BASLFR

GASEOUS SULFUR COMPOUNDS ANALYZER

Rev. 2.0

BASLFR is part of the **BAGGI BASE® Instruments Series**.
They are the result of combining the latest state-of-the-art-technology with over 60 years of industry experience.
This analyzer uses ultraviolet spectrophotometry for measuring the concentration of Sulfur compounds in a gas mixture.

BAGGI BASE® offer solutions for measurement and analysis in gases, solids, liquids, steam and multiphase:
Temperature
Humidity
Velocity – Flow
Pressure
Level – Interface
Components Analysis
Sampling and Filtration
Data Acquisition
Data Communication
Vision systems

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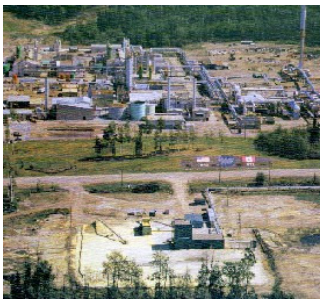
1 Introduction

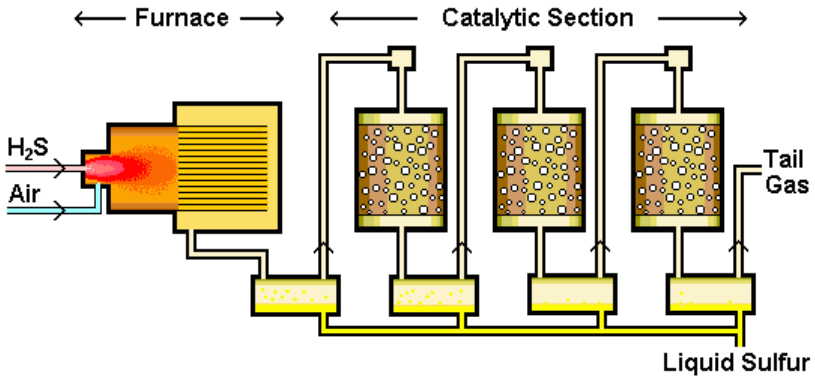
The BAGGI® BASE instrument BASLFR offers accurate measurements of sulphur compounds (typically H_2S, SO_2, CS_2 and COS) concentration in a mixture of gases.



The instrument is based on a Ultra-Violet (UV) spectroscope that provides high wavelength resolution.
The measurement technique relies on the *Beer-Lambert* law.
This one is a relationship that relates the absorption of electromagnetic waves energy to the properties of the material through which the waves are travelling.
The material (gas) is introduced in a sample cell of specific optical path length.
The UV energy is transmitted to the cell via an optical fiber cable, it passes through the gas space and the residual energy is transmitted to the UV sensor by a second optical fiber. The analysis of the wavelengths where energy has been absorbed allows to calculate the concentration of the compounds under measurement.
The analyzer is optimized for the following measurement ranges:

- H_2S (hydrogen sulphide): 0 – 5 %
- SO_2 (sulphur dioxide): 0 – 5 %
- CS_2 (carbon disulfide): 0 – 0,5 %
- COS (carbonyl sulphide): 0 – 0,5 %

but the measuring principle applies to any other compound that has an absorption spectrum in the UV/Visible band.
A very common application is Tail Gas analysis in the Claus Sulphur Process Control (refer to the figure beneath):



In this application, the analyzer is also able to calculate the Air Demand output signal, for driving the combustion air to the furnace.
It is suitable for outdoors installation (ATEX zone 2).
Maintenance is reduced to a minimum due to:

- Very long life UV lamp
- Direct mount on the process pipe
- Ruggedized components
- Controlled sulfur condensation
- Cell clean-up with instrument air
- No moving parts
- Self-monitoring
- Calibration facility
- Remote control

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2 Architecture

Embedded computer

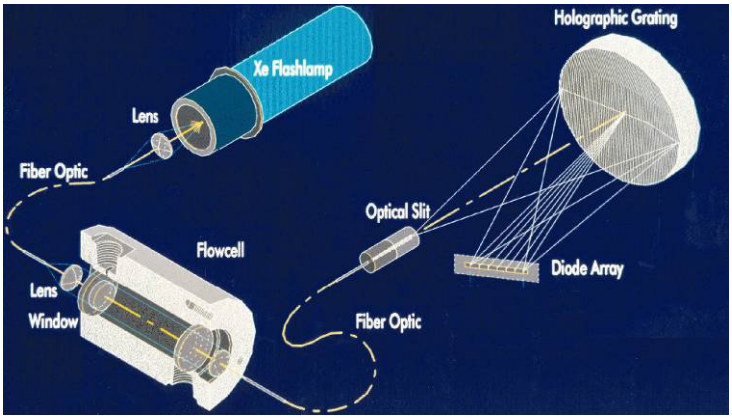
The implementation of the BASLFR analyzer follows the general philosophy of the BASE Instruments Series.
The raw input data from the sensors (UV spectrophotometer) are processed by algorithms provided by BAGGI, running in an embedded computer that is the heart of the system.
The computer, together with the sensors and the power supply, is within an enclosure provided with a protective purge system and a Vortex cooler (connected to the plant instrument air system).
The following figure shows the computer's monitor with the functional keys:

The computer is in charge of:

- Actuating the UV lamp of the spectrophotometer
- Reading the electrical signals from the CCD array (related to the intensity of the absorbed UV energy)
- Calculating the concentration of the compounds
- Calculating the combustion air demand (when required)
- Actuating the digital/analog conversion for outputting the calculated values over 4…20 mA signals
- Actuating the output relays for indicating possible alarms
- Displaying the measurement output data in a Graphical User Interface (GUI)
- Storing the measurement archives into non volatile memory (Microsoft Office compatible format)
- Interfacing the human operator for system configuration and alarm reporting
- transmitting remotely the information/alarms via serial lines, Ethernet and WiFi;

Spectrophotomer

The spectrophotomer schema is shown below:



The instrument is composed of an UV lamp and a diode array. The UV beam, after passing through the measurement cell, reaches a holographic grating disk. This one diverts each wavelength composing the beam onto a specific diode of the array. The voltage emitted by the individual diodes is measured and this information is acquired by the embedded computer through a serial line.
There are no moving parts.
The computer knows the amount of UV energy that has been transmitted by the lamp and is able to draw the absorption spectrum. Finally it calculates the concentration of the components.
The spectrophotometer is controlled by the computer by means of an internal USB line and is housed in the same enclosure. The measurement cell is placed on top of the sample probe (see next page).

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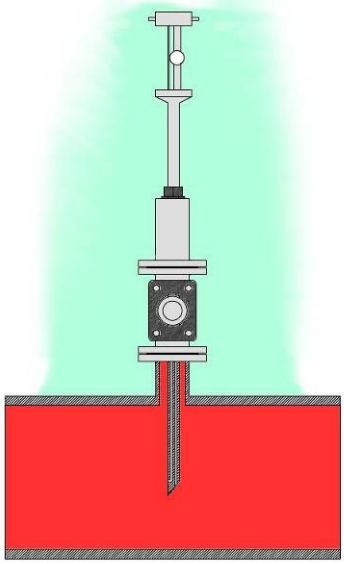
Probe

The third main component of the analyzer, in addition to the embedded computer and the spectrophotometer, is the sample probe. No sampling system is needed, the probe is inserted directly into the process pipe.



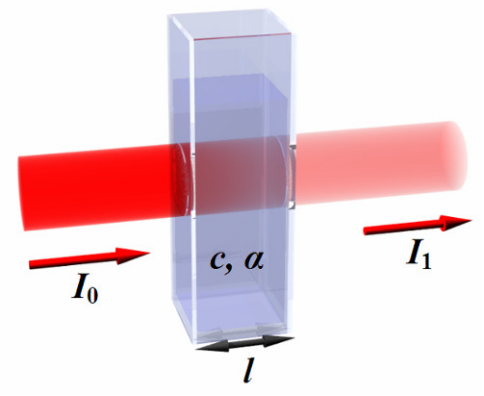
The sample probe has been designed to solve the common problem of sulfur clogging.
In particular, the sample is taken from a small pipe inside the probe, its temperature is decreased by a cooler to let the sulfur vapor to condensate and fall back into the process.
The sample is then heated to the same temperature of the process (to prevent the condensation of any residual sulfur) and passes through the measurement cell.
The core analyzer (computer + spectroscope) can be mounted near the sample location on a self standing skid.
The connection from the core analyzer to the sample probe is made by two Stainless Steel armored fiber optics cables.

The measurement cell is able to provide the following additional pneumatic inlets and outlets:

- Calibration gases from certified cylinders
- Instrument air and steam for cleaning purposes (optional)

3 Principle of Operation

As anticipated, the measurement is based upon the Beer-Lambert law.
This one is an empirical relationship that relates the absorption of light (or UV waves) to the properties of the material through which the light (UV) is travelling.
The measurement is centered on the wave length where the investigated material has maximum energy absorption.



In the figure, $\mathbf{I_0}$ and $\mathbf{I_1}$ are the intensity of the incident signal and of the outgoing signal, respectively;

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l is the length of the path, **c** is the substance (e.g. H_2S) concentration and **α** is a constant related to the substance.
α can be written as:
α = εl
where **ε** is the molar absorptivity of the absorber (e.g. H_2S).

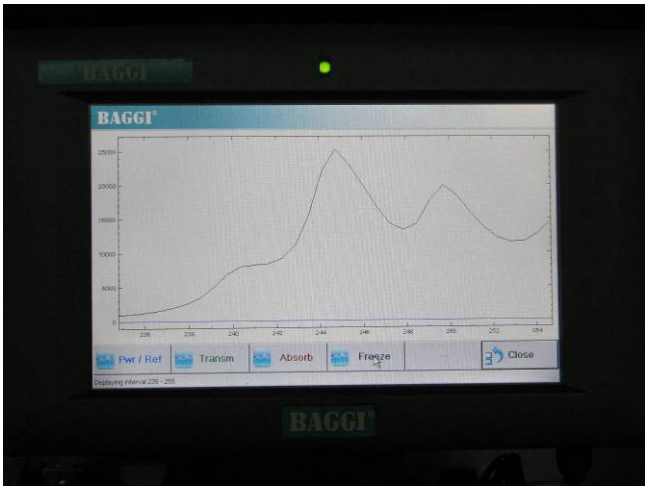
The following relation holds:
$$I_1/I_0 = 10^{-\varepsilon lc}$$

The transmission of the signal through the sample is expressed in terms of "**absorbance**", which is defined as:
$$A = -\log_{10}(I_1/I_0)$$

This implies that the absorbance is linear with the concentration:
$$A = \varepsilon lc$$

The analyzer establishes the intensity of the signal transmitted by the lamp of the spectrophotometer and measures the intensity of the signal received by a photodiode array.
The signal is transmitted at wavelenghts where the absorbance of the measured substance is maximal.
Then the application software calculates the concentration according to the measured values and the above formulas. A multi-compounds analysis is possible, because each compound has its unique absorbance spectrum.

The figure beneath shows a typical absorbance spectrum of a compound (absorbance in the y-axis versus wavelength in the x-axis):



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4 Technical Specifications

Here follow the standard specifications of the BASE Instrument Series.
For specific requirements, please contact the e-mail address below:
info@baggi.com

Instrument Specification

Power:
- Standard: 90-264 VAC, 47-63 Hz; 6A max

Environment:
- 0° to 40°C (32° to 104°F)
- 0° to 55°C (32° to 131°F) with vortex cooler

Dimensions:
- Skid-mount 500mm H x 400mm W x 250mm D
  (19,68" H x 15,74" W x 9,84 D)

Approximate Weight:
- 15 Kg

Analogue Inputs:
- Four inputs filtered with transient protection

Analogue Outputs:
- Six isolated outputs, 4 – 20 mA

Digital Inputs:
- Six digital inputs

Digital Outputs:
- Eight isolated relay signals

Enclosure Protection:
- IP66

Compliances:
- EN61326, EN61010-1
- ATEX (optional)
  II 2 G Ex px II T6
  II 3 G Ex pz II T6

Gaseous Sulfur componds application

Components range according to the model, typically:
- H_2S 0 – 5 %
- SO_2 0 – 5 %
- CS_2 0 – 0,5 %
- COS 0 – 0,5 %

Instrument Accuracy:
±1% F.S.

Overall Accuracy:
Function of instrument calibration; optimized by BAGGI by in-field survey .

Response time:
90% of final value in 10 sec. (typical)

Services required:
- Instrument Air
- Steam

All the specification data are subject to changes without notice

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