Model 888, Class I Div 2

SULFUR RECOVERY
Technical Note

SULFUR RECOVERY
Technical Note

AMETEK® PROCESS INSTRUMENTS

The AMETEK Model 888 Diagnostics Reducing Unscheduled Downtime

IDENTIFY

Risk can be managed and reduced by understanding the potential failure modes of an analyzer, its sample conditioning system, and the process. The first step in the process is to define all of the critical conditions needed to make a valid measurement. The second step is to determine which diagnostic methods can be used to evaluate each of the conditions. Diagnostic methods require the collection or generation of data which is then evaluated against the conditional requirements and to provide either a direct or indirect indication of the potential failure modes. There are three types of diagnostics that are implemented in the Model 888 process analyzer. They are observational, model-based, and functional. These three diagnostic types are differentiated by the means through which the evaluated data is collected.

Observational Diagnostics extract useful information through the evaluation of sensor data. For the Model 888 temperature, pressure, and flow sensor data are monitored. Temperature control is one of the major challenges of tail gas analysis in a sulfur recovery unit (SRU). The successful measurement of hydrogen sulfide (H_2S), and sulfur dioxide (SO_2), in SRU tail gas using ultraviolet photometry is predicated on the reduction of the elemental sulfur vapor concentration in the measured stream. This is achieved through controlled condensation using a demister under tight temperature control at temperature. After the demister, the temperature of the sample conditioning system must be maintained at a temperature that is greater than that of the demister temperature to prevent the condensation of sulfur in the measurement cell and sample return line.

Temperature sensors are used to monitor the sample conditioning system of the Model 888 tail gas analyzer. These temperatures are evaluated against two deviation limits. The warning deviation limit, indicates the expected tolerance for temperature control during normal operating conditions. The alarm deviation limit, indicates the maximum allowable deviation before action must be taken to protect the system. If the temperature of the sample conditioning system decreases below the warning threshold, a warning is communicated and the technician would be alerted to a potential problem. If the temperature of the sample conditioning system decreases below the alarm threshold, an alarm is communicated alerting the technician that the analyzer needs immediate attention.

If the warning is the result of a true failure, the escalation from warning to alarm may happen much faster than the technician's ability to respond to the initial warning. The Model 888 reacts intelligently to the alarm condition to protect itself from damage. The danger posed by the alarm condition is from the condensation or solidification of elemental sulfur vapor somewhere in the sample condition system leading to a plug. In reaction to the alarm, the Model 888 analyzer purges the sample conditioning system of process gas. This automatic reaction to the identified alarm suspends normal operation but protects the sample conditioning system from additional damage thereby reducing the amount of unscheduled maintenance that will be required by the technician.

www.ametekpi.com

AMETEK®
PROCESS INSTRUMENTS

455 Corporate Blvd., Newark, DE 19702
Ph. +1-302-456-4400, Fax +1-302-456-4444
www.ametekpi.com

ISO 9001 REGISTERED MANAGEMENT SYSTEM

F-0466 Rev 1 (0115)

One of a family of innovative process analyzer solutions from AMETEK Process Instruments.
Specifications subject to change without notice.

SALES, SERVICE AND MANUFACTURING:

USA - Pennsylvania
150 Freeport Road, Pittsburgh PA 15238 • Tel: +1-412-828-9040, Fax: +1-412-826-0399

USA - Delaware
455 Corporate Blvd., Newark DE 19702 • Tel: +1-302-456-4400, Fax: +1-302-456-4444

Canada - Alberta
2876 Sunridge Way N.E., Calgary AB T1Y 7H2 • Tel: +1-403-235-8400, Fax: +1-403-248-3550

WORLDWIDE SALES AND SERVICE LOCATIONS:

USA - Houston, Texas
Tel: +1-713-466-4900, Fax: +1-713-849-1924

BRAZIL
Tel: +55 19 2107 4100

CHINA
Beijing / Tel: +86 10 8526 2111, Fax: +86 10 8526 2141
Chengdu / Tel: +86 28 8675 8111, Fax: +86 28-8675 8141
Shanghai / Tel: +86 21 6426 8111, Fax: +86 21 6426 7818

USA - Austin, Texas
Tel: +1-512-252-2440, Fax: +1-515-252-2430

FRANCE
Tel: +33 1 30 68 89 20, Fax: +33 1 30 68 89 99

GERMANY
Tel: +49 21 59 91 36 0, Fax: +49 21 59 91 3639

INDIA
Tel: +91 80 6782 3200, Fax: +91 80 6782 3232

SINGAPORE
Tel: +65 6484 2388, Fax: +65 6481 6588

Model-based Diagnostics extract useful information from the output of predictive models. Elemental sulfur vapor is a strong ultraviolet (UV) absorber. H_2S and SO_2 are the two primary components of interest in tail gas analysis. The UV absorption spectrum of elemental sulfur vapor overlaps the UV absorptions of both H_2S and SO_2. The strong absorbance of sulfur vapor is reduced using a demister prior to the spectral analysis. The amount of sulfur vapor that makes it through to measurement cell depends on the control temperature of the demister. It is important that a known and predictable amount of sulfur vapor absorbance is present at any given time. It is important to note that this is not the concentration of sulfur vapor in the process but rather the concentration of sulfur vapor in the conditioned sample after the demister. The Model 888 firmware contains an elemental sulfur calibration model and the calculated sulfur vapor concentration is used as a diagnostic evaluation of the demister performance.

A difference between the expected and calculated sulfur vapor concentration indicates a potential problem. Warning and alarm deviation levels are used. At the warning level, there is no imminent threat to the analyzer and the warning directs the technician to be prepared to examine the demister during the next scheduled preventative maintenance. At the alarm level, the background absorbance from the sulfur vapor will compromise the primary measurements. If the alarm occurs the analyzer purges the sample conditioning system of process gas. This relieves the sample conditioning system of the excessive sulfur vapor condition and the Model 888 then performs a calibration check to verify the performance of the photometer. The analyzer then returns to measuring the concentrations of the H_2S and SO_2 analytes.

Functional Diagnostics are based on internal and external challenges to various subsystems. Measuring a zero reference gas, is one of the basic functions of all process photometers including the Model 888. The zero reference is the signal reaching the detector when the sample cell is filled with a non-absorbing gas. Over time the amount signal reaching the detector can be affected by a reduction in the output of the source due to aging, degradation of optical components, and contamination of the sample-wetted optical surfaces. The Model 888 self-adjusts for changes in the signal intensity by periodically measuring the zero gas. If the signal intensity continues to decrease over time, so does the signal-to-noise ratio and the reported concentrations for the H_2S and SO_2 analytes become less accurate. The zero reference eventually becomes too small and maintenance must be performed.

The Model 888 employs a functional diagnostic routine that adjusts the operation of the photometer such that the signal-to-noise ratio remains constant thereby extending the period between required maintenance interventions. The Model 888 uses a Xenon flash lamp as the UV source. Xenon flash lamps are used primarily in ultraviolet and visible process photometry due to their high output intensities and relatively long lifetimes. This combination makes them well suited for use with SRU tail gas analysis since the primary measurements of H_2S and SO_2 are made in the UV.

The Model 888 photometer integrates the signal intensity from multiple individual flashes of the Xenon lamp during each measurement. Every 90 minutes the zero reference gas is measured and the diagnostic routine evaluates the change in signal intensity since the last zero reference gas run. The light intensity reaching the detector is automatically increased by integrating the signal from additional flashes per measurement.

If the signal intensity decreases by a higher than normal amount this unexpected loss of signal is communicated to the technician as a warning that the cell windows may have been fouled and should be cleaned. The analyzer implements the needed correction to the signal integration and the Model 888 returns to normal operation. The technician has been alerted to the problem but understands that intervention can wait until the next scheduled preventative maintenance period to pull the cell and clean the windows. The analyzer will generate an alarm if there is insufficient signal to make accurate measurements when using the maximum integration time limit.

COMMUNICATE

The Model 888 local AMEVision user interface gives a technician a level of control while monitoring and/or performing maintenance near the analyzer. The AMEVision interface allows an analyzer to be used as a standalone device. The AMEVision interface uses a full color display and a set of rugged buttons to navigate the setup and diagnostic screens which are similar to those found on a smart phone. An extension of the local user interface is the ability to connect an external hardware for communication. The Model 888 can communicate over an Ethernet connection using a standard web browser. All of the major web browsers are supported and no additional software must be installed on the external PC.

REACT

Situations can occur that are out of the control of the analyzer. In addition to communicating the event, the Model 888 is designed to react to prevent and/or avoid undesired consequences. The reaction of the analyzer can fall into one of two categories: self-preservation or corrective response.

An act of self-preservation takes the Model 888 out of its normal operating mode to prevent further undesired consequences. The analytical output of the analyzer may be suspended temporarily or indefinitely before normal operation is resumed. A corrective response which is the result of model-based or functional diagnostics, differs in that the Model 888 makes an automatic self-adjustment so that it can maintain or return to normal operation. Corrective responses are intended to extend the time between required maintenance interventions. The goal of reacting to an event, whether through self-preservation or a corrective response, is to reduce the amount of unscheduled downtime for the Model 888 analyzer.