TSA-100

A TOTAL SULFUR ANALYZER

For Continuous Sulfur Monitoring in Liquid and Gas

Applied Analytics **TSA-100**, designed for accuracy, versatility, fast-response, and ruggedness in any range of total sulfur measurements. This innovative multi-component analyzer has critical advantages over older standards such as the lead acetate tape method, a high-maintenance process with slow measurements, cumbersome adjustments, and toxic consumable. Most significantly, the **TSA-100** is engineered for insusceptibility to component cross-interference, meaning that the analyzer can provide accurate total sulfur measurements when interfering compounds like H_2S, SO_2, and mercaptans are all present in the sample.

The system consists of four major subunits: 1) a xenon light source, which sends light through fiber optic cables into the 2) flow cell, in which the unique characteristics of the sample define its interaction with the light; the light then enters a 3) holographic grating, which separates white light into its components such that the 4) diode array detector can measure the intensity of radiation at each wavelength. These measurements report on the absorption of light by the various components in the sample, and thus reveal the concentrations of the components. The analyzer is solid state (no moving parts), making **TSA-100** suitable for even the harshest industrial environments. Using the full high-resolution spectrum from the diode array, our analyzer can easily switch between extreme wavelength ranges to provide instantaneous and continuous measurements at 0-10 ppm and 0-100% all in the same instrument.

AAI offers effectively two different methods of determining total sulfur. In the ***DIRECT METHOD*** (**H2S-220**), the analyzer mathematically derives the concentration of each sulfur compound from the full, high-resolution absorbance spectra it obtains from the original process stream. There is no need to mechanically consolidate all sulfur into one specific component, as by combustion in the standard method. The concentrations of sulfur based components like H2S, COS, and mercaptans are computed individually from the spectrum and added together, such that the computer outputs a total sulfur reading. The direct method effectively measures total sulfur in the original process stream as multiple components.

The second is the conventional *STANDARD METHOD* (**TSA-100**), which involves placing the hydrocarbon sample in a hot combustion tube in an oxygen-rich environment (ASTM D 5453 – 06) The sulfur is oxidized to SO_2. The analyzer uses the absorption of the single component (SO_2) to determine its concentration, and the total sulfur. The **TSA-100** provides the ideal SO_2- monitoring solution in case the standard method is your route. The **TSA-100** is recommended for streams containing high-level aromatics.

Comparison to paper tape: The paper tape method has several important shortcomings which help elucidate why it may be an outdated system. In this method, H_2S and lead acetate react to form a color spot of lead sulfide precipitate on the tape. The rate that the color changes is related to H_2S concentration.

The most obvious flaw with the paper tape is an economic one: as a consumable, the tape must be continually purchased and replaced. Furthermore, due to the hazardous nature of lead acetate (causes fetal mortality, possibly carcinogenic), the tape must be returned after use to the manufacturer for disposal. The purchase and disposal of paper tape become constant expenditures which, over the long run, are of great financial concern.

In addition, a moving parts sulfur-detection system relying on paper tape requires substantial maintenance, frequently incapacitated by sample saturation or tape replacement. The regular response time can be as long as several minutes, depending on the sulfur concentration. Lastly, this method is quite vulnerable to inaccuracies stemming from cross-interference among the sample components.

The advantages of the TSA-100 over paper tape are economically, environmentally, and technologically significant. The spectrophotometric principles of the analyzer eliminate the need for costly, polluting consumable like lead acetate; the only part that would ever need to be replaced is the inexpensive and long-lasting xenon lamp. The analyzer is solid state (no moving parts), and since it connects to the sample through fiber optic cables, it can be installed far from any explosive or poisonous gases.

While lead acetate tape gives slow, discrete measurements, the TSA-100 provides instantaneous and continuous measurements. Using the full high-resolution spectrum obtained by the diode array, the analyzer can easily switch between extreme wavelength ranges, allowing measurements of 0-10 ppm and 0-100% in the same instrument. Comparable range flexibility using paper tape might require dilutions, producing an additional sampling concern and possibly inviting inaccuracies.

The cross-interference of H_2S, mercaptans (the functional S-H group), SO_2, and other sulfur compounds is a concern which makes the paper tape method incompatible with the current technological demands of industry. AAI's innovative analysis corrects for this interference, allowing simultaneous measurement of all sulfur components and the *total sulfur* .

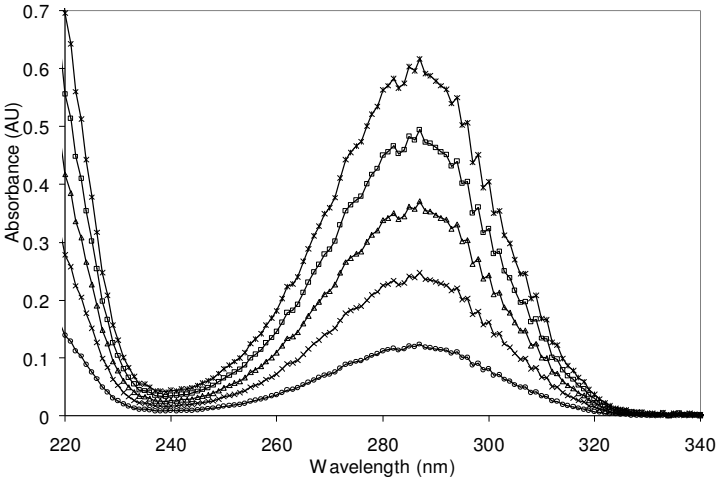


Figure 1: Absorbance spectra of SO_2 , different concentrations

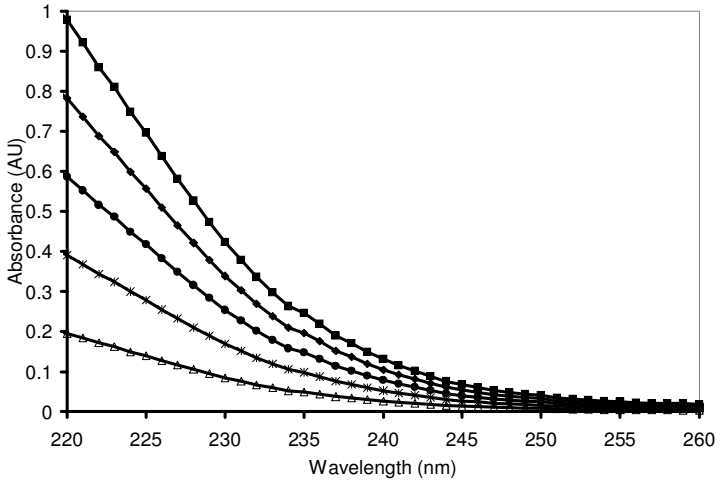


Figure 2: Absorbance spectra of H_2S , different concentrations

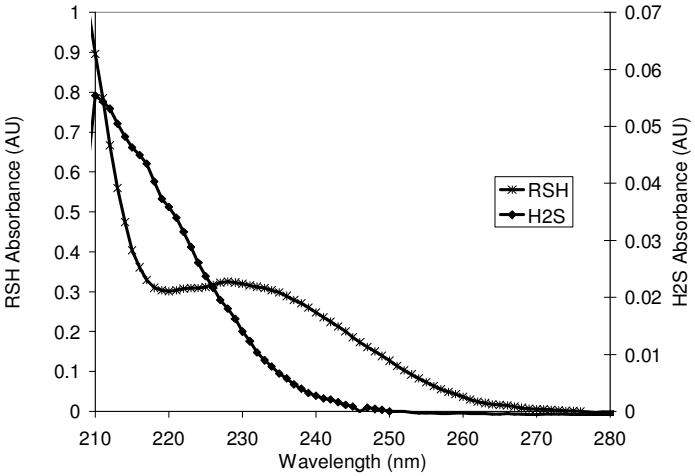
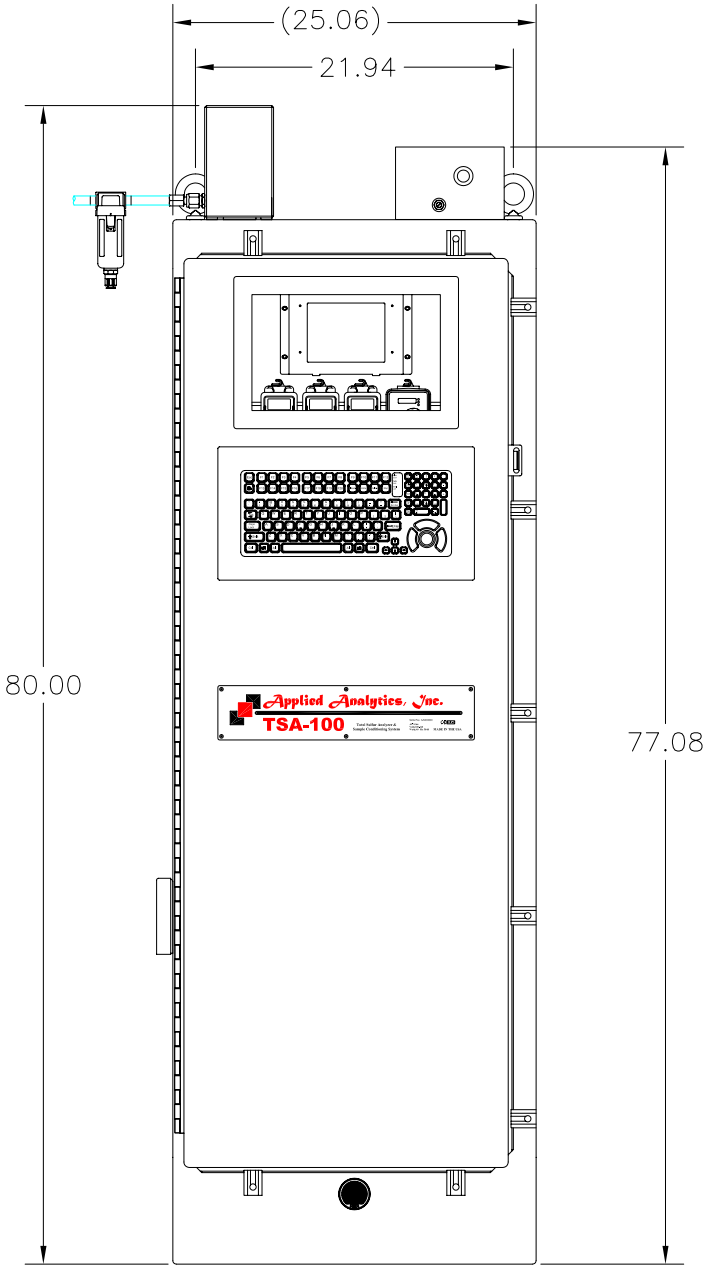


Figure 3: Absorbance spectra of H_2S and methyl mercaptan

Total sulfur by conversion to SO_2 (combustion sampling system)

The sulfur based compounds in the sample stream are pyrolyzed to give SO_2. The flow of the sample gas and O_2 are regulated to keep the correct mixture for optimal conversation. These gases are mixed in a chamber before they are injected into the furnace where all sulfur compounds are converted into SO_2. The SO_2 is then transferred into the analyzer's flow cell where it is measured by a UV process diode array spectrophotometer. The SO_2 stream is returned to a waste line that can be vented or sent to the flare. The sampling system allows for automatic zero (blank) with Nitrogen at preset time intervals.

ENCLOSURE:
72" X 25" X 18" PAINTED CARBON STEEL
NEMA 4 COMPLIANT



TSA-100 Specifications

Measurement principle	UV absorbance
	The process fluid and a stream of O_2 flow through a quartz tube that is heated to 1100 °C. The SO2 that is generated is then passed to a flow cell where it is measured by UV absorbance.
Total sulfur by conversion to SO2 (combustion sampling system)	The sulfur based compounds in the sample . stream are pyrolyzed to give SO2. The flow of the sample gas and O2 are regulated to keep the correct mixture for optimal conversation. These gases are mixed in a chamber before they are injected into the furnace where all sulfur compounds are converted into SO2. The SO2 is then transferred into the analyzer's flow cell where it is measured by a UV process diode array spectrophotometer. The SO2 stream is returned to a waste line that can be vented or sent to the flare. T he sampling system allows for automatic zero (blank) with Nitrogen at preset time intervals
Detector	1024 elements diode array
Light source	Long life Xe lamp
Components	H2S COS mercaptans SO2
Flow cell	Fiber optics transmit light to and from cell (Fiber length depending on installation) (flow cell length depending on H2S concentration)
Repeatability	±0.5% of scale
Measurement range	0-10PPM; 0-100PPM; 0-1000PPM; 0-1%; 0-100%
Accuracy	±1% of scale (or ±1PPM)
Zero drift	2% for 24 hour (5% for low PPM range)
Response time	20 sec
Ambient Temperature	0-55C(32 to130F) standard -20C to 55C (-4 to 131 F) optional
Flow cell	
Temperature	-50 to 300C (-60 to 570F)
Pressure	200 bar (3000 psig)
I/O	
Analog outputs	two galvanically isolated 4-20mA (additional channels are optional)
Digital communication	RS232 Modbus, TCP/IP Modbus
PLC	OPC server included
Fault relay	One SPDT alarm relay

Spectrometer	
Wavelength range	190-800nm
Slit Width	1nm
EP resolution	>1.6 toluene in hexane, ratio absorbance at 269nm / 266nm
Wavelength Accuracy	<±0.5nm (NIST 2034)
Wavelength reproducibility	<±0.04nm (NIST 2034)
Photometric accuracy	±0.005 (NIST '930e)
Photometric noise	<0.002AU 32 scans at 0 AU at 250nm
Photometric stability	<0.002AU/h at 0AU at 340nm +-10C
Power	80 to 240 Volts AC 40 to 60 Hz, 20 Watts
Analyzer Dimensions	16"(H)x14"(W)x8"(D) (41x36x20cm)
Sampling system	24"(H)x24"(W)x12"(D)

Area Classifications	Standard
General purpose NEMA-4X IP 65	Optional (Z purged)
US Class I Div. 2 Groups C&D	
Zone 2(22) Category G D3	Optional (X purged)
US Class I Div. 1 Groups B,C&D	
EEx d II C T6 Category G D2	Optional (Enclosure)
NEMA 6 Class 1 div 1 B,C,D	Complies with all relevant European directives
EMC and LVD	SO2 in N2 gas for calibration
Supplies	N2 for Zero
	O2 for combustion
	Air for purging

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