TECHNICAL PAPER

Tail Gas Analyzers for Non-Traditional SRU Process

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Tail Gas Analyzers for Non-Traditional SRU Processes

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Abstract

In the past, conventional sulfur recovery units have been adequately controlled based on the calculation of either ratio or excess process air. The development of new sulfur recovery processes has dramatically changed the analytical requirements placed on the Tail Gas Analyzer. These applications require accurate chemical concentration data, rather than excess air or ratio data. For example, selective oxidation processes are frequently controlled based solely on the H_2S concentration. These processes, and others, require the analyzer to control at several different "off-ratio" conditions. For example, in the SUPERCLAUS™ process[a], the H_2S/SO_2 ratio is less than 1:7 during catalyst conditioning, greater than 10:1 during SUPERCLAUS™ operation, and 2:1 if the selective oxidation bed is being bypassed. In addition, process excursions can occur during any of these phases, and the analyzer must be able to provide reliable process data to correct these excursions. Conditions such as these demand that the analyzer be accurate over a wide dynamic range of H_2S and SO_2 concentrations. The BOVAR Western Research 900 ADA (Air Demand Analyzer) has been developed with these applications in mind, and both laboratory and process data have been acquired which demonstrate the successful application of the analyzer to both conventional and non-conventional SRU processes.

[a] SUPERCLAUS is a trademark of COMPRIMO b.v. (Netherlands)

1) Introduction

New Sulfur Recovery Unit (SRU) processes are being developed to maximize sulfur recovery and minimize SO_2 emissions. Associated with these new processes are new requirements for the balance of reactant species, and these requirements are typically more stringent than those for the conventional Claus process. Specifically, they require that the SO_2 and H_2S concentrations be measured accurately in the tail gas. In addition, there is often no longer a single desired operating setpoint, but rather several different operating points dependent on the status of the process. Accurate Tail Gas Analyzers,capable of operating in these varying conditions are required to monitor the process status. The BOVAR Western Research 900 ADA has been designed to meet the requirements of accuracy and reliability essential for efficient operation of these new processes.

In the conventional Claus process, sufficient air is required to oxidize one third of the H_2S in the feed gas to SO_2. The Claus catalyst then converts the resultant H_2S and SO_2 to elemental sulfur. An accurate assessment of whether the process is being optimally controlled can be determined by calculating the amount of excess or deficient air from the tail gas constituents[1] via:

$$\Delta A = 2\ [SO_2]_t - [H_2S]_t$$

It is important to note that accurate determination of the control variable, ΔA, does not require that the SO_2 or H_2S concentration in the tail gas be measured accurately. Rather, it is important only that any biases in the measurement of SO_2 and H_2S cancel out when the excess air calculation is performed. This can readily be achieved by selection of appropriate analytical wavelengths in a non-dispersive UV analyzer. Furthermore, since it is only important that the excess air be minimized, instrument biases in calculation of the excess air can be minimized simply by controlling to a non-zero setpoint, which can be determined as that which minimizes plant emissions. These factors greatly simplify the design of tail gas analyzers for conventional Claus applications.

These simplifying factors are not applicable to some of the new SRU processes, which require that the analysis of the SO_2 and H_2S concentrations be accurate. The SuperClaus™ process is a prime example, in which concentration accuracy is imperative and the typical concentration for each of the species can vary dramatically depending on the status for the process. To better understand what is required of the Tail Gas Analyzer for this application, it is useful to first consider the details of a typical selective oxidation process, such as SUPERCLAUS™. There are three standard operation modes in this process: Catalyst Conditioning, Selective Oxidation, and Selective Oxidation Bypass (or normal modified-Claus operation).

During catalyst conditioning, the iron oxide catalyst is converted to iron sulfate[2]. This is achieved by reacting the iron oxide with SO_2:

$$Fe_2O_3 + SO_2 \rightarrow FeSO_4 .$$

It is imperative that the competing reaction between H_2S and the catalyst:

$$Fe_2O_3 + H_2S \rightarrow FeS .$$

is suppressed, otherwise the catalyst could be deactivated.

To achieve this, the reaction furnace is operated with significant quantities of excess air such that the H_2S is almost completely reacted in the Claus catalyst beds, and the gas entering the SuperClaus™ catalyst bed contains percent levels of SO_2 and low levels of H_2S (~2000 ppm). The Tail Gas Analyzer must be capable of providing accurate measurements of both the H_2S and SO_2 concentration at an operating ratio of 1 to 7. Given the high concentrations of SO_2 relative to the H_2S, it is imperative the analyzer displays **minimal cross-talk** of SO_2 onto the H_2S measurement. Furthermore, it is important the analyzer provides for **accurate compensation** for interfering species such as sulfur vapor.

Once the selective oxidation catalyst bed has been conditioned and normal SUPERCLAUS™ operation begins, the reaction furnace is operated with deficient air, such that the SO_2 is almost completely reacted in the Claus beds, and the tail gas entering the selective oxidation bed contains approximately one percent H_2S and only 500 ppm of SO_2. At this point, the operating ratio becomes almost 20 to 1. Control of the process is now based on accurate analysis of the H_2S concentration. In light of these conditions, and those required previously for the conditioning phase, it becomes obvious the Tail Gas Analyzer must demonstrate exceptional **linearity** over the full scale range of measurements for both the SO_2 and H_2S concentrations.

Should conditions occur during plant operations such that the selective oxidation bed must be bypassed, the plant will typically revert to regular Claus operation. In these situations, the analyzer is required to operate at a 2 to 1 ratio of H_2S to SO_2. Provided the previous requirements of accuracy, linearity, cross-talk compensation and interference rejection have been met, the Tail Gas Analyzer will also be able to run the plant optimally during conventional Claus operation.

In summary, tail gas analyzers for non-conventional SRU processes must meet the following requirements:

1) Exceptional linearity and dynamic range
2) Minimal cross-talk between species, and interference compensation
3) Low drift and high signal to noise ratios

4) Accurate measurement of the H_2S and SO_2 concentrations
5) Integrated calibration and diagnostic facilities
6) Stable operating features for temperature and flow control
7) Reliable and full-featured process control interface to plant DCS

This paper describes a tail gas analyzer which has been designed specifically with these characteristics in mind.

2) The 900 ADA

The BOVAR Western Research 900 ADA is a process tail gas analyzer specifically designed for use in sulfur recovery units. The analyzer sample cell is situated in an oven which has precise temperature control. Separate temperature control zones are maintained for the oven, sulfur knockout (SKO), sample and vent lines. This microprocessor based analyzer uses the widely accepted method of non-dispersive ultraviolet absorption spectrophotometry to analyze the tail gas stream for H_2S, SO_2, sulfur vapor content and optionally CS_2. The inherently stable optical design, high photometric accuracy of the photomultiplier tubes, and extremely narrow line-width of the light sources, result in a detection system that is characterized by exceptional stability, precision and linearity of response. The analyzer consists of four highly integrated sub-assemblies: the sample handling system, the photometer, the microprocessors, and the process control interface.

2.1) Sample handling system

A properly designed and functional sample handling system is crucial for the proper operation of a Tail Gas Analyzer. This sub-system must ensure that the sample can be transported to the measuring cell reliably, without causing any bias in the measurement. The sample system comprises the sample and vent lines, which transport the sample to and from the analyzer oven, the sulfur knockout vessel (SKO), and an air driven aspirator to draw the sample from the process. The sulfur knockout is maintained at a constant temperature by air flow around the body of the vessel. The SKO ensures that the amount of sulfur vapor in the tail gas is reduced, thereby minimizing the potential for interference during the measurement of both SO_2 and H_2S. Precise PID control is provided to each of the four temperature zones (sample and vent lines, SKO and analyzer oven). The analyzer sample system has been designed to meet the requirements for hazardous area classification (Class 1, Div 1 Groups C&D), and both Cenelec and CSA certification are in progress.

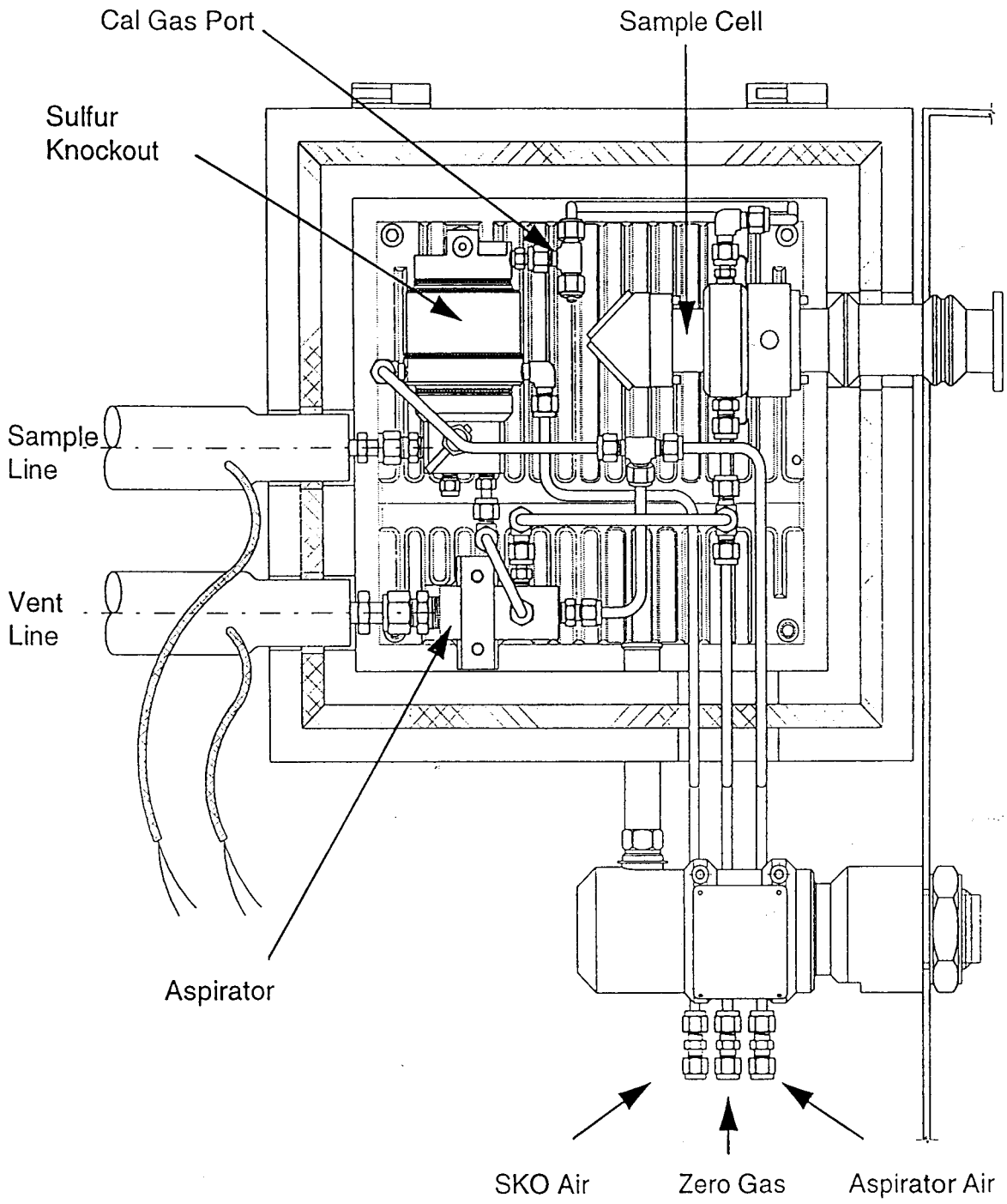

Figure 1. Analyzer sample handling system and oven enclosure

2.2) Photometer capabilities

The accuracy, linearity, response time, dynamic range and immunity to cross-talk of a process tail gas analyzer are determined primarily by the design of the photometer and the data analysis software. Optimal design of the photometer will minimize the requirement for complex data analysis procedures and result in a robust analyzer that can perform reliably over a wide range of process variations.

The photometer is a dual beam system, which uses multiple wavelength hollow cathode lamps as the radiation source and photomultiplier tubes in the detection system. Dual beam photometers have inherently high signal to noise ratios, because variations in the intensity of the light source cancel out in the detection system. Photomultiplier tubes generate very precise and linear measurements of the light intensity, and thus possess high photometric accuracy when compared with solid-state detectors. The extremely narrow line-width (< 0.15 nm resolution) of the emission lines from the hollow cathode lamps ensure that a linear response to the gas phase concentrations can be achieved, unlike the variations which may be observed in photometers employing broad-band sources. Further, the precise wavelength accuracy of the emission lines completely eliminates any potential errors or drift in the wavelength accuracy of the photometer. The photometer fully meets or exceeds the requirements for accurate process tail gas analysis.

The linearity of the response of the analyzer to SO_2 and H_2S is depicted in Figures 2 & 3 respectively. The data presented are based on a random selection of the quality control reports for analyzers passing through production, and are not experimental results for an analyzer which had specifically been optimized for laboratory use. The linearity of response of the analyzer is typically better than +/- 1% for both SO_2 and H_2S. In addition, the reproducibility is typically better than 99.5%. These linearity specifications apply across the entire full scale range of the analyzer (typically 0 - 1 % SO_2 full scale and 0 - 2% H_2S). When spanned to a accurate calibration tank of SO_2 or H_2S (+/- 1%), a relative accuracy of +/- 2% can be achieved across the full scale range of the analyzer. The analyzer is also capable of performing accurate analysis of samples which exceed the recommended full scale range. Typically, the SO_2 channel can be over-ranged by a factor of four and still exhibit +/- 2 % linearity and +/- 3 % relative accuracy, while the H_2S channel can be over-ranged by a factor of two with the same specifications. These factors combine to provide the **linearity**, and **dynamic range** required for SRU control.

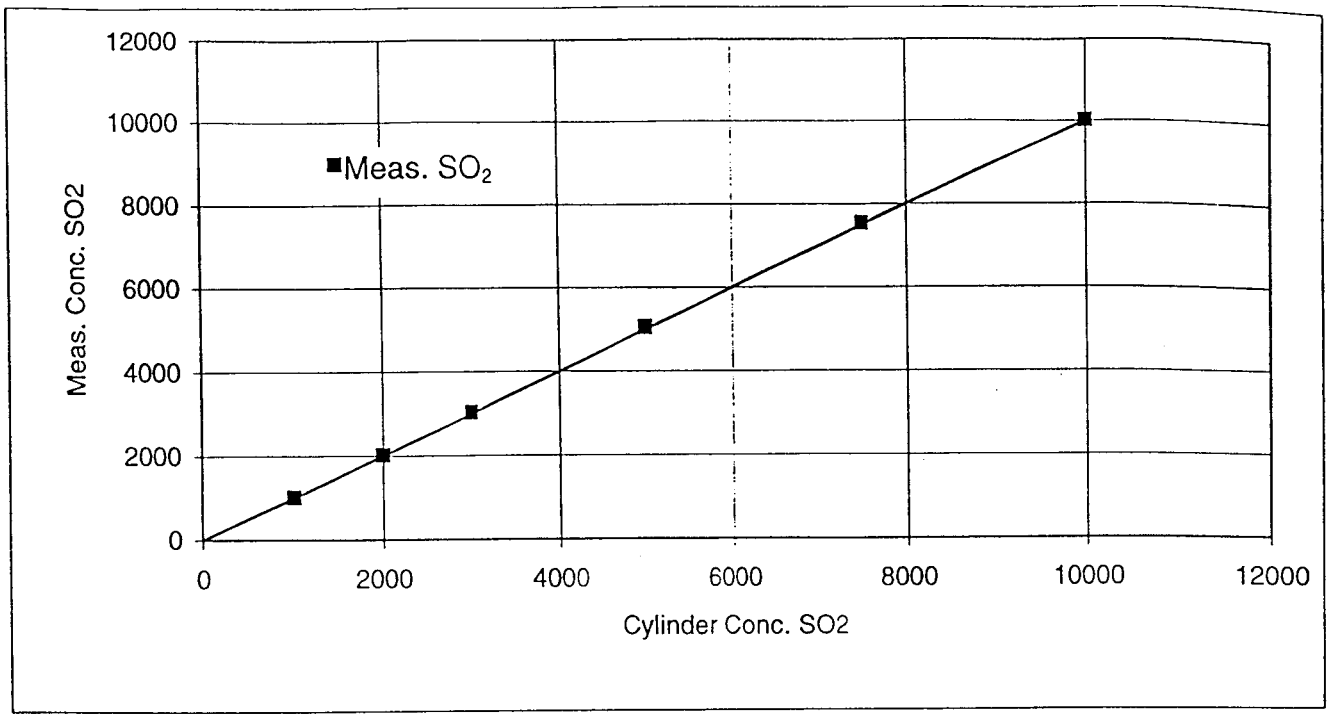

Figure 2. Typical linearity of SO_2 response for 900 ADA. Maximum deviation from linearity was 1.3 %, rms deviations from linearity were 0.7 %.

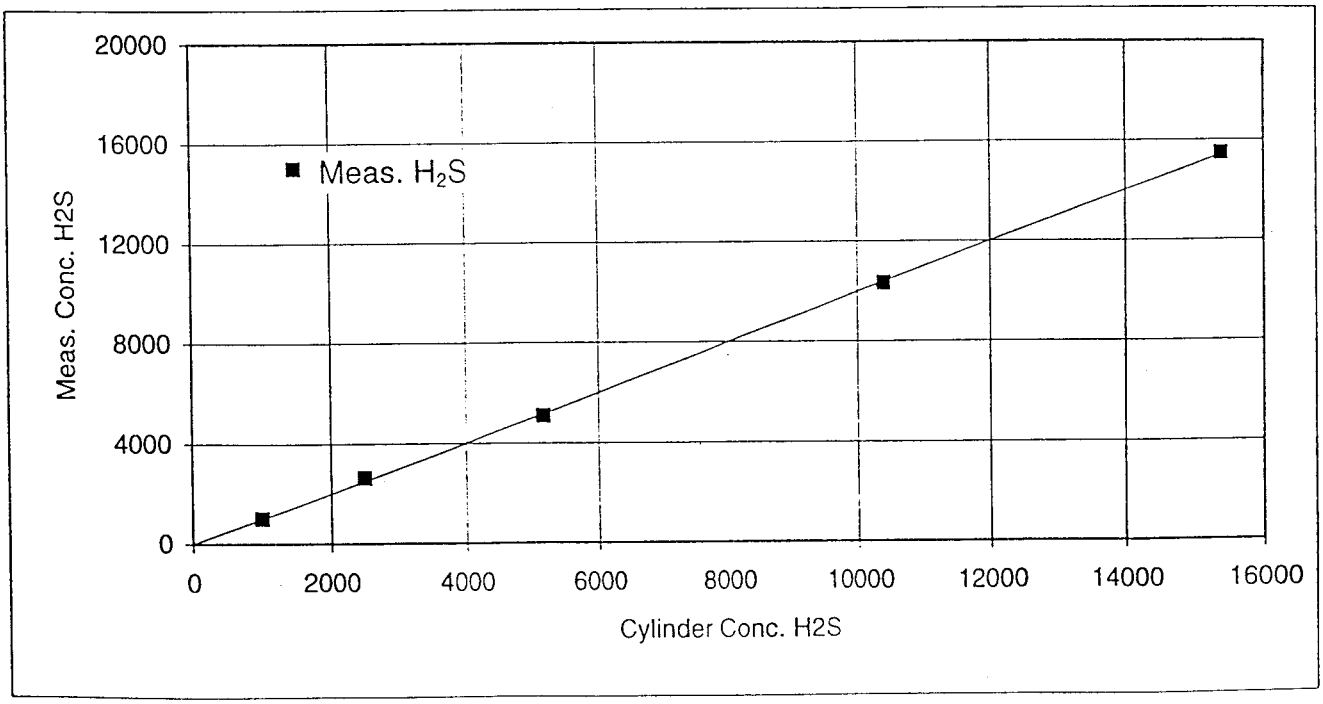

Figure 3. Typical linearity of H_2S response for 900 ADA. Maximum deviation from linearity was 1.7 %, rms deviations from linearity were 0.6 %.

To perform reliable tail gas analyses, it is not sufficient that the analyzer accurately measure the individual species, but rather it is required that multicomponent analysis be performed with minimal cross-talk between species. This can be problematic for analyzers that use broadband radiation, which results in non-linearities in the absorption spectra for species like SO_2. The use of narrow emission lines in the spectrometer minimizes the non-linearities, and results in very low cross-talk between SO_2, sulfur vapor and H_2S. Figure 4 depicts the observed cross-talk of SO_2 onto H_2S during quality control inspection for a random sample of five 900 ADAs. The amount of cross-talk exhibited is expressed as the percentage of the H_2S full scale range that can be observed when measuring SO_2 at a given percentage of its full scale range. Typically, the amount of cross-talk is less than two percent of the SO_2 reading, and is always less than 200 ppm H_2S on a 0 to 1 % SO_2, 0 to 2 % H_2S analyzer. The cross-talk of sulfur vapor onto H_2S and SO_2 is shown in Figure 5. At typical operating sulfur concentrations of 50 to 70 ppm, less than 50 ppm cross-talk onto either the H_2S or SO_2 is experienced.

The absolute accuracy of the H_2S and SO_2 measurements is dependent on the linearity, dynamic range and interference rejection of the analytical technique, as well as on the drift characteristics of the photometer. Three factors are important in describing the types of error that can occur during a measurement cycle: noise, zero drift, and temperature related drift. Noise is determined from the random fluctuations in the photometer over short time intervals (seconds to minutes), while zero drift represents fluctuations which occur over long time intervals. Temperature related drifts are associated with variations in gain of the electronic and opto-electronic components, as well as variations in the performance of the optical components as the temperature of the analyzer varies.

Specifications based on 10 cm Cell, 0 - 1 % SO_2 0 - 2 % H_2S Full Scale		
Characteristic	SO_2	H_2S
Noise (rms)	< 10 ppm SO_2	< 20 ppm H_2S
Zero drift (8 hours)	<50 ppm SO_2	< 100 ppm H_2S
Temperature Drift	< 5 ppm SO_2 / ° C	< 20 ppm H_2S / ° C

Table 1: Noise and Drift Specifications for the BOVAR Western Research Model 900 ADA

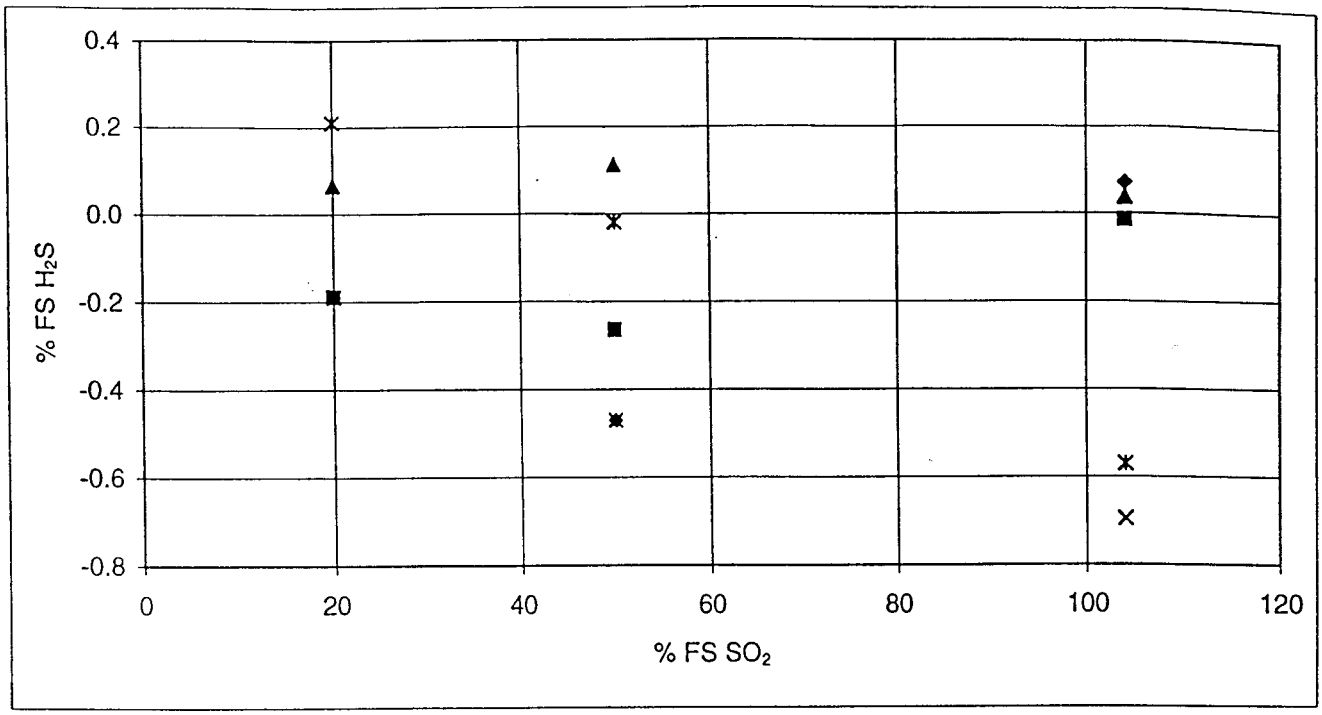

Figure 4. Potential Cross-talk of SO_2 onto H_2S for 900 ADA. The measured concentrations of each species is expressed as the percentage of the full scale maximum for the analyzer. Data displayed are typical results from QC inspection data.

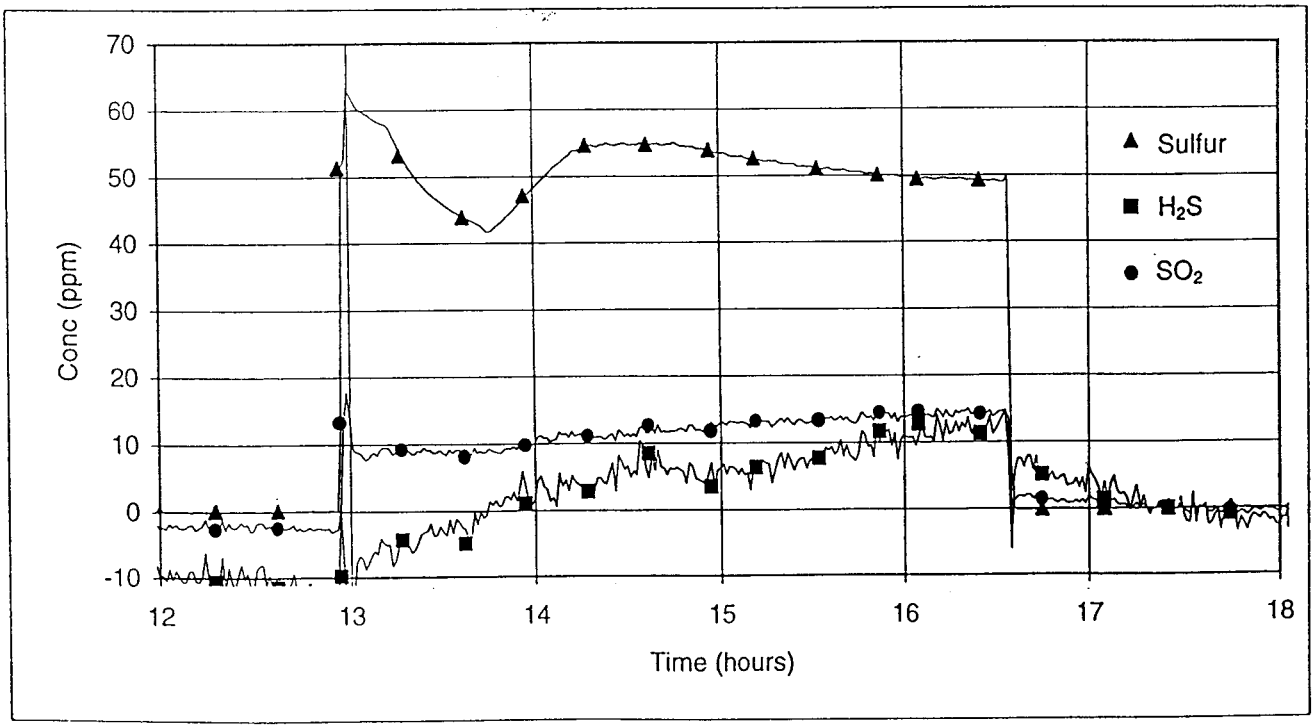

Figure 5. Potential Cross-talk of sulfur vapor onto H_2S and SO_2

In the standard configuration, the analyzer is capable of measuring the H_2S and SO_2 concentrations, as well as the sulfur vapor content. If desired, the analyzer may be optionally configured to include the measurement of carbon disulfide (CS_2). As with SO_2 and H_2S, measurements of CS_2 is similarly immune to noise, interference and drift. However, due to the low molar absorptivity of CS_2, the accuracy specification is reduced, with typical configurations using a 0 - 5000 ppm full scale range for CS_2 and +/- 500 ppm accuracy. This accuracy specification encompasses the range of possible errors associated with the measurement, including zero drift, temperature drift and cross-talk. While the accuracy of this analysis is significantly less than that of the H_2S and SO_2 signals, this signal does not play a part in the control of the process. Rather, its intended use is to provide information on the catalyst activity in the first Claus reactor to the plant operators and engineers. Optimal sizing of the sample cell to maximize the accuracy of the CS_2 measurement would result in poorer dynamic range and accuracy on the control signals.

In summary, the analyzer photometer has been designed to provide accurate measurements of the H_2S and SO_2 concentration, with immunity to noise, cross-talk, interference and drift. The photometer is capable of routinely providing +/- 2 % accuracy on both the H_2S and SO_2 signals over a concentration range spanning from 20 % of the full scale up to twice the full scale specified for the analyzer, and +/- 5 % accuracy for concentrations below 10 % of the full scale range. The analyzer exhibits a linear response to the species of interest, due to the photometric accuracy of the detectors and the narrow line width of the light sources. This ensures that a simple and robust data analysis procedure may be employed. The design of the photometer and data analysis systems have ensured that it is capable of meeting requirements 1 through 4 specified previously.

2.3) Microprocessor capabilities

The data acquisition, data analysis, user interface and process control interface functions of this analyzer are provided by two microprocessors, both housed in the same cabinet as the photometer. One micro-controller performs the majority of the input/output operations, such as data acquisition, signal processing, and photometer control, while a second processor performs the majority of the numerical analysis, DCS interface and user interface functions.

The user interface enables the operator to access all of the parameters used by the analyzer, along with informational items such as a history of any errors which may have occurred. To ensure that the analyzer parameters can not be reset by untrained personnel, two levels of password protection are provided. In the operational (RUN) mode, which requires no password, the current settings of the analyzer can be examined but not changed. Parameters related to the analyzer accuracy, such as span factors, can be modified in calibration (CAL) mode, which requires a password.

Parameters related to the photometer setup and analyzer configuration can only be changed in configuration (CFG) mode, which requires a separate password.

The system performs numerous diagnostic checks on a periodic basis. These diagnostics provide information on the status of the lamps, detectors, sample cell and sampling system. Some diagnostics produce warnings only, indicating that some service may be required, while others are faults indicating that the analyzer is currently not capable of performing the tail gas analysis. For example, a warning is generated if the lamp current is becoming excessive, or if the readings for a species are beyond the range specified for the analyzer configuration. A fault may occur if one of the temperature control zones is not at it's control temperature, or if there is a communication failure between the microprocessors. These diagnostic features are available from the analyzer console, and can also be wired directly into the control room to provide remote diagnostic capabilities.

The microprocessors have complete control over the output capabilities of the analyzer, and the user can modify the configuration of the analyzer outputs. The 4-20 mA (self or loop powered) outputs can be calibrated through the interface software. The analyzer display and analog outputs can be configured to monitor any of the following results: SO_2 Concentration, H_2S Concentration, CS_2 Concentration, Sulfur Vapor Concentration, Drift "Concentration", Air Demand, and/or Trend. Any three output variables may be present on the display, and four can be selected for 4-20 mA output. In addition, a track and hold function is available to hold the outputs at a constant value (either the last measured or a preset value) in the event that the analyzer is performing an automated zero operation. This is especially important in selective oxidation applications, in which the analyzer must be providing a control signal in order for the SUPERCLAUS™ process to be online. The track and hold function thereby allows the analyzer to be calibrated without bypassing the selective oxidation bed. An RS232 or RS422 port is also available to provide additional output capabilities.

The system can be configured to perform functions such as a periodic automatic zero, with adjustable zero frequency and zero duration. With this configuration the analyzer can indicate an off-line condition after the zero function is complete. This ensures that there is sufficient time for the signals to stabilize prior to the analyzer resuming control of the excess air. In addition, the analyzer is continually monitors and controls each of the four temperature control zones to within +/- 0.2 °C. Should one of the temperature zones deviate from the setpoint by more than 5 °C, the analyzer will generate a fault condition and immediately begin backpurging the system. This prevents sulfur condensation and freezing in the sample lines and/or analyzer in the event that a heating element is not functioning.

The advanced capabilities of the dual microprocessors available in this analyzer ensure that it can perform the analysis required, control the sample handling system,

and communicate the results and status of its operation to the user. These features effectively ensure that requirements 5 and 6 discussed previously are met.

2.4) Process control interface capabilities

The results and status of the analyzer can be interfaced to the plant's DCS through the use of close contact switches for fault and warning messages, and 4-20 mA outputs for monitoring species concentration and/or process control variables. The outputs are fully configurable to match the requirements of the plant control system.

The analyzer also supports the MODBUS communication protocol over the RS232 or RS422 port. Through the use of this communication protocol, all of the results, diagnostics and calibration functions performed at the analyzer keypad can be initiated through the DCS. This interface is especially useful in operations which need complete remote control over the analyzer and require more than the four results available from the 4-20 mA outputs. Furthermore, MODBUS is an industry standard protocol, and thus many complementary instruments can be obtained which support this protocol.

The analog and MODBUS output capabilities of this analyzer ensure that an effective and fully featured interface to the process control system can be achieved, thus satisfying requirement 7 stated previously.

3) Field results

Currently, there are approximately twenty Model 900 ADAs in operation around the world, with at least half of these on SUPERCLAUS™ plants. The analyzers have proven to be stable and reliable, and capable of providing the required process information. Typical data from a SUPERCLAUS™ operation and from a conventional Claus with abnormally high CS_2 concentrations are presented here for illustrative purposes.

3.1) SUPERCLAUS™ Operation

The data presented in figures 6 through 8 was acquired from a 900 ADA operating on a SUPERCLAUS™ SRU at a Canadian refinery. The data was acquired by interfacing a laptop PC to the RS232 port of the analyzer, and recording five minute averages of the concentration data. The data presented in figures 6a & 6b represent the measured SO_2 signals during a one week period of plant SUPERCLAUS™ operation. It is important to note that this SRU was on a refinery, and that no feed forward control analyzer was in place. Thus, the SRU was subject to the variations which occur in the upstream process, and significant variations in the acid feed gas composition were common.

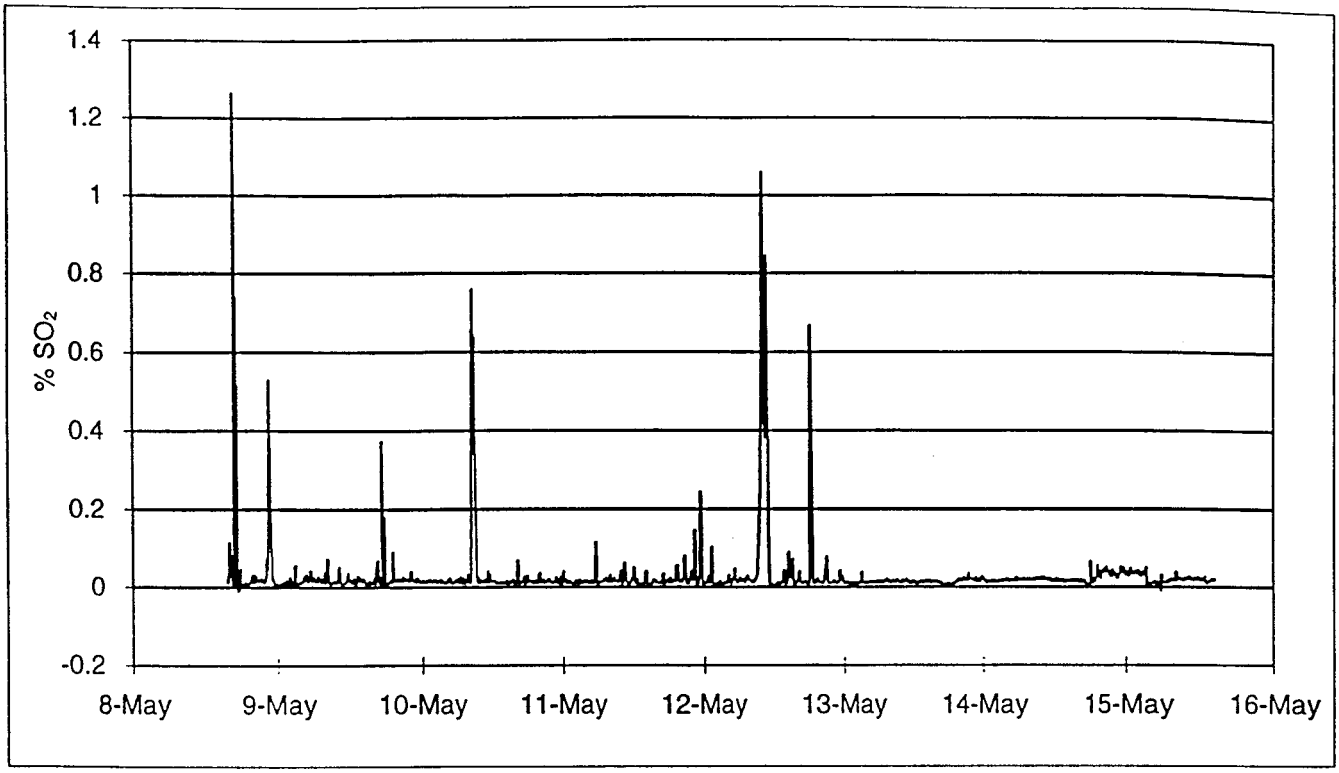

Figure 6a. Measured SO_2 from a 900 ADA on the tail gas stream of a SuperClaus SRU at a refinery.

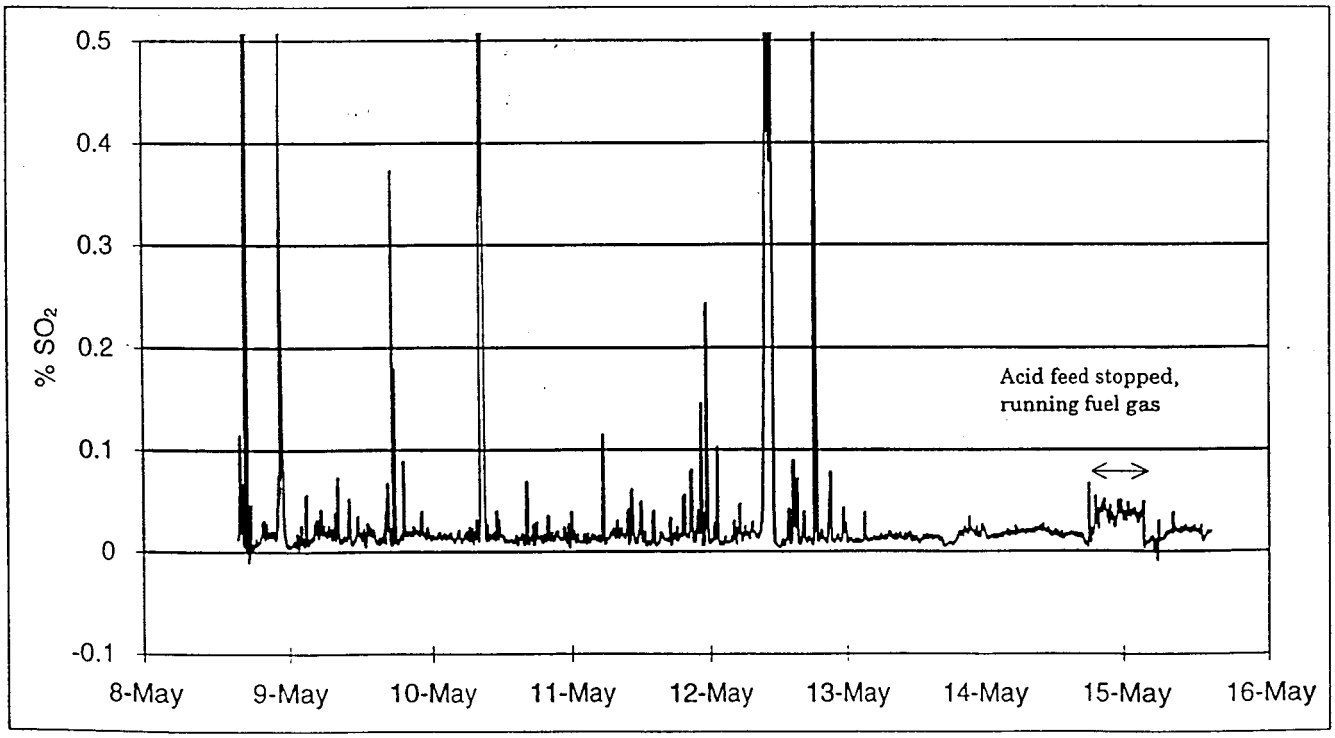

Figure 6b. Rescaling of data from Figure 6a with SO_2 range reduced.

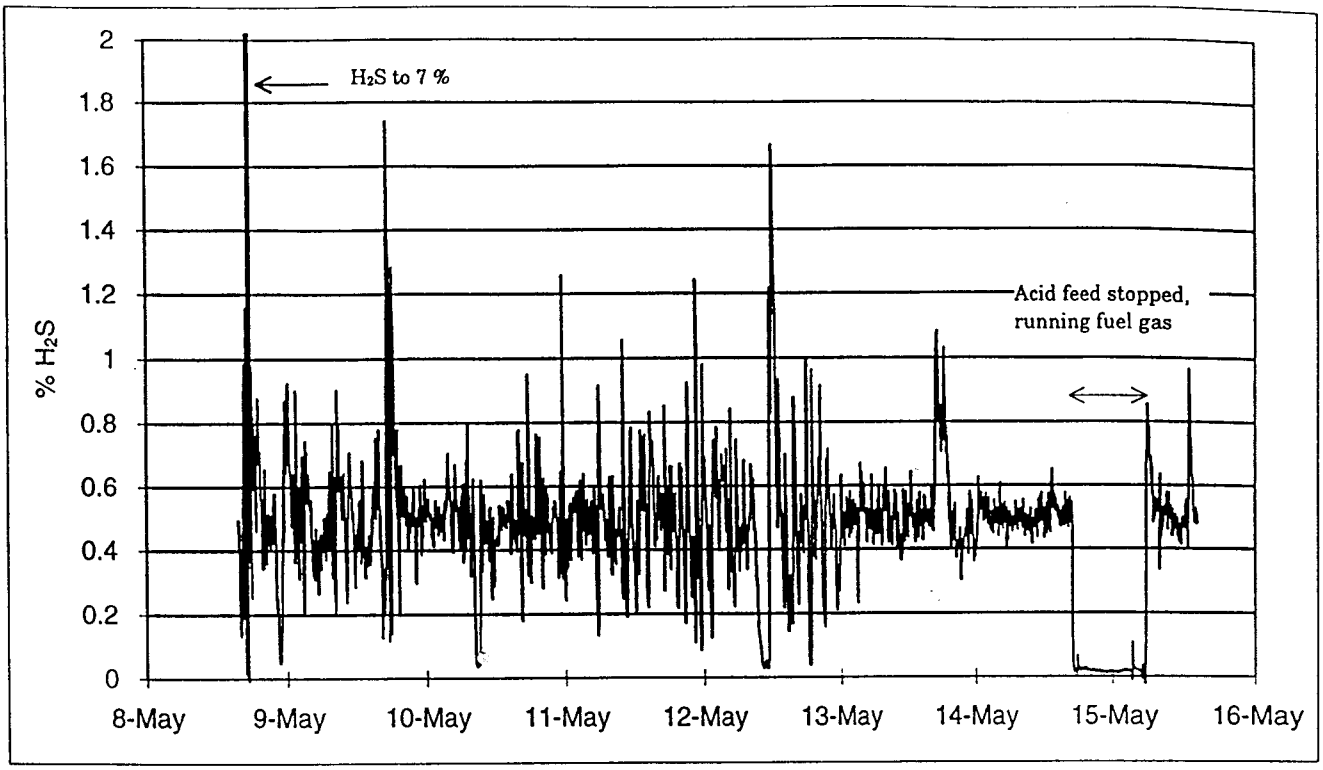

Figure 7. Measured H_2S signal from a 900 ADA operating on the tail gas stream of a SuperClaus SRU at a refinery.

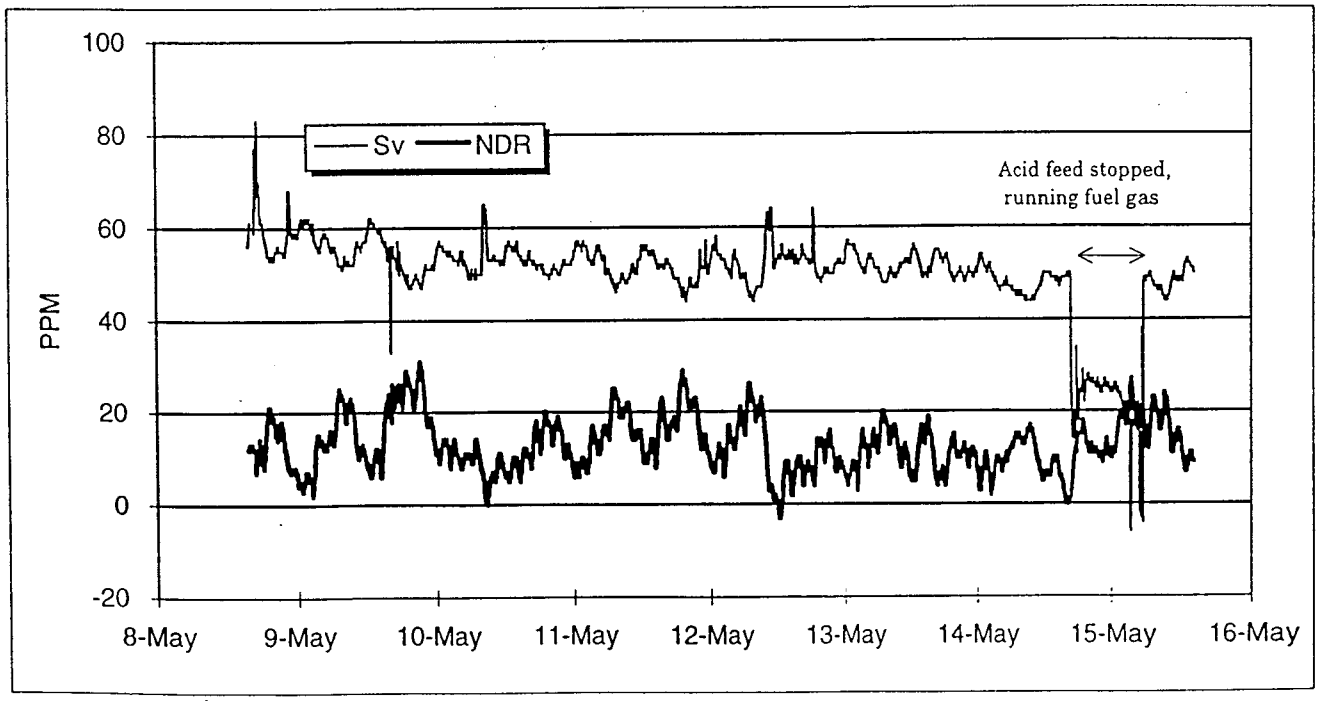

Figure 8. Measured sulfur vapor and drift compensation from a 900 ADA operating on a tail gas stream of a SuperClaus SRU at a refinery.

In figure 6a and 6b, the measured SO_2 concentration is typically 200 ppm, but significant excursions do occur. This emphasizes the requirement for linearity and wide dynamic range in a tail gas analyzer which will be applied to these process streams. The variations seen are typically due to process fluctuations. A period of relative stability is seen during the daylight hours of May 13, 1994. During the four hour period between 12:00 and 16:00, the mean SO_2 concentration was 140 ppm, with a standard deviation of 25 ppm, which demonstrates the stability and precision of the measurement technique. During this same period, the mean H_2S concentration (see figure 7) was 0.51 %, with a standard deviation of 0.04 %. By comparing figures 6a and 7, it is apparent that the analyzer results are consistent with our expectations of the process, in that increases in H_2S concentration occur simultaneously with decreases in the SO2 concentration, and vice versa. While the data presented are for SUPERCLAUS™ operation, some indication of the suitability of the analyzer for catalyst conditioning can also be discerned. During periods of high SO_2 concentration, such as that on May 12, the H_2S signal recorded was on the order of 500 ppm. Thus, the low cross-talk of SO_2 onto H_2S allows for low concentrations of H_2S to be measured when the SO_2 concentration is elevated. Achieving this capability is difficult for analyzers based on broadband ultraviolet sources.

Also of interest is the event which occurred between 20:00 May 14 and 4:00 on May 15. A sudden increase in the SO_2 concentration was recorded. When the H_2S data and sulfur vapor data, presented in figures 7 & 8 respectively, are examined, it is observed that the H_2S concentration and sulfur vapor concentration were reduced dramatically at this same time. These events are completely consistent with the fact that the SRU lost acid gas feed, and switched to refinery fuel gas to maintain the bed and furnace temperatures. The burn was near-stoichiometric, resulting in almost complete conversion of the sulfur species in the fuel gas to SO_2, and producing little H_2S. The measured sulfur vapor was due to entrained vapors as the warm gas passed through the catalyst beds and condensers.

The sulfur vapor concentration and drift correction signal are presented in Figure 8. The sulfur vapor concentration remained relatively constant for the entire week at approximately 55 ppm, with the exception of the period during which the SRU was burning refinery fuel gas. This indicates that the analyzer sample system and SKO were operating correctly and efficiently to control the sulfur vapor concentration in the analyzer sample cell. The drift correction signal is a measurement performed by the analyzer to nullify any drift in the analyzer baseline. One ppm of neutral drift (NDR) corresponds to one ppm of SO_2, and/or two ppm of H_2S drift. The algorithm used in the analyzer uses the NDR measurement to correct the SO_2 and H_2S signals. For the entire week (during which a zero operation was not performed on the analyzer), the amount of baseline drift remained relatively constant between 0 and 20 ppm. This indicates that no significant zero drift had occurred for this week of operation.

In summary, the data presented in figures 6 through 8 indicate that the analyzer can reliably measure the concentration of the species of interest over the range of situations encountered during SUPERCLAUS™ operation. The wide dynamic range is evident by the analyzer response to significant SO_2 excursions. The analyzer is capable of performing tail gas analysis over extended periods of time while exhibiting little or no drift.

3.2) CS_2 Measurements

The concentration of COS and/or CS_2 in the tail gas can serve as an indication of the reactivity of the first catalyst bed of a conventional Claus SRU[3]. Traditionally, COS and CS_2 have been measured by chromatographic analysis of the tail gas stream, and this remains the most accurate method of determining the breakthrough of these species. In addition, the reactivity of the first catalyst bed can be accurately assessed by monitoring the temperature profile across the bed. Despite these available methods, there is increased interest in the dynamic measurement of the CS_2 concentration in the tail gas stream. As mentioned previously, the analyzer is also capable of performing dynamic measurement of the concentration of carbon disulfide in addition to SO_2, H_2S and sulfur vapor. COS measurements are not performed, as this would require a shorter sample cell which would impact on the accuracy and reliability of the analyzer in performing its primary function, the analysis of SO_2 and H_2S concentrations.

The data presented in Figure 9 were acquired using a 900 ADA on a conventional SRU at a plant which is known to have significant quantities of CS_2 in the tail gas. The high CS_2 levels at this facility were due to a number of factors, including high aromatic hydrocarbon content of the feed gas (which both enhances CS_2 production and causes sooting of the first catalyst bed), and high plant loads for the reaction furnace design. The measured CS_2 concentration remained fairly constant for the entire week of data collection, and did not exhibit any cross-talk from the SO_2 or H_2S signals. The analyzer was being operated with auto-zero enabled, and thus the signals dropped to zero periodically. Based on this data, the precision of the CS_2 measurement is approximately ± 100 ppm, although this may be impacted by analyzer drift if the auto-zero capabilities are not used.

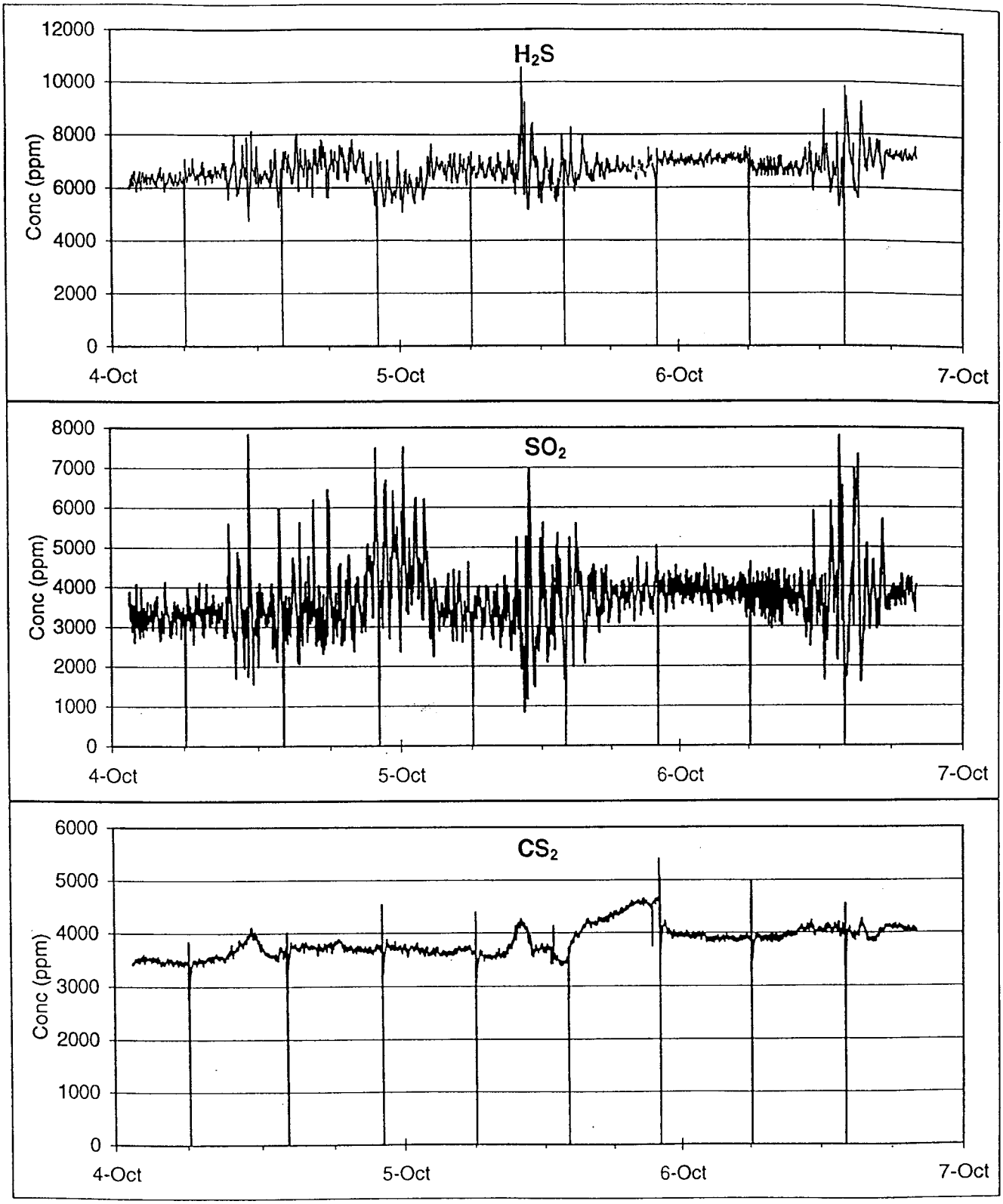

Figure 9. Dynamic H_2S, SO_2, and CS_2 measurements performed by a 900 ADA at a conventional Claus SRU

4) Conclusions

New processes and requirements for SRU applications have increased the demands for accuracy and reliability in tail gas analyzers. In particular, the SUPERCLAUS™ process requires that the analyzer be accurate over a wide range of H_2S and SO_2 concentrations. In addition to the analytical requirements, increased sophistication in the analyzer software is necessary to satisfy the needs of the process control system. These requirements have been addressed in the design of the BOVAR Western Research 900 ADA, and the analyzer has been demonstrated to meet the requirements of:

1) Linearity and dynamic range
2) Minimal cross-talk between species, and interference compensation
3) Low drift and high signal to noise ratios
4) Accurate measurement of the H_2S and SO_2 concentration
5) Integrated calibration and diagnostic facilities
6) Stable operating features for temperature and flow control
7) Reliable and full-featured process control interface to plant DCS.

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