Dual Plasma Sulfur and Nitrogen Chemiluminescence Detectors

Unsurpassed Stability, Selectivity, and Sensitivity for your GC Analysis

Agilent Technologies

Now with New Dual Plasma Technology

Overview

The Agilent Technologies Sulfur Chemiluminescence Detector (355 SCD) and Nitrogen Chemiluminescence Detector (255 NCD) are the world's most sensitive and selective chromatographic detectors for sulfur and nitrogen-containing compounds. Agilent Technologies has further enhanced 355 SCD and 255 NCD performance and ease of use by developing the Dual Plasma Technology with its patented detection method, now available in the new Dual Plasma Burner and Controller.

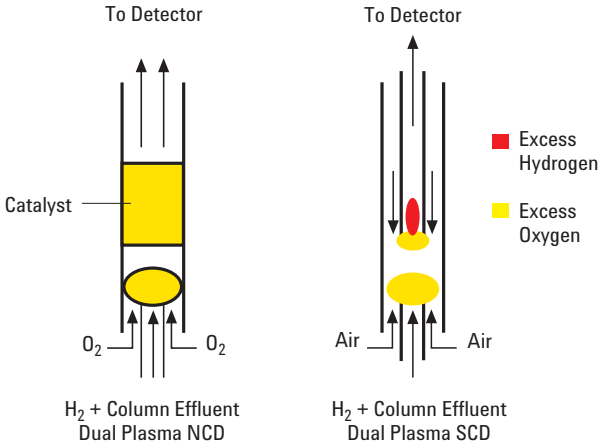
Dual Plasma Burner and Controller

The compact Dual Plasma advances the established technology by improving performance, reducing maintenance, and adding a low temperature safety shroud. The Burner easily mounts on major GC brands and incorporates features for easier and less frequent maintenance. The Dual Plasma Controller has in-line electronic flow sensors, a digital display with added controls and functionality, and a smaller footprint. The new Dual Plasma system delivers the easiest and fastest start-up times of all chemiluminescence detector systems.

Dual Plasma Technology

The Dual Plasma Technology harnesses the power of two-flame plasma combustion, optimizing combustion of the sample matrix and formation of either sulfur monoxide (SO) or nitric oxide (NO). This results in unsurpassed:

- Stability
- Selectivity over carbon
- Sensitivity
- Equimolar and linear response
- Absence of quenching



355 Sulfur Chemiluminescence Detector (355 SCD)

Overview

The 355 Sulfur Chemiluminescence Detector (355 SCD) is the world's most sensitive and selective chromatographic detector for sulfur containing compounds. The 355 SCD is based on patented technology, and it provides a linear and equimolar response to sulfur compounds without interference from most sample matrices. The exceptional performance of the 355 SCD has resulted in its widespread use and acceptance for the analysis of sulfur compounds in a wide range of applications. The new Dual Plasma Burner and Controller significantly enhance the performance of the 355 SCD, increase ease of use, and reduce maintenance.

Patented Technology

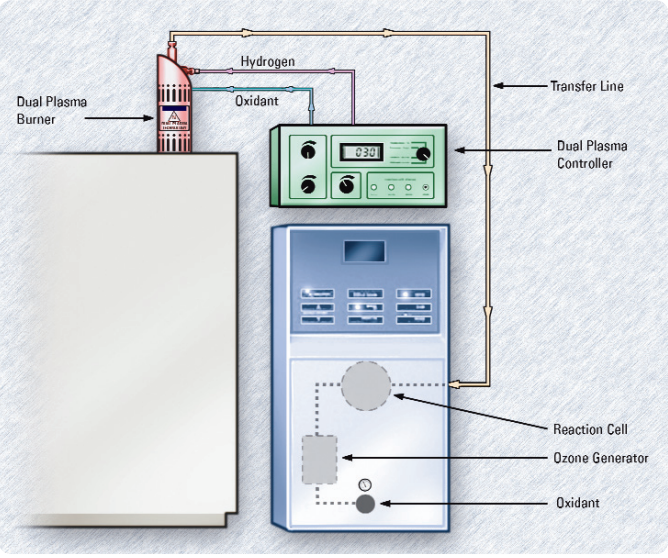
The 355 SCD utilizes the combustion of sulfur compounds to form sulfur monoxide (SO) and the subsequent chemiluminescence reaction of SO with ozone (O_3). The unique combustion process achieves high temperatures (> 1,800 °C) which are unattainable by standard pyrolysis methods. This patented technology allows the 355 SCD to make ultra-sensitive measurements of any sulfur containing compound that can be analyzed by gas chromatography (GC) or super-critical fluid chromatography (SFC).

$$R\text{-}S + O \longrightarrow SO + \text{Other Products}$$
$$SO + O_3 \longrightarrow SO_2 + O_2 + h\eta$$

The light (hv) passes through an optical filter and is detected by a photomultiplier tube (see 355 SCD Fluidics diagram). This mechanism provides selective sulfur detection which is described in the following US and foreign patents: 5,330,714: 5,227,135: 5,310,683: 5,501,981: 5,424,217; 5,661,032; 6,130,095; WO 95/22049 and patents pending.

Method Approval

The 355 SCD is the detector of choice for ASTM Standard Test Method D 5504: Determination of Sulfur Compounds in Natural Gas and Gaseous Fuels by Gas Chromatography and Chemiluminescence, and ASTM D 5623: Sulfur Compounds in Light Petroleum Liquids by Gas Chromatography and Sulfur Selection Detection, and is the original detector of choice for ASTM Standard Test Method D 7011: Standard Test Method for Determination of Trace Thiophene in Refined Benzene by Gas Chromatography and Sulfur Selective Detection. The SCD is the only detector tested for ASTM D 5623-95 in which data was sufficient for determining method precision. (ASTM Research Report: RR: D02-1335).

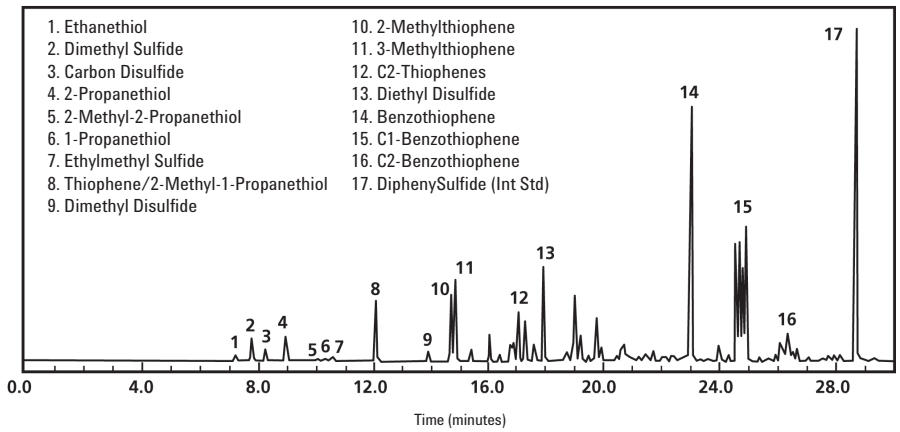


355 SCD Fluidics

Applications

Natural Gas, Petroleum, and Petrochemical Products

Gas chromatography with sulfur chemiluminescence detection provides a rapid means of identification and quantification of sulfur compounds in petroleum feeds and products. Examples include the analysis of sulfur compounds in monomers such as ethylene and propylene; solvents such as paraffins, benzene, toluene and xylenes; and fuels such as natural gas, LPG, gasoline, kerosene, jet, and diesel fuels (see Chromatogram 1, Sulfur Compounds in Gasoline).

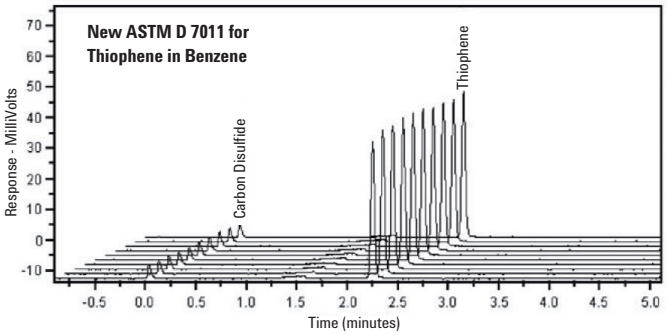


Chromatogram 1. Sulfur Compounds in Gasoline

Analysis of trace levels of thiophene (ASTM D 7011) and carbon disulfide in refined benzene serves as a good example of the superior performance of the Dual Plasma 355 SCD. Benzene is an important aromatic solvent and chemical intermediate and component that is widely produced and used in the petrochemical and other industries.

Sulfur containing compounds are notorious for their detrimental effects as catalyst poisons, and the use of more selective catalysts generally require higher purity starting materials. Thiophene is of particular concern as a source of sulfur because its boiling point is close to that of benzene and it is a known potential contaminant.

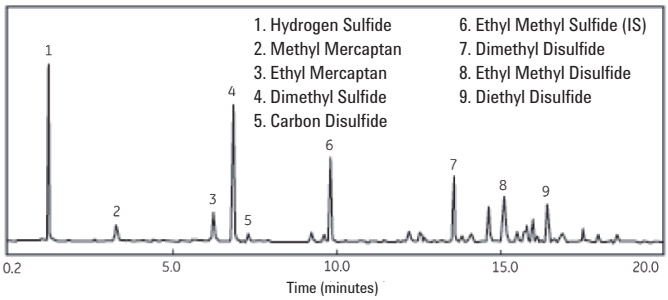
Chromatogram 2 shows an isometric plot of ten repetitive injections of a refined benzene sample that contained about 90 ppb carbon disulfide and 1 ppm thiophene (each as sulfur). The chromatograms demonstrate excellent sensitivity and selectivity, and these ten injections yielded 2.6% RSD for carbon disulfide and 1.4% RSD for thiophene. Repetitive analyses made over 72 hours yielded 10.4 and 3.6% RSD, respectively.



Chromatogram 2. CP Wax 52 GC Column as per ASTM D 7011, 1 µL Injection Split 1:10

Short-term Precision: 1.4% RSD for 1 ppm S Thiophene, 2.6% RSD for CS_2 at 90 ppb S, N=10

Long-term Precision: 3.6% RSD for 1 ppm S Thiophene, 10.4% RSD for CS_2 at 90 ppb S, N=42 over 72 hours



Chromatogram 3. Volatile Sulfur Compounds in Beer

Food and Beverage Products

Sulfur compounds possess extremely low odor and taste thresholds, making them very important in flavor and fragrance chemistry. The SCD is the detector of choice for analysis of sulfur compounds which affect product odor and flavor because of its sensitive and selective detection. As an example, sulfur chemiluminescence detection is useful for identification and quantitation of sulfur compounds in beer as shown in Chromatogram 3.

Gaseous Sulfur Emissions

The reliable measurement of atmospheric sulfur gases is important because these compounds are notorious for their foul odors when present at only part-per-billion levels and may be toxic at higher levels. There are numerous natural and industrial sources of sulfur gases. Natural sources of emission include: animals, vegetation, soils and volcanoes. Industrial sources include: refineries, smelters, kraft paper pulpers, food processors and power generators.

255 Nitrogen Chemiluminescence Detector

Overview

The NCD is a nitrogen-specific detector that couples to major gas chromatograph (GC) brands. The NCD produces a linear and equimolar response to nitrogen compounds (except N_2 and nitrogen species with N-N_2 bonds), allowing analysis of complex samples without interference from other compounds in the sample matrix. In addition to detecting organic nitrogen compounds, the NCD responds to ammonia, hydrazine, hydrogen cyanide, and NO. Other NO_x species can be detected, provided they can be chromatographed.

Key Features

- Nitrogen-specific detection for gas chromatography (GC) or supercritical fluid chromatography (SFC)
- Picogram detection limits
- No hydrocarbon quenching
- Linear, equimolar response to organic nitrogen compounds including nitrosamines
- Responds to ammonia, hydrazine, hydrogen cyanide, and NO_X

Major Applications

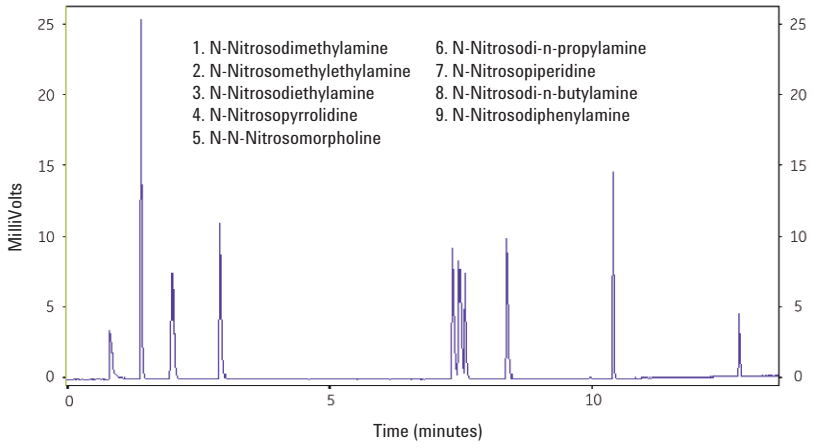
The 255 NCD may be used for the following applications: chemicals, environmental samples, food and beverages, fuels, gases, pesticides and herbicides, petrochemicals, polymers, and nitrosamines (Chromatogram 4).

Principle of Operation

The effluent from a gas chromatography column enters the Dual Plasma Burner. A hydrogen and oxygen plasma in the combustion tubes converts all nitrogen compounds to nitric oxide. A catalyst is used to prevent secondary nitrogen species from being formed and to ensure that all potential interferences are destroyed prior to detection.

$$R\text{-}N + O_2 \rightarrow NO + CO_2 + H_2O$$
$$NO + O_3 \rightarrow NO2 + O2 + h\eta$$

Nitric oxide reacts with ozone to form electronically excited nitrogen dioxide. The excited nitrogen dioxide emits light in the red and infrared region of the spectrum (600–3200 nm) when it relaxes to its ground state. The light emitted is directly proportional to the amount of nitrogen in the sample.

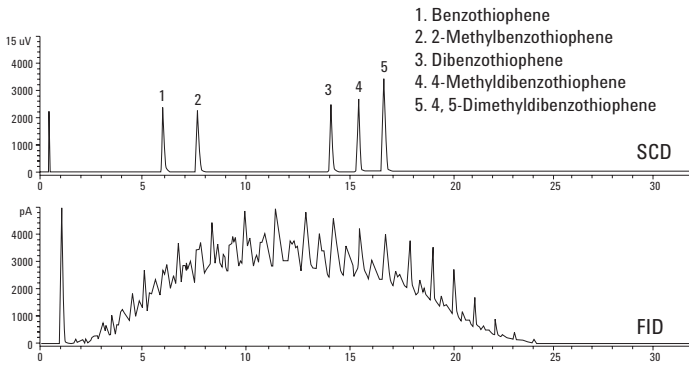


Chromatogram 4. Selected Nitrosamines by GC/NC, 1 µL Injection of a 2.0 µg/mL Standard, 10:1 Split

355 SCD and 255 NCD Accessories and Options

FID Adapter

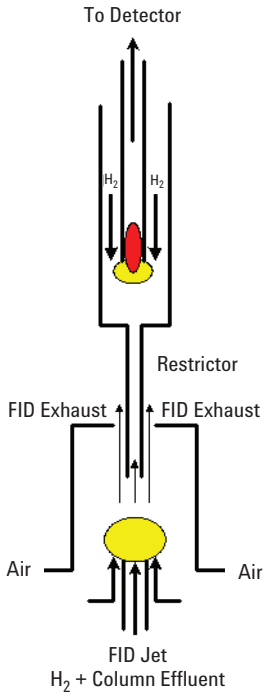
The Flame Ionization Detector (FID) Adapter eliminates the need to split the column effluent between two detectors operating at different pressures, and the associated problems with that approach. FID adapters are available for a number of major GCs. Chromatogram 5 obtained from an ultra-low sulfur diesel fuel spiked with low ppm levels of benzo and dibenzothiophenes illustrates the capability of this mode to produce sulfur and hydrocarbon signals simultaneously from a single column and injection. The figure to the right represents the way in which this is accomplished. This approach is important for applications that require both signals, such as sulfur and nitrogen simulated distillation. Furthermore, this approach is especially useful for comprehensive 2D GC (GC x GC). The SCD and NCD are the only commercially available detectors with this capability and they alone possess the required speed of response. The inherent speed of response of the detectors is important for other applications, such as fast GC.



Chromatogram 5. Sulfur Response Factors (Mean = 1.00 ± 0.03)

Dry Piston Oil-Free Pump

The optional dry piston oil-free pump eliminates the need for vacuum pump oil, resulting in easier maintenance and lower operating costs.



Learn how you can benefit from Dual Plasma Sulfur and Nitrogen Chemiluminescence Detectors.

- Go to: **www.agilent.com/chem**
- Call: **1-800-227-9770** (in the U.S. and Canada)
- Contact your local Agilent representative or Agilent Authorized Distributor

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