CONTROL ENGINEERING®
Reed Business Information®
Vol. 56 No. 10
OCTOBER 2009 Covering control, instrumentation, and automation systems worldwide

technology UPDATE

Leak detection: Technology catches up to theory

Making sure all the oil that goes in a pipeline comes out the other end is harder than it sounds.

Marsha Yon
Micro Motion
Richard Leonard
Pro-Tech Solutions
Alvin Shoop
Expert Systems Group

One of the world's largest steam generating plants is located on an island in a major U.S. metro area. The plant distributes steam for heating and air conditioning throughout its local service area, but has to pull fuel for its oil-fired boilers from a tank farm approximately two miles away. To complicate matters, 85% of that distance is through a tunnel under a heavily traveled river. Given local environmental concerns, that fuel delivery system has to be closely monitored to make sure no oil is being lost in between.

The plant purchases No. 6 fuel oil from a tank farm across the river, so oil has to be pumped through a pressure-controlled pipeline that runs through a tunnel under the river, at a maximum flow rate of 300 gpm. Stringent requirements for the leak detection systems on the pipeline require that the system be able to detect any leak in excess of 60 gallons in 20 minutes, which effectively amounts to 1% of maximum flow.

Oil in = oil out?

The material balance method of leak detection is simple: quantity in – quantity out = size of leak. Simple, yes, but implementation is more complicated. The system must manage temperature and pressure differentials and time lag. If the system is based on volume, temperature compensation is especially challenging when different segments of the pipeline run at different temperatures. The oil temperature can change as it passes from the tank to underground to under water. Because multiple measurement devices are involved, measurement error accumulates, with negative consequences for overall accuracy.

In the early 1990s, the utility company assessed its leak-detection system and found it lacking. This prompted a 15-year effort to monitor, upgrade, and optimize the system so that it not only met but exceeded requirements.

The basic concept of the original system was straightforward and used paddlewheel sensors on each end of the pipeline. A comparator device developed in-house collected pulse data from the sensors via dedicated telephone lines, compared the inlet pulse rate to the outlet pulse rate, and calculated the difference in flow.

Unfortunately, the paddlewheels never were able to generate data with required accuracy. Variations in temperature and density made the errors worse, and the dedicated phone lines failed frequently. Although no significant leaks occurred over the 30 years the system operated, the company recognized the risk, and took steps to correct the problem.

Improved system, version 1

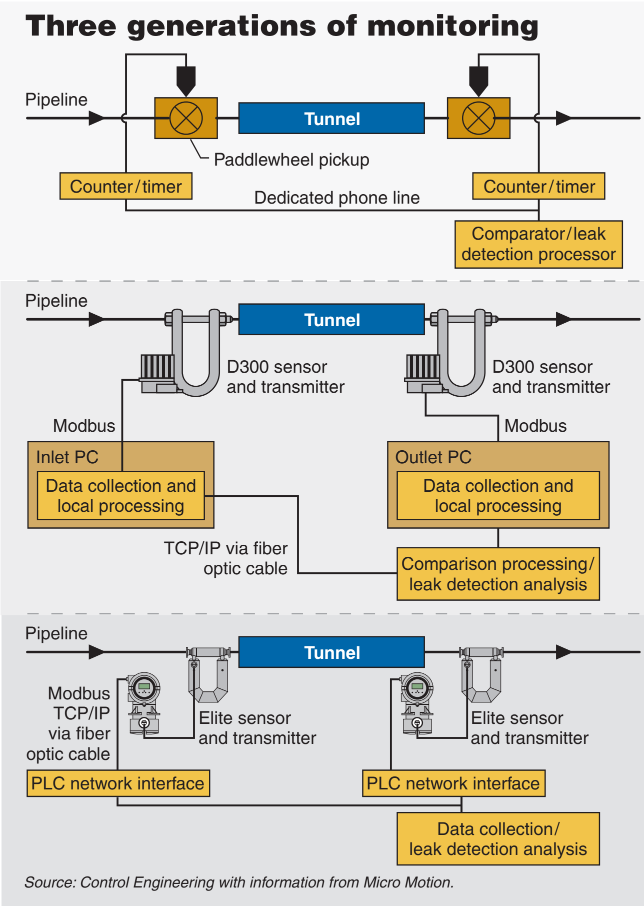
In the mid-1990s, the utility contracted system integrator Expert Systems Group to redesign and implement a system that would meet their specifications for sensitivity, accuracy, and reliability.

The sensing technology was changed from paddlewheels to Micro Motion D300 Coriolis mass flowmeters. Mass measurement is not affected by pressure and temperature variation, so an improvement in accuracy was realized immediately. Communications and processing were handled by two PCs connected by fiber optics. The PCs ran the Microsoft Windows 98 operating system, a custom data analysis program, and ProLink, a software tool from Emerson that retrieves process data from the

ONLINE

For more information, visit:
www.expert-systems-group.com
www.micromotion.com
www.pro-techsolutionsltd.com

Read this story online at www.controleng.com/archive for more information on leak detection with Coriolis flowmeters.



Comparing the schematics of the three systems, it is possible to see how the technology evolved over 40+ years of operation.

sensors. As shown in the diagram, after local processing, the inlet PC sent data over TCP/IP to the outlet PC, where it performed comparison processing and leak detection analysis.

Although mass data is more stable, the leak rate is specified as a volume, so Al Shoop, proprietor of Expert Systems Group, had to make a conversion using mass and density readings measured by the D300 meters. By taking the direct density measurement from each end of the pipeline and assuming a straight-line temperature gradient from one end of the pipeline to the other, Shoop was able to generate temperature-corrected data that improved accuracy; other optimizations reduced the average system discrepancy to less than one gpm.

Even so, the enhanced system was still not ideal. The bulky D300 meters were hard to fit into the existing pipeline. Non-optimal positioning caused occasional bubbles in the line, which resulted in spikes and false alarms. The Windows operating system did not have real-time capability and its timer did not produce exact two-second data samples. Moreover, the PLCs of the time did not have sufficient computational and memory capacity to do the job. Still, the system ran flawlessly for 10 years.

Not only had PLC capabilities evolved during this time period, so too had the Coriolis sensor. The Elite Coriolis meter was five-times more accurate than the D300. Modbus-to-TCP/IP converters on each meter meant that no computers were needed because newer PLCs had no trouble processing and comparing the raw data.

The new equipment was installed beside the existing system, and immediate improvements were seen. "As a result of the increased accuracy and the preprocessing performed by the meter, for example, onboard data smoothing and noise reduction, the standard metering error dropped from 20–30 gallons in 20 minutes to less than 2 gallons in 20 minutes," says Shoop. With decreased metering error, there is no danger of false alarms caused by spikes. The previous problem with bubble formation was addressed by adding S-bends to the pipeline, thus providing space to install the sensors in their optimal orientation.

Shoop knew the system was a success when one day he noticed a slight increase in the standard metering error. It was not reported because it was below the alarm limit, but a few days later, a technician saw sheen on the ground. The glint proved to be a small puddle of oil from a pinhole leak. Although no trip was initiated, the system had successfully detected the event.

Marsha Yon is Micro Motion business development manager for liquid custody transfer. Richard Leonard is executive VP and CFO of Pro-Tech Solutions, Ltd. Alvin Shoop is president of Expert Systems Group.