine the piping configuration of a hypothetical large standard process pump paired with an installed spare. Controlling the flow of process fluid that the pump moves requires some form of flow-measuring device to provide feedback to a control valve. The control valve, in turn, opens or closes to throttle the flow coming through the pump. These two basic field devices are interconnected to transmitters and other items of instrumentation. The whole package is then connected to control wiring that feeds signals to and from a centralized control room.

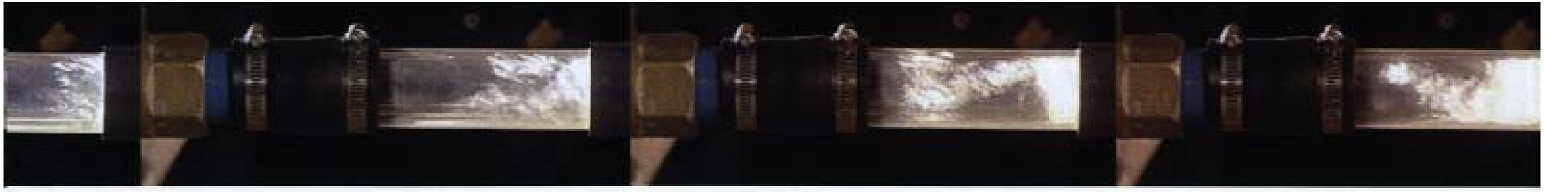
Depending on the application, the piping at the pump pair may also include recirculation lines on each to protect the pumps from running dry when the control valve closes down during periods of low demand for process fluid. Finally, to bring electrical power to operate the pumps, there would also be two locally mounted pump starters.

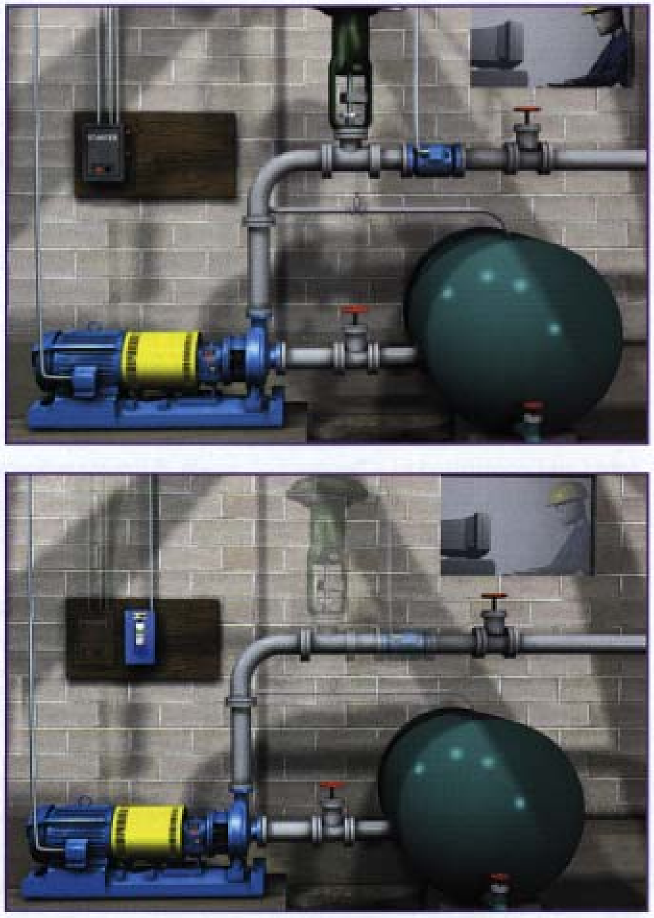
As is the case with every company in this country, employees must now do more with less while continuously increasing productivity, operating margins and profitability. The Air Products design team is not exempt from these imperatives. The company places great emphasis on minimizing total capital cost, operating cost and maintenance cost—the usual expectations that engineers face every day.

An opportunity

Since the cooling water pumps are considered long-lead items, they were ordered during the early part of the conceptual phase of the project. The specifications for the pumps called for cast iron casings, which makes good engineering sense since that material is relatively inexpensive and perfectly suitable for cooling water service.

Somewhat late in the design process, Goulds Pumps approached Air Products to determine if it had any interest in witnessing an "unofficial demonstration" of a new technology being developed at one of the Goulds plants. Sensing an opportunity, Air Products elected to incur whatever travel expenses it required to investigate the new technology. As a result of what they saw, Air Products immediately changed the purchase order specifications for the two cooling water pumps from cast iron to rather expensive stainless steel.





The lower photo shows the components that are rendered extraneous by SmartPump technology.

Why would they do that?

For cooling water pumps of this size, the change in the material of construction appears to run counter to the generally accepted definition of what it means to minimize total capital cost. Clearly, the change did not reduce the purchase price of the pumps. Also, since stainless steel is usually considered to be overkill for cooling water service, the change made absolutely no difference in the expected life of the pumps. As far as operating cost is concerned, stainless steel reduces neither the operating cost in a fully automated plant nor the expected cost of maintenance.

Missing parts

Nevertheless, what was it that Air Products saw during the test? In brief, the demonstration project showed very clearly that new technology is capable of reducing each of the relevant cost elements and improving flow control simultaneously.

For example, the pumping arrangement used in the demonstration project needed minimal hardware to operate. The pump required no control valve. It needed no device for measuring the flow. It had no pump starters. The recirculation line was conspicuously absent. Nevertheless, it was impossible to get the pump to cavitate, run dry or run against either a closed suction valve or discharge valve. The pump automatically reacted to system changes and upsets. And it did all this without human intervention. The demonstration project showed that the technology was perfectly capable of controlling flow accurately in spite of the missing hardware, process problems and human error.

How did they do that?

Although the pump was a standard unit similar to those found in every plant, this one was connected to a special controller that monitored the performance of the pump and adjusted its speed through a variable frequency drive. It drove the pump operation as close as possible to the best efficiency point on the pump curve.

The controller "knew" what was going on because it continuously compared the value of the operating variables it measured, such as pressure, speed and horsepower, against what the pump curve predicts should be happening to the pump. The key element of the control system was a digitized version of the pump curve held in the memory of the controller.

Also held in memory were other important variables, such as user-selected alarm points, trip points and the setpoint. The microprocessor was now able to match the output of the pump to the demands the fluid handling system imposed on it. It was also capable of controlling on the basis of pump speed, discharge head or flow rate. In each case, the controller adjusted the pump speed, either by holding it constant (if controlling on pump speed) or by modulating it in response to process changes that alter the system head and flow.

A significant part of the demonstration project was proprietary flow-measuring technology built into the pump casing. Having an alternate way to measure this input variable eliminated the orifice plate, mag meter, Coriolis meter and every other style of flow-measuring device. The system relied on the pressure drop across the discharge nozzle of the pump and pump speed as the determinants of flow rate through the unit.

This may be well and good for normal operations, but what about process upsets? I saw a similar demonstration at the Chem Show in New York City in November. When the manual suction valve was closed, the system sensed and properly interpreted the process change and, within seconds, slowed the pump to a minimum safe speed at which it could operate indefinitely without producing mechanical damage. Shortly after the suction valve was reopened, the pump speed rose until flow and pressure once again stabilized at the setpoint. With such fail-safe features, it is no wonder that including a control valve in a pump installation has been rendered obsolete as a design standard. Also rendered obsolete are recirculation lines. Imagine for a moment a world in which rebuilding and recalibrating control valves are two maintenance-related activities that are no longer needed.

Field testing

Air Products recognized the potential savings this technology could generate for the hydrogen purification facility and, therefore, decided that the facility could serve as a beta site for the "smart pump." Paul Altpeter, senior principal machinery engineer at Air Products in Allentown, Pa., defined the technical requirements and specified the major pieces of equipment for the hydrogen facility. He said, "This technology is not a perfect application for the 'smart pump,' but it represents a good way for Air Products to demonstrate to ourselves that the technology works."

Testing in a non-critical way is the essence of field testing a new technology. Cooling tower pumps are well-known workhorses, and surprises are not the norm. However, Altpeter said, "The ideal use would be one that requires control of the operating parameters in a mission-critical service. A good application would be boiler feed-water pumps." Altpeter also pointed out that "a user can achieve greater savings with higher horsepower installations since the savings is a percent of a greater base cost. However the installed cost of a 'smart pump' does not increase very much when the horsepower is doubled."

The compressor is another key piece of process equipment in the hydrogen facility. Because of its importance, that unit is heavily instrumented and monitored remotely. In contrast, the two cooling water pumps are being monitored and controlled in a "go/no go" mode. Altpeter reports that he would like to integrate more of the data from the "smart pump" controller into the existing plant-wide network as is done with the hydrogen compressor.

According to Jerry Connolly, director of new business development of Goulds Pumps, Seneca Falls, N.Y., "The pump (at the Air Products facility) running with the valve in operation is consuming 98 hp, while the new system is consuming only 63 hp and is running more than 300 rpm slower. At $0.06/kW-hr, this represents more than $12,000 in energy savings per year. And because it continuously calculates savings, the running total, in dollars, will constantly be in view in the DCS control room or on the unit's keypad."

Just as hydrogen has the simplest known molecular structure, it makes sense that the best system for purifying should be simple. Truly, when it comes to pumps, less is more.

Figures courtesy of Goulds Pumps