

## Workplace Monitoring of Benzene using AMETEK Mass Spectrometers

### Introduction

Benzene is a flammable, volatile, colorless liquid. Historically, this aromatic hydrocarbon was produced as a by-product of coke production in the steel industry, but increasing demand led to benzene being produced from petroleum.

Benzene was once used as a petrol additive, increasing the octane rating to reduce knocking, until tetraethyl lead replaced it as the most common antiknock additive. Following the phasing out of leaded petrol, benzene made a comeback as a gasoline additive in some countries. But concerns over its health effects and the possibility of benzene entering the groundwater led to strict regulation of petrol's benzene content, with limits typically around 1%. Benzene is still widely used as an intermediate in the production of polymers, plastics, resins, fibers, detergents and adhesives.

### Health Concerns

Benzene is a known carcinogen with documented cases of leukemia among workers exposed to the chemical over several years. Short-term exposure to high levels of benzene can lead to symptoms such as drowsiness, unconsciousness, and even death.

The current permissible workplace exposure level is 1 ppm in air ( $3.25 \text{ mg/m}^3$ ) based on an 8-hour average, with a short-term exposure limit of 5 ppm. In Europe this is specified in Directive 2004/37/EC. In addition, the European Union has developed an Air Quality Standard (AQS) for benzene, Directive 2000/69/EC. This represents a target ambient concentration of benzene in town or country air, which is believed to present no risk to public health. The benzene AQS has been fixed at  $5 \text{ } \mu\text{g/m}^3$ .

The same levels apply to the U.S. as noted in OSHA 1910.1028. In Brazil the levels are noted as 0.5 TWA for the TLV and 2.5 ppm as the STEL (ICSC:0015).

### Requirements for Workplace Monitoring

Benzene's volatility means that leaks or spills will quickly disperse in air with the possibility of harmful exposure levels. Companies producing or using benzene are therefore required to monitor the workplace for benzene. Historically, a number of techniques have been used, from laboratory analysis of grab samples by GC or GC/MS to online analysis by IR or GC. None of these techniques provide the speed of response to warn of spills or accidental discharges; only process mass spectrometry has the combination of speed and sensitivity required to meet current and future requirements.

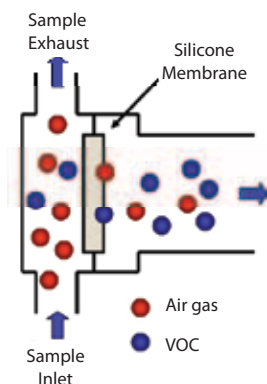


... only process mass spectrometry has the combination of speed and sensitivity required to meet current and future requirements for monitoring of benzene in the workplace.

## Membrane Inlet Mass Spectrometry (MIMS)

AMETEK's ProLine and ProMaxion Process Mass Spectrometers are able to detect and quantify harmful VOCs such as benzene in air quickly and unambiguously at low levels, typically significantly below legal exposure limits. They help protect workers from potentially hazardous leaks and ensure exposure data is available for regulators.

The fast scanning quadrupole mass spectrometer provides fast, sensitive plant coverage and, combined with AMETEK's Process 2000 software, clearly identifies and quantifies the VOCs, avoiding costly false alarms.



A key feature of the AMETEK mass spectrometer is the silicone membrane inlet. This shows strong preference for organic molecules over air gases and other inorganic gases, so it provides selective enrichment and high signal/noise.

The membrane inlet is not affected by water, as the



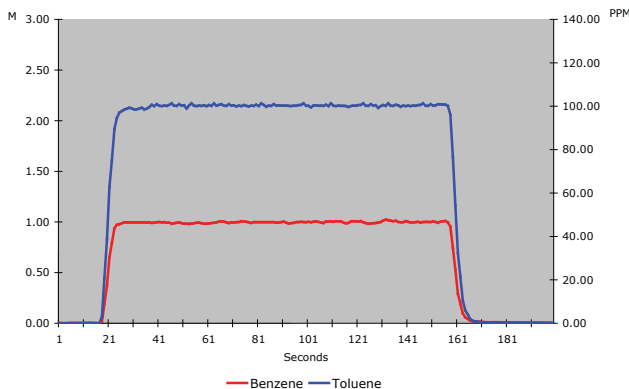
membrane is water repellent. This means the ProMaxion system does not require heated or lagged sample lines to transport the ambient air to the analyzer. A conventional mass spectrometer with a capillary inlet needs heated and lagged sample lines, as the capillary is extremely susceptible to blockages due to water droplets.

The combination of membrane inlet and mass spectrometer analyzer allows benzene to be detected down to 25 ppb in air and other VOCs such as toluene, ethyl benzene and

xylene can also be monitored. In addition, the fast response time of the mass spectrometer allows for area monitoring of a high number of points (up to 60).

### Summary of Benefits

- II MIMS provides fast, sensitive, multi-point monitoring
- II High sensitivity enables trace detection well before reaching legal exposure limits
- II MS gives confident identification of benzene even in complex mixtures
- II Multiple compounds monitored by one analyzer with minimal method development



Example of trace levels of benzene (1 ppm) and toluene (100 ppm) monitored by AMETEK MIMS. Response time to signal change is less than 5 seconds and there is no cross-interference between the two VOCs.

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