To comply with environmental regulations in the production of low-level sulfur fuel, it is necessary to get reliable information about the product quality and sulfur content. The Siemens Maxum II, Total Sulfur on-line process gas chromatograph, provides this information in a reliable manner using process suitable analytical procedures. The Total Sulfur solution applies a continuous sample nebulization and FID combustion in the highly reliable Maxum II platform, known for its common hardware and unsurpassed networkability.
Measuring Total Sulfur in Combustion Fuel... We have the Process Solution!

The Situation
Combustion engine fuels include sulfur components that are converted to Sulfur Dioxide during combustion. Annually, millions of tons of Sulfur Dioxide are released and damage the environment by means of smog or acid rain. Additionally, Sulfur Dioxide negatively impacts the performance and the lifetime of exhaust catalysts.

The introduction of low sulfur fuel is also a prerequisite for the utilization of new exhaust clean up techniques, such as DENOX-catalyst or NOx-traps, as well as the development of more fuel-efficient engines.

More Stringent Requirements
To reduce the total sulfur emission originating from fossil fuel, more and more stringent regulations are implemented, mostly in industrialized countries. For example, the Auto-Oil program in Europe requires the reduction of Sulfur contents in Gasoline and Diesel fuel from more than 1000 ppm in 1995 to less than 50 ppm in 2003. In the USA, amendments to the federal regulations defined in the Clean Air Act of 1990 require the reduction of Sulfur to 30 ppm after 2005. Further reduction of the maximum concentration to below 10 ppm is expected.

In order to comply with environmental regulations to produce low-level sulfur fuel, analytical procedures are needed that provide information about the product quality and sulfur content in a reliable and timely manner.

The Measuring Task: A Challenge!
In the fuels to be analyzed are various Sulfur components with unknown distribution. The type and concentration of individual Sulfur components strongly depend on the origin of the crude oil. However, all these sulfur components can be chemically converted to sulfur dioxide which then represents the total sulfur concentration.

Our Solution
The Total Sulfur analyzer from Siemens is a specific application utilizing the MAXUM edition II Process Gas Chromatograph. With the newly designed vaporization system, Sulfur concentrations below 1 ppm are detected reliably and continuously online.

Continuous Vaporization instead Liquid Injection valve
The boiling point of Gasoline and Diesel ranges from about 40°C to 400°C. Because the distribution of the sulfur components depends on the source of the crude oil, it is typically not known when the first and last sulfur component vaporized.

- No injection valve can vaporize the sample instantaneously and therefore can not provide a representative vaporized and homogenous sample plug to the column
- Constant volume injection does not take sample density variations into consideration

Therefore we choose continuous vaporization!

The Heart of the Analyzer: A standard FID as reactor
From our years of experience with reactors, we know that a flame is superior to a furnace reactor:

- The flame is reliable, fast and forgiving! High and low quantities of any kind are converted in a linear manner without residue
- The flame has no memory, it is always clean
- Nothing evades the flame plasma
- Sample density changes can be detected and compensated for because this is a standard FID’s flame
- The FID-Signal is also utilized as sample flow monitor.

The sample is continuously nebulized and vaporized
Precise Results....
And How to Get There:
Innovative Ideas!

On the Technical Side
Using an inert gas, a small, constant sample flow is nebulized and homogeneously vaporized in a hot inlet. This continuous flow is combusted in a standard FID to Carbon Dioxide, Water and Sulfur Dioxide. Sulfur Dioxide represents the amount of all individual sulfur components in the sample. The gas exiting the FID flows continuously via a gas injection valve to the vent. The gas injection valve injects a fixed amount to the separation column. The separation system consists of two columns utilizing column switching to Backflush water. Sulfur Dioxide is measured with a Flame Photometer Detector (FPD).

The chromatographic system contains the electronic controller for monitoring, measuring, data reduction and communication. The analytical part consists of pressure regulator for auxiliary gases, individually heated dual oven, FID as well as FPD.

Linearized Measuring Signal
The FPD Signal is linearized using the provided software.

Normalization and Sample Flow Monitoring
In addition to combusting the sample flow, the FID signal is used to "count" Methyl-Groups. Any sample flow variation due to density, viscosity or sample pressure change is detected with the FID. The FPD signal is then normalized with the FID signal.

Presentation of the Measuring result
The results are available utilizing 4-20 mA or RS232/RS485 with MODBUS as well as Ethernet Data Highway TCP/IP and OPC for communication to Workstations and control systems.
Case Study

Additional Sulfur Applications available from Siemens, for example for....

- Natural Gas: Determination of Sulfides, Mercaptanes, Thiophenes, Disulfides
- Odorant Analyzer, H₂S analyzer, Tail Gas and Sour Gas analyzer
- Other processes such as Natural Gas processing plants, Claus Process, Fertilizer and Carbon Acid plants.

Your Advantages

- Proven technique from the world market leader in Process Gas Chromatography
- One of a kind continuous vaporization is memory free and highly representative
- Optimum and complete combustion in a hot flame (1200...1400 °C)
- Integrated diagnostic possibility utilizing FID-signal
- Linearized Flame Photometer Detector
- Certified for hazardous area installations
- Optionally available for multiple sample streams
- Standard Process Gas Chromatography communication and networkability
- Minimum maintenance
- Worldwide service and support

Technical Data

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Total Sulfur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Gasoline, Diesel, Kerosene, Jet Fuel, Natural Gas, Liquid or Vapor Hydrocarbons</td>
</tr>
<tr>
<td>Max. Boiling End Point</td>
<td>about 400 °C</td>
</tr>
<tr>
<td>Cycle Time</td>
<td>180 seconds</td>
</tr>
<tr>
<td>Measuring Ranges</td>
<td>0-30 ppm to 0-5000 ppm (adjustable)</td>
</tr>
<tr>
<td>Detectability</td>
<td>1% of range (min. ≤ 1 ppm)</td>
</tr>
<tr>
<td>Repeatability</td>
<td>± 2% FS (8 hours)</td>
</tr>
<tr>
<td>Linearity</td>
<td>&gt; 5 x 10²</td>
</tr>
</tbody>
</table>

Auxiliary Gases

| Carrier Gas | Helium or Nitrogen | > 99.999% | approx. 440 ml/min / 25 scfd |
| Burning Gas | Hydrogen | > 99.999% | approx. 130 ml/min / 7 scfd |
| Combustion Air | Air | Hydrocarbon Free | approx. 400 ml/min / 23 scfd |

If you have any questions, please contact your local sales representative or any of the contact addresses below.

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