CASE HISTORY:
STORA ENSO'S PORT HAWKESBURY, NS

VALVE DIAGNOSTICS help AVOID DOWNTIME in TMP mill

"We see impending problems before they become failures."

By Stuart Sullivan and Tim Cunningham

Few unexpected shutdowns have occurred due to control valve failures in the thermo-mechanical pulping (TMP) operation at the Stora Enso North America Mill in Port Hawkesbury, NS, since good diagnostic information on the valves became available and well understood. However, it took some time to get to this point after the TMP plant started producing pulp in late 1997.

The Port Hawkesbury Mill produces some 185,000 tonnes of newsprint on PM1 and about 350,000 tonnes of supercalendered (SC-A+) paper per year on PM2. The TMP plant generates more than 850 tonnes of pulp per day, primarily for PM2, which went into operation in April, 1998.

Just over 200 control valves in the TMP plant were outfitted from the beginning with FieldVue digital valve controllers (DVC)[1]. These devices utilize embedded microprocessors to acquire, store, and transmit data about the operation and condition of the valves on which they are mounted. At the time, this was one of the largest DVC installations in North America. Engineers and technicians use the ValveLink software to communicate directly with these smart positioners, obtaining accurate feedback on valve position, travel deviation, and other functional information. Valves could also be configured and calibrated from a central location without sending instrument technicians into the field with a hand held communicator or calibrator to carry out these tasks. Initially, valves are checked visually to verify that they are operating properly with full rotation. These positioners have proven to be very useful for diagnosing valve problems.

Shortly after the TMP plant started producing pulp, it became evident that some of the rotary valves were suffering from internal buildup and were subject to sticking. The relatively dirty service in which some of these valves are placed causes residues to build up in the valve bodies resulting in sluggish operation and eventual sticking. This prompted us to enable the higher functionality advanced diagnostic (AD) within the instrument on those valves to take advantage of their greater diagnostic capability.

Tim Cunningham testing a valve in the shop before it is returned to service

Stuart Sullivan and Tim Cunningham doing a series of analyses during a shut-down day while John D. MacDonald (right) observes.

The AD feature provided enough additional information on the buildup for us to be able to accurately predict when a valve should be replaced in order to prevent it from actually causing unexpected downtime. Initially, a program was set up to monitor 25 valves that displayed a tendency to stick. That number has grown over the years, and now diagnostics from about 70 valves are used to help us predict when one of those valves will need maintenance before causing trouble.

Deciding which valves to pull in preparation for a planned shutdown is no longer a guessing game; we know what is happening inside those valves, and we pull the right ones!

Diagnostics are run on valves that are not in service, and a graphical representation, or "signature", is generated showing the actuator pressure required to move the valve versus valve travel from zero to 100 percent open. A calculated numerical value indicates the torque required to move the valve. That calculated torque value plus the graphical representation are used in order to determine how much buildup has occurred in the valve. Both the signature and the numerical torque value are studied to determine which valves are most likely to stick in the near future. For example, the critical torque values for an 8-inch diameter valve with a small actuator would be less than for a larger valve with a larger actuator. Of course, experience is very useful in making that determination.

Analyzing the diagnostics enables us to identify other problems, such as an insufficient air supply, poorly adjusted springs, worn linkages, etc, all of which can increase process variability by eroding the dynamic performance of a valve. Conditions uncovered by examining valve signatures include cracked air supply tubes at the valve actuator, failed air supply pressure regulators, and a failed I/P in a positioner. Using diagnostic information for timely valve maintenance keeps valves at top performance. A properly functioning valve is one ingredient in minimizing process variability, which is a measure of how closely a process matches the setpoint despite inline disturbances. This is very important in helping to optimize the TMP process in order to maintain constant throughput and product quality.

Being able to quickly check on the operation of a specific valve has helped solve a number of valve related problems in the TMP plant. By doing step response testing of some valves identified as being "sluggish" plus some experimentation in the shop, we found that increasing the tubing size between the positioner and valve actuator improved the step response of some valves. We could see immediately the effects of our changes on the valve response while the valve was on the bench and did not have to wait for results from another control audit.

Initially, the specialized software was loaded into a laptop, which we placed in the rack room for the Valmet XDi control system. AD-level diagnostics could be performed on DVC-equipped valves by connecting the laptop with the I/O point for any valve in question. While faster than going into the field to find and hook up to a valve, this turned out to be fairly time consuming as well.

We now have a desktop computer dedicated to the software in the control system rack room. Any AD capable smart valve in the TMP plant can be quickly examined from this computer through a multiplexer in the rack room to obtain a current valve signature, which can then be matched with a signature on file for that valve when new or when last checked. It is also possible to set up a batch program to obtain signatures on a given set of valves without having to get them one at a time.

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In addition to having baseline signatures on every smart valve in the TMP plant, a file of good signatures and poor signatures has been accumulated, so anything out of the norm can generally be identified by making comparisons with signatures already on file. In one case, valve diagnostics showed what looked like a faulty valve. Comparing this valve signature to a similar one from another valve and noting the fix for that problem enabled us to avoid removing the valve and only replace a feedback pot in the positioner.

Although initially applied to "sticky" valves, our predictive maintenance program of doing valve signatures has been extended to more than 70 valves, which have been identified as having potential to impact the stability of the TMP plant. Depending on the anticipated buildup, signatures may be taken on certain valves during planned shutdown days once per month or three months. Other valve signatures may be updated and reviewed every six-months or annually, depending on the criticality of that valve. Our computerized maintenance management system generates a work order when a signature on a particular valve is due. After analysis of the signatures, work orders may be generated to correct apparent problems.

Valves showing signs of a buildup are prioritized for replacement, with the most seriously contaminated valves taken first. Prioritizing is important, because if a choice must be made on which valve to replace, a logical basis exists for making that decision. Normally, removed valves are hydroblast cleaned and returned to spares outside of a shutdown day. However, if time permits, the valves may be removed, hydroblast cleaned, and reinstalled during a shutdown.

Signatures are taken on all repaired and cleaned valves before they are returned to service. Analysis of these signatures gives us the confidence that a valve has been properly repaired or cleaned, but it takes time to develop the ability to read control valve signatures and understand what is going on within a valve. Once the smart valve positioners were installed, Atlantic Controls of Saint John, NB[2], sent a certified instructor to the mill to teach a course on diagnostics using the software. Twenty instrument technicians learned the techniques necessary to acquire and interpret valve diagnostic information. Our expertise in troubleshooting valve problems has evolved from that training plus day-to-day experience. The training also generated the confidence needed to establish an effective predictive maintenance program requiring very little external support.

It is possible to set up online monitoring of all valves with a system of alerts to provide early warnings in case of an impending failure. We have not yet taken advantage of this functionality, largely because we already maintain such a close watch on those valves that historically pose the greatest threat of malfunctioning.

However, we are currently experimenting with online, in-service diagnostics using the new performance diagnostic (PD) capability to see if this higher level of diagnostics could be incorporated into the program to make the discovery of valve problems even more efficient. We expect this to provide better data on the operability of hot valves versus signatures now taken on cold valves. There may be less tendency to stick when a valve is operating with hot materials passing through, so the diagnostics obtained on valves in operation may be more useful than those on cold valves in determining when a valve should be removed for service.

The use of advanced diagnostics has enabled us to establish an effective condition-monitoring program for our control valves. We can now evaluate valve performance and correct most problems before significant control degradation or breakdown occurs. **P&PC**

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[1] made by Emerson Process Management

[2] a division of Laurentide Controls, Emerson Process Management's local business partner in Montreal