

### FEED FORWARD ANALYSIS FOR SULFUR RECOVERY UNITS

## Sulfur Recovery Units

A feed forward control scheme based on feed gas analysis prior to the reaction furnace can provide more timely air demand signal adjustments during non-steady-state conditions. Fast multi-component analysis in acid gas feed, together with modern control systems, can be an effective methodology for controlling the air flow to the reaction furnace.

### PROCESS CONTROL CONSIDERATIONS

The Claus sulfur recovery process is the partial oxidation of hydrogen sulfide ( $H_2S$ ) to sulfur dioxide ( $SO_2$ ) and conversion to elemental sulfur by maintaining a 2:1 ratio of  $H_2S$  to  $SO_2$ . There are several factors that affect recovery efficiency of the sulfur recovery unit (SRU), but air control (air demand) is by far the most dynamic and has the most influence on the recovery efficiency.

Primary air control using feed forward flow ratio of air to acid gas accounts for approximately 90% of the combustion air. Secondary air control using tail gas analysis ratio of  $[H_2S]/[SO_2] = 2/1$  and controlling a trim air valve by feedback control (or cascading to the feed forward controller) accounts for the balance of combustion air. Feedback control based on process analysis provides the most precision; however, it is limited by process lag time of approximately 30 seconds, especially if the composition of the acid gas changes rapidly.

The primary feed forward air control assumes a fixed constant for the composition, and hence the combustion air requirement of the various source(s) of acid gas, unless there is a feed gas analyzer. Under steady state conditions air control is stable, but in the case of sudden changes in the composition of the acid gas it is not uncommon for air control requirements to exceed the ability of the feedback control loop. In these cases, the excursion from the set point of  $2[H_2S]$  to  $1[SO_2]$  can be extreme: A serious loss of recovery efficiency and increased emissions. Practical developments in process analytics can provide comprehensive real time analysis of multi-component acid gas.



Sulfur Recovery Unit

### ANALYSIS OF FEED GAS COMPONENTS

Feed gas analysis requires a real-time (<5 seconds) quantification of the combustion components, and so analysis time is paramount.

- Quantification of  $H_2S$  in feed gas provides a real-time air demand estimate, therefore, improving SRU efficiency significantly.
- Hydrocarbons are minor components, but fast-moving and have a significant combustion air requirement. Measurement of total hydrocarbon (THC) content - which can be used to determine total air demand - takes seconds versus the minutes required to speciate and measure all of the individual hydrocarbons.
- Ammonia ( $NH_3$ ) is present in sour water stripper gas and must be accounted for if present.
- Measuring  $CO_2$  helps knowing the possible effects on air demand due to COS formation, if hydrolysis of COS is not great in the first converter bed. It can also affect the flow metering by changing the molecular weight, specific gravity, and viscosity of the acid gas mixture.
- Moisture ( $H_2O$ ), while not contributing to air demand, can be used for gas gravity adjustments for air control.

A combination of a dispersive ultraviolet optical bench with a non-dispersive infrared (NDIR) sensor for the simultaneous measurement of H<sub>2</sub>S, THC, NH<sub>3</sub>, CO<sub>2</sub>, and H<sub>2</sub>O is used in the IPS-4 analyzer to achieve a fast response time for effective feed forward control.

Certain wavelengths in the mid-infrared spectrum can accurately measure an integrated value of the carbon bonds and, therefore, accurately account for the overall air demand without having to speciate each component in THC. The IPS-4 dual bench analyzer has an independent ultraviolet and infrared photometer utilizing a shared platform, electronics, sample cell, and sample handling system. It is ingress-rated IP65 for installation without an analyzer house or cabinet. It has a web-enabled interface for complete remote interrogation and diagnostics, which minimizes the technician's exposure to potentially hazardous situations.

A significant number of acid gas/feed gas installations have been abandoned or under-utilized because of the perceived safety risk in sample handling when dealing with a high concentration of H<sub>2</sub>S. AMETEK offers a Heated Acid Gas (HAG)

sample probe with built-in particulate and membrane filters to extract the sample from the gas line while removing any liquids or particulates. This allows the sample point to be moved upstream of the knock-out drum, closer to the amine unit outlet, providing faster response time and early warning of changes in acid gas composition. The probe can be isolated from the process and back flushed, along with the analyzer, so safety is maintained during service. The HAG probe, as well as the entire sample system, are maintained above the dew point of the sample so it is a true "hot-wet" analysis.

While closed-loop feed forward control may only demonstrate recovery efficiency improvements of 0.3 to 0.5% over the long term, it is the recovery from gross upsets where the real benefit lies. There are several examples where feed gas upsets have resulted in recovery efficiency losses of 5% or more, and for the event to last many hours. Mitigating recovery efficiency losses with quick recovery, and preventing an environmental exceedance, proves the true value of the measurement.



#### SALES, SERVICE & 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 NE  
Calgary AB T1Y 7H9  
Tel: +1 403 235 8400  
Fax: +1 403 248 3550

#### WORLDWIDE SALES AND SERVICE LOCATIONS

##### USA

Tel: +1 713 466 4900  
Fax: +1 713 849 1924

##### Brazil

Tel: +55 19 2107 4100

##### France

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

##### Germany

Tel: +49 2159 9136 0  
Fax: +49 2159 9136 39

##### India

Tel: +91 80 6782 3200  
Fax: +91 80 6780 3232

##### Singapore

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

##### 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 5868 5111  
Fax: +86 21 5866 0969



© 2019, by AMETEK, Inc. All rights reserved. Printed in the U.S.A. A-0299 Rev 8 (0119)  
One of a family of innovative process analyzer solutions from AMETEK Process Instruments.  
Specifications subject to change without notice.



To find out more or request a quote visit our website

