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VARIOLYTICS

1 *Variolytics detects even low concentrations of pollutants in drinking water.*
2 *Variolytics prototype.*

VARIOLYTICS – REAL-TIME MASS SPECTROMETER FOR GASES AND LIQUIDS

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Applications

- Quantitative analysis of all gas compounds via heated stainless steel capillary in a pressure range down to 1 mbar vacuum and up to 100 bar overpressure and a maximum temperature of 400°C
- Quantitative analysis of all volatile substances in liquids via membrane inlet in a pressure range of 0 bar up to 10 bar high pressure and a maximum temperature of 100°C
- In-situ liquid analysis in fermenters with newly developed membrane sensor element

Advantages

- Selectable valves freely select the sample
- Stand-alone monitoring of up to 30 substances
- Fast response time below 1 second
- Very wide measurement range of 8 decades (10 ppb – 100 %)
- Detection limit below 10 µg/L and in the low ppb range
- Small sample volumes needed: for gases 1 – 10 sccm and liquids 1 – 100 mL
- Fully automated operation with auto calibration
- Upstream filtration in case of samples containing solids

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New process measurement system

Variolytics is a compact analyzing setup based on a new patented method for online monitoring of gases and liquids with just one measuring system. A newly developed sensor element allows in-situ analysis directly inside reactors such as fermenters. Selectable valves choose freely between gaseous, liquid or in-situ liquid analysis.

Gaseous samples are sucked via heated stainless steel capillaries into the vacuum system of the detection unit by means of laminar flow. Heating prevents the gases from adsorption inside the sample lines. Monitoring gases is possible down to a vacuum of 1 mbar and up to an overpressure of 100 bar depending on the length and diameter of the capillaries. The gas flow may be turbulent.

Sucking the gases into a vacuum permits distances from the point of withdrawal of 10 meters and more. There is no need to transfer the sample gases to the analyzer unit in a time-consuming and cost-intensive way using pumps or some other kind of transport technology.

Membrane inlet

Volatile substances in liquids enter the detection unit via a microporous membrane. This membrane is permeable for gases but not permeable for polar liquids such as aqueous solutions. Its special three-dimensional structure makes it resistant to clogging by solid particles.

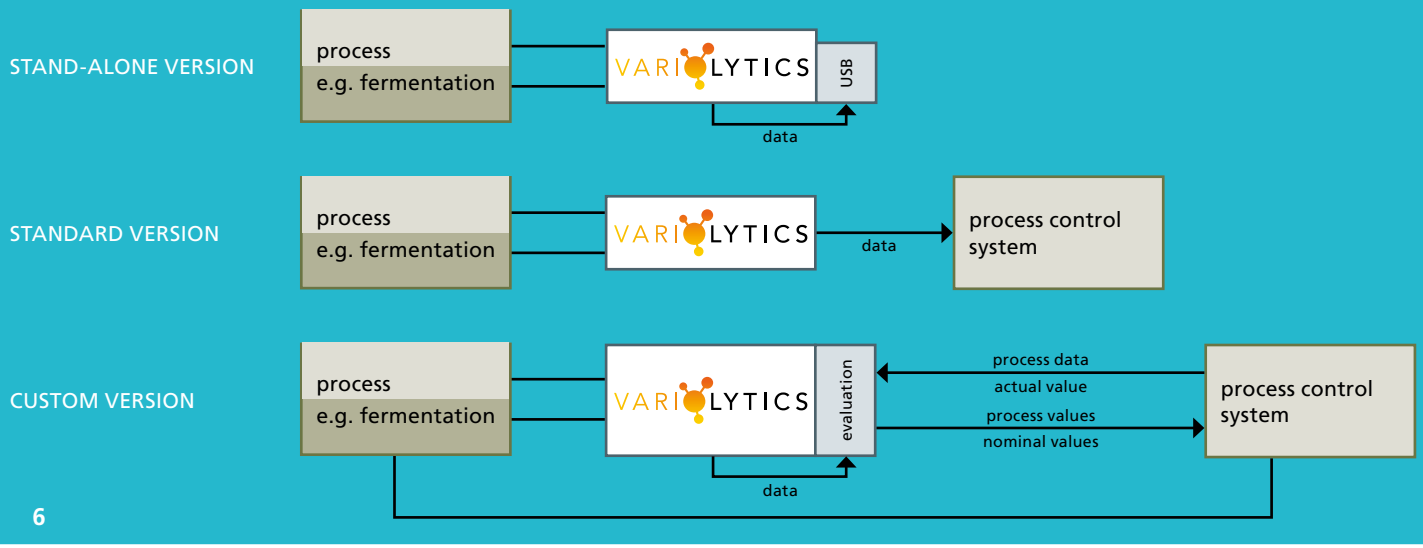
Henry's law constant, which indicates the equilibrium of a compound between water and the gas phase above the solution, is crucial for transporting the substances through the membrane. The lower the water solubility and the higher the boiling point of a substance, the bigger is its specific Henry's law constant. Compounds with high H values are therefore analyzed better. The membrane is pressure-resistant up to a maximum of 10 bar overpressure and stable at temperatures up to 100°C. For non-aqueous solutions a maximum temperature of 200°C is possible.

Multi-inlet system

The membrane is used for two inlet systems. The bypass version carries the analyzing solution continuously through a thin-layer flow cell. Usually the entire membrane inlet system is adjusted to a certain temperature in order to prevent measurement failures by temperature drift.

The second version is for in-situ analysis, for instance in fermenters. The sensor element is located inside the reactor. The membrane also acts as a gas inlet system and thus permits monitoring of the reactor process in situ. Here the membrane and process temperature are the same.

Due to the physical evaporation process in a chemically resistant membrane both inlet systems display very good long-term stability with no cross sensitivity.



Detection with mass spectrometer

A quadrupole mass spectrometer known – a proven analyzing method – enables the detection of up to 30 substances in a mixture simultaneously. The response times for all three inlet systems are below 1 second. The biggest advantage of a mass spec over all other known analyzing methods is its very wide measurement range of 8 decades starting from 10 ppb going up to 100 %. Other important advantages of a mass spec are its high sensitivity and the very small sample volumes required. The detection limit of Variolytics is below 10 µg/L and in the sub-ppb range. To analyze gases a flow rate of 1 – 10 sccm per minute is good enough. To analyzing volatile substances in liquids with the membrane inlet bypass version a flow rate of 1 – 10 mL per minute is sufficient. To obtain fast response times the flow rate selected is usually between 10 – 100 mL per minute.

Feedback system

Variolytics is designed for fully automated operation including auto calibration. Selectable valves choose the sample freely from one of the three inlet systems.

Variolytics is controlled via a standard automation system. This system offers a variety of communication interfaces that are used in the industry (OPC, Profinet, RS485, analog, digital etc.).

Variolytics communicates via these interfaces directly with existing process automation systems. This also allows connection to SCADA technologies.

Variolytics versions

The stand-alone version displays the measured values and stores them on commercially available media (USB stick, SD card).

The standard version transfers the data directly to an existing automation technology.

The custom version also reads process values from the existing automation technology. Using these data Variolytics determines process values (e.g. pressure, temperature, concentrations) that are transferred to an existing process control to support the process.

Depending on the application, Variolytics can be used as a measurement instrument alone. In this case the operation is done manually via an HMI (Human Machine Interface). When connected to a process control system, the operation can be carried out manually or via process automation.

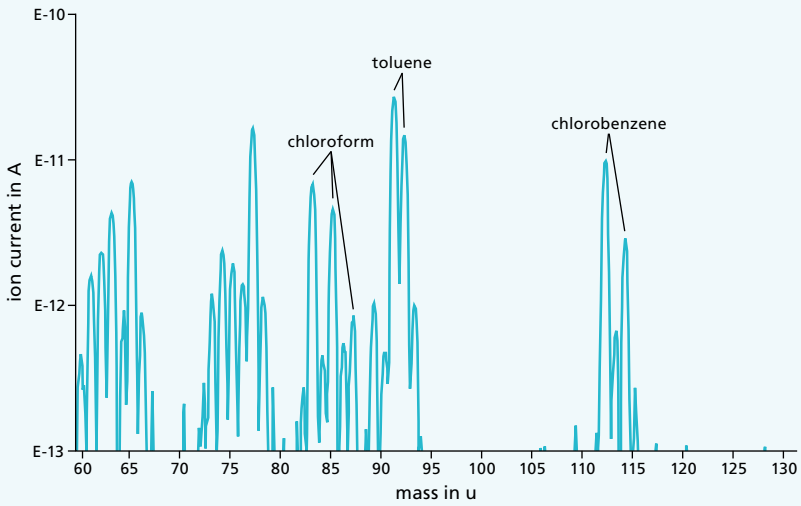
3 *Both exhaust gas and wastewater in gasification plants can be tested for pollutant concentrations.*

4 *The simultaneous detection of several substances enables new possibilities in biotechnology.*

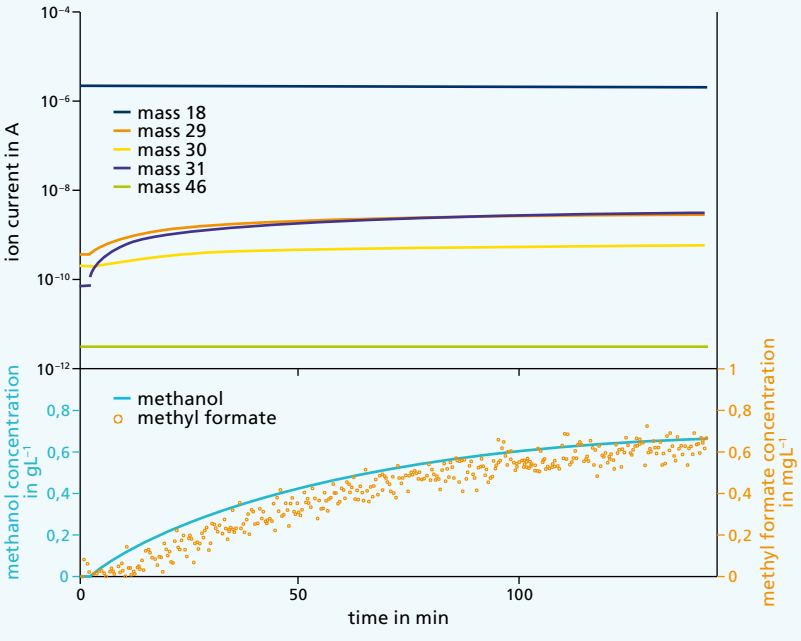
5 *The multi inlet system can be equipped with any variety of inlets for the analysis of gases or liquids.*

6 *Variolytics versions adapted for various purposes.*

1. Industrial wastewater analysis



2. Simultaneous detection of methanol and methyl formate



Application examples

As early as 1995 the wastewater of paint and coatings industry was monitored with real-time mass spectrometry by membrane inlet (Fig. 1).

Simultaneous detection of methanol and methyl formate during an enzyme reaction. The mass spectrometer provides ion currents (above), which are converted by the feedback system in concentrations (below) (Fig. 2).