



TELEDYNE
ANALYTICAL INSTRUMENTS
A Teledyne Technologies Company

MODEL

6000/6400-TSG

and

6000/6400-TSL

Sulfur Analysis Systems



- Designed to meet technical requirements of ASTM D5453 and ASTM D6667
- Ultra-low detection to 10ppb Total Sulfur
- Ranges as low as 0-200ppb Total Sulfur



TOTAL SULFUR APPLICATION

Steam Methane Reformer (SMR)

Hydrocarbon feed-stocks are routinely passed over expensive catalysts for conversion purposes. Undesirable sulfur compounds present in the feed stream can serve to poison the catalyst and reduce its conversion potential. By continuously detecting the total sulfur content present on the inlet and outlet of a sulfur scrubber, the operator can gain an early warning of an upset or break-through condition and take preventative steps that will serve to preserve the catalyst life and increase product yields.



Refinery Fuel and Flare Gases

Stricter environmental regulations have led to an increased demand to continuously monitor total sulfur content found in refinery fuel gases, hydrogen recycled gas streams, re-useable natural gas, flare vent gases (Rule 1118) as well as in liquid-based fuels such as gasoline, diesel fuel, jet-fuel, kerosene and other engine oils. Studies have shown that fuel sulfur atoms can bond with reactive sites on the catalyst surface of a vehicle's catalytic converter preventing the reactions needed to break down NOx and hydrocarbon emissions.



Hydrogen Sulfide in Natural Gas

Natural gas processing plants are used to purify the raw natural gas extracted from underground gas fields. After removal of liquid water & condensates, acid gases like hydrogen sulfide (H₂S) and CO₂, are typically removed by an amine scrubber. Continuous detection of H₂S is conducted before and after the acid gas removal process to ensure proper operation of the purification process. Monitoring of the incoming gas to the plant to assess corrosion of the pipelines is also commonly done to ensure pipeline integrity.



Food and Beverage Grade Carbon Dioxide

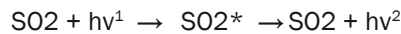
The CO₂ used in the beverage market is typically reclaimed from natural gas, chemical plants and power plants and then cryogenically purified. Quality assurance in the beverage industry starts by ensuring that the CO₂ source gas, used in the carbonization process, has been properly purified and delivered contamination-free to the bottling/canning operations. For health and safety purposes, industry regulations call for the analysis of unwanted impurities in the pure CO₂—namely, total sulfides, which are known to cause unwanted sensory effects on humans.



SERIES 6000/6400E OVERVIEW

The TAI Series 6400E utilizes our field-proven ultraviolet (UV) fluorescence technology to continuously monitor the Total Sulfur content found in process gas and liquid feeds. UV-Fluorescence is a non-consuming method of detection, eliminating the hassles associated with replacing tape cartridges, and enables detection as low as 10 ppb, depending on application, with stable, reproducible results.

The undesirable sulfur compounds present (i.e. H₂S, DMS, COS, CH₃SH, CS₂, etc) are converted into sulfur dioxide (SO₂) under precisely controlled temperature and flow conditions.



When SO₂ is exposed to UV light energy, hv¹, it creates an “excited” form of sulfur dioxide, SO₂*. A molecule in a high, vibrational level of the excited state, SO₂*, will quickly fall to its lowest vibrational level by losing energy to other molecules through collision. Fluorescence occurs when the molecule returns to its electronic ground state. The intensity of the emitted light, hv², is directly proportional to the total sulfur content found in the sample.

To provide the end-user with the most reliable sulfur conversion capability possible, TAI has developed two converter modules which are tailored to contend with the process stream variations expected in either gas (Model 6000/6400-TSG) or liquid (Model 6000/6400E-TSL) phase applications.

TAI Converter Technology

TAI'S Model 6000/6400-TSG utilizes a flame combustion converter module (FCCM) which provides a complete combustion conversion of the sulfur compounds present under the intensity of a hydrogen flame. The FCCM approach is best suited for gas phase applications where the analyzed sample is either steady-state or having a wide variation in the hydrogen or hydrocarbon content. Furthermore, the FCCM approach also provides a truly continuous analysis providing a real-time indication of the total sulfur content present in the sample gas. The FCCM is capable of oxidizing raw or unrefined fuels without coking and no carrier gas or switching valves are necessary.

For Total Sulfur analysis in liquid fuels, TAI's Model 6000/6400-TSL performs the sulfur oxidation conversion with a quartz tube converter module (QTCM). A fixed volume of fuel is mixed with a carrier gas into the electrically-heated QTCM, vaporizing the fuel and oxidizing the sulfur into sulfur dioxide at 1,100 Deg C to ensure complete conversion of all sulfur compounds. Enhanced temperature and flow control is built-in to ensure excellent repeatability.

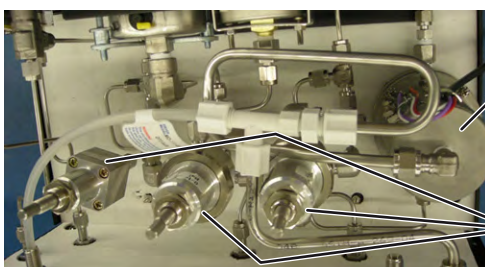
The converted sample gas is passed from either the FCCM or QTCM, through a drier for water removal, and directly onto the Model 6400E UV Fluorescence Analyzer where the SO₂ Analysis takes place and is conveniently displayed, as Total Sulfur, for the operator to view.



TAI Model 6400E UV Fluorescence Analyzer

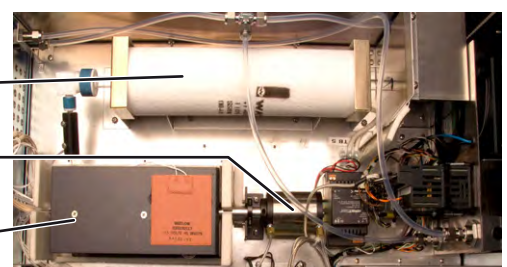
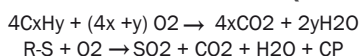


TAI Model 6400E-TSG installed on a California Refinery Steam Methane Reformer



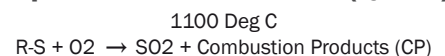
Flame Converter Module
Utility Gas Regulators

Gas Phase Conversion (FCCM)



Quartz Tube Module/Heater
Switching Valve
Pre-heater

Liquid Phase Conversion (QTCM)



USER INTERFACE COMMUNICATION & DIAGNOSTIC LINKS - FEATURES & BENEFITS

User Interface Communication & Diagnostic Links

The Series 6400E is a single or multi-stream analysis system solution which provides the end-user with a wide variety of links to ensure effective system operation. In addition to conventional 4-20mA outputs for tracking the Total Sulfur concentration, the 6400E can also provide a number of discrete I/O's as well as a bidirectional RS-232C serial link and Ethernet communication capability. This enhanced system communication capability allows the end-user to maintain an up-to-the-minute status of how the system is functioning and allow for a remote calibration or range change, should process changes so dictate.



Outputs:

- 4-20mA TS Concentration
- Alarm Relays – Conc. & Fault

I/O:

- RS-232C Bi-directional interface
- Ethernet Communication
- Range Selection
- Calibration Mode
- Detector Temperature
- Sample Flow
- UV Lamp Voltage
- Converter Status

Features and Benefits

- Continuous analysis of total sulfur content, under gas-phase conditions, using TAI's Flame Combustion Converter Module (FCCM) technology providing immediate, real-time TS readings for enhanced process control.
- Superior flow and temperature control of liquid-phase samples via TAI's Quartz Tube Converter Module (QTCM) Pyrolysis Technology ensuring high reliability and repeatability.
- Wide dynamic detection capabilities from ppb up to % levels.
- Excellent linearity for both gas and liquid phase conditions.
- Wide range of analyzer diagnostic capabilities to continuously provide plant operators with system status conditions .
- Easy-access, dual-door (front & rear) NEMA-4/4X system enclosures.
- Multi-stream, sequencing capabilities with a single system providing reduced capital and installation costs.
- Purged cabinet solutions for hazardous area installations with ambient temperature control devices designed-in for reliable field operation.
- Ethernet connection allowing for remote control without having to defeat system purge.
- Front panel, weather-proof N4 control switches allowing for local control without having to defeat system purge.
- Sulfinert treated wetted parts to ensure trace levels of sulfur compounds are not absorbed into the pores of the tubing. Ensures accurate and quick response to process changes.

ASTM D-6667

Standard Test Method for determination of Total Volatile Sulfur in gaseous hydrocarbons by UV Fluorescence

ASTM D-5453

Standard Test Method for determination of Total Sulfur in light HC's, spark ignition engine fuel, Engine Diesel Fuel and Engine Oil by UV Fluorescence

Sulfide Speciation

For various applications, you may want to speciate and report just the amount of H₂S present in your sample - in addition to reporting the Total Sulfur content present. TAI has developed a sampling methodology which allows for this type of analysis. By placing a GC column upstream of the converter module, and using a switching valve to allow for the introduction of a carrier gas, TAI can selectively provide a readout for desired sulfide compounds. TAI's sulphide chromatograph capabilities offer the ability to speciate and quantify the amount of hydrogen sulfide, mercaptans and thiophene present in your sample gas.

TECHNICAL SPECIFICATION

	Model 6000/6400 - TSG	Model 6000/6400 - TSL
Detection Method	UV-Fluorescence	UV-Fluorescence
Converter Method	Flame Combustion Converter Module (FCCM)	Quartz-Tube Module (QTM)
Analysis	Continuous	Semi-continuous with updates every 2-6 minutes
Compliance	Designed to meet requirements of ASTM D6667	Designed to meet requirements of ASTM D5453
Area Classification	Class I Div 1 / Zone 1 and Div 2 / Zone 2 versions with third-party approved purge available as standard	Class I Div 1 / Zone 1 and Div 2 / Zone 2 versions with third-party approved purge available as standard

Range	0-200 ppb to percent levels Total Sulfur (TS) - specify at time of order	0-30 ppm to percent levels
Repeatability	±2% of full-scale, optionally ±1%	±2% of full-scale, optionally ±1%
Response Time	90% of full-scale in less than 100 seconds	90% of full-scale in less than 8 minutes
Operating Temperature	41-104 °F (5-40 °C)	41-95 °F (5-35 °C)
Zero and Span Noise	Less than 1% of full-scale	Less than 1% of full-scale
Zero and Span Drift	2% of full-scale per week, optionally 1%	2% of full-scale per week, optionally 1%
Alarms	One system alarm and two concentration alarms. Form-C relays rated @ 3A 125VAC	One system alarm and two concentration alarms. Form-C relays rated @ 3A 125VAC
Supply Voltage	110 or 220 VAC 50/60 Hz	110 or 220 VAC 50/60 Hz
Maximum Power Consumption	500 W	1850 W
Outputs	4-20 mA DC (isolated) RS-232 Ethernet (optional)	4-20 mA DC (isolated), 0-1 VDC RS-232
Maximum Load Impedance of 4-20 mA Output	500 ohms	500 ohms
Flow Rate	10 SCFH (5 LPM) standard	60 ccm standard
Utility Gases	Air, <1 ppm sulfur (500 ccm nom, 40 psig) Hydrogen, <1 ppm sulfur (30 ccm, 40 psig) Nitrogen or air for purge (optional) Zero and span calibration gases	Air, (1 LPM, 40 psig) Nitrogen or air for purge (optional) Zero and span calibration liquids
Dimensions	6400 25" W x 72" H x 30" D (635 x 1829 x 762 mm) 6000 48"W x 60"H x 16"D (1219 x 1524 x 406 mm)	25" W x 72" H x 33" D (635 x 1829 x 838 mm) 48"W x 60"H x 16"D (1219 x 1524 x 406 mm)



**Class I Div 2 air-conditioned system approach
for high ambient temperature installations**



**6000 TSL wall mount design for installations
in shelters**



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Warranty

Instrument is warranted for one year against defects in material or workmanship.

NOTE: Specifications and features will vary with application. The above are established and validated during design, but are not to be construed as test criteria for every product. All specifications and features are subject to change without notice.

TAI Representative

