Advanced Diagnostics in a Pressure Transmitter Avoids Process Shutdown in a Refinery

RESULTS

- Avoided shutdown and lost production costs of up to $1M per day
- Improved throughput
- Increased plant availability

Early warning of a process upset allowed operators to take corrective action to control the process and avoid a shutdown.

APPLICATION

Catalyst circulation in an aerated standpipe of the Fluidized Catalytic Cracker (FCC) unit

CUSTOMER

Exxon Mobil

CHALLENGE

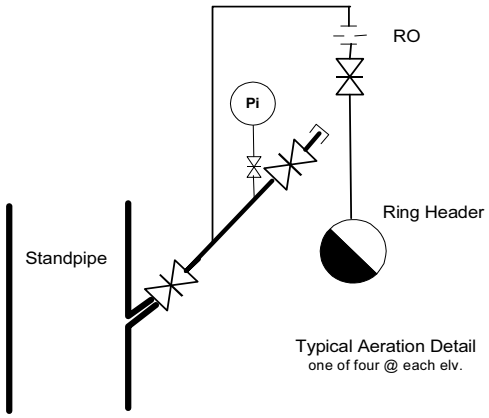
In an FCC unit at a refinery, one critical variable in maintaining the process is adequate circulation in regeneration catalyst standpipe. Low circulation or poor catalyst fluidization can create severe issues, including costly damage to the standpipe, a process shutdown or a process upset. All of this can result in lost production and maintenance costs ranging from thousands to millions of dollars. In a worst case scenario, the cost of shutting down a FCC unit could be as much as $1M per day with a start-up time of up to seven days.

The key challenge is to ensure that you have both adequate circulation as well as an advanced warning as to when the process is becoming imbalanced so there is appropriate time to make a process correction before the unit shuts down or becomes damaged.

SOLUTION

To understand the problem, it is important to understand the details of the aeration point in the regenerated standpipe of the FCC unit (See Figure 1). Under normal conditions, the gas is entrained into the standpipe and travels downward between the catalyst particles. While traveling downward it gets compressed and the bubbles join with other bubbles and then break apart creating a random pressure fluctuation or noise. At certain conditions (low circulation, poor catalyst fluidization properties), the catalyst will over de-aerate, causing the bubbles to disappear as they travel downwards. When this happens the pressure build-up along the pipe is no longer smooth but erratic.

Figure 1: Aeration point in the regenerated catalyst standpipe of a refinery FCC unit.



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Under severe conditions, the catalyst bridges across the standpipe, leading to a stop and start type catalyst flow also called “stick slip flow.” Such flow causes severe pressure fluctuations that are no longer random, resulting in costly damage mentioned above.

Traditionally, historian data from the DCS had been used to identify these process upsets. Because DCS tracking capabilities are slow, such process upsets would not be detected in time, leading to huge maintenance costs. An early warning of the process upset would allow operators to take corrective action to control the process and avoid a shutdown, thereby increasing plant availability.

The solution is to use the Rosemount 3051S Advanced Diagnostic Block for Statistical Process Monitoring with a DeltaV Fieldbus host and AMS™ Suite: Intelligent Device Manager. The advanced diagnostic block continuously samples the process signal at high frequencies and calculates the mean value of the signal and how it changes with time. It also tracks the standard deviation of the pressure signal noise.

During an upset in the catalytic flow, there is a change in the process noise and a resulting change in its standard deviation. These changes in the process noise start well before the process reaches the stick slip flow condition. The 3051S is able to detect it well before the DCS historian.

At this particular test site, the customer reported seeing the transmitter detect the pressure change approximately 30 minutes before it was observed at the DCS. Early warning of this process upset allowed operators to take corrective action to control the process and avoid a shutdown.

Online AMS software (See Figure 4) tracks the process information available from the 3051S and provides a user-friendly display of the various parameters, including standard deviation and mean from the Advanced Diagnostic Block.

A HART alarm(See Figure 5) is activated when the process noise is beyond the configured limits. The alarm directs the operator to the relevant tag where they can view the increased dynamic variation and take appropriate action to avoid excess noise and damage to the standpipe. This helps avoid severe process conditions and a costly shutdown, thereby increasing plant availability.

The cost of shutting down an FCC unit can be as much as $1M per day, with a startup time of up to 7 days.

Figure 2: 3051S Process Monitoring

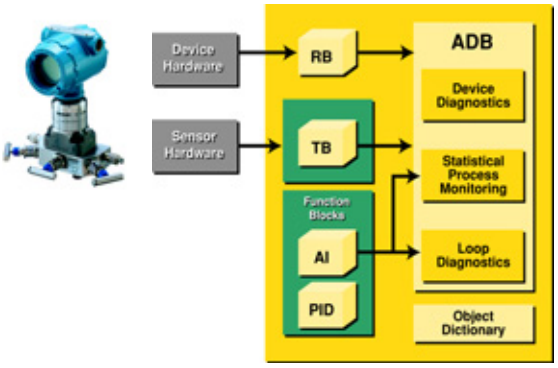
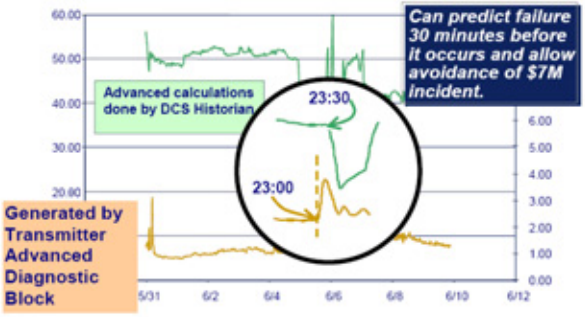


Figure 3: Data Gathered over a two-week period



REFERENCE

For further details refer to the Technical Article *“Diagnostics Capabilities of FOUNDATION Fieldbus Pressure Transmitterss”* by Ron Szanyi, Mike Raterman, and Evren Eryurek, ExxonMobil Research and Engineering. Hydrocarbon Processing. April 2003.

http://www.emersonprocess.com/home/library/articles/hycbproc/hycbproc0304_xom-diagnostics.pdf

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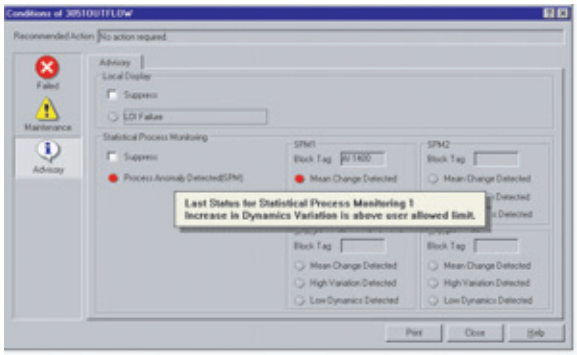
Online AMS software tracks the process information available from the 3051S and provides a user-friendly display of the various parameters, including standard deviation and mean from the Advanced Diagnostic Block.

Figure 4: Online AMS Software

Figure 5: HART Alarm



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