# Methods for monitoring exposure to styrene

## Introduction

During the processing of unsaturated polyester resins (UP Resins) workers are exposed to styrene emissions. In most European countries, limits are set to determine the maximum level of occupational exposure to styrene. These legal limits are explained in Technical bulletin No 3 in this series. Exposure to styrene can be measured in several ways, from a simple colour-change tube to a long term data monitoring system. This bulletin will give an overview of the different methods that are available. It will also explain how to choose the best method under different conditions.

## Legal requirements for measuring and monitoring styrene

A number of European standards outline the requirements for measuring workplace atmospheres and worker exposure to chemical agents, like styrene:

**EN 838 1996**
Workplace atmospheres. Diffusive samplers for the determination of gases and vapours. Requirements and test methods.

**EN 689 1996**
Workplace atmospheres. Guidance for the assessment of exposure by inhalation to chemical agents for comparison with limit values and measurement strategy.

**CEN/TC137**
Published standards. Assessment of workplace exposure to chemicals.

Most legislation stipulates that the responsibility for measuring and monitoring workplace concentrations of dangerous substances lies with the employer. The company can either carry out the necessary work themselves or they can employ an outside agency to carry out monitoring on their behalf.

The relevance and representative nature of the data generated from workplace monitoring will depend greatly on the quality of sampling. This will be influenced by a great many factors like the process being used; ventilation conditions; time of day; temperature; the position in the moulding cycle at the time of measurement; and the proximity of the measuring device to the operator.

A proper assessment of the real exposure to styrene can therefore only be achieved if the measurements are carried out in combination with a physical observation of the worker who is being monitored.

## Measuring systems and parameters

The simplest way to measure a styrene concentration in the air is by using glass tubes that contain a medium that discolours when exposed to styrene. The extent of discoloration is an indication of the styrene concentration. These tubes are useful for quick spot checks on concentration levels but are no substitute for controlled, accurate, long term monitoring methods.

If styrene exposure is measured to check compliance against legal exposure limits, such as the 8 hr average TLV, equipment must be chosen that can measure the average styrene concentration during the day. Active carbon badges or Tenax tubes have proven to be a suitable method for this type of measurement.

*Badge monitoring and data analysis system for recording workplace styrene exposure*

Active carbon badges alone, however, do not provide information about the variations in exposure due to process conditions, ventilation of the workshop and the position of the worker during the work. Equipment that records and stores the styrene concentration in an internal memory should be used in that case.

Reading the data and checking the findings against the activities of the worker during the measurement gives valuable information about the relationship between the activities and the exposure level.

When the operators use personal protection equipment, such as breathing masks that provide filtered air, the concentration of styrene in the air will give too high a result in the exposure assessment. In such cases the exposure should preferably be assessed by biological monitoring: measuring styrene breakdown products in urine samples (mandelic acid (MA) and phenyl glyoxylic acid (PGA) taken from the worker at the end of the shift. The table on P2 summarises the most appropriate methods.

(*Continued*)

### Measuring methods and measuring instruments

There are a number of different monitoring and analytical test equipment on the market. The following list is not exhaustive and we are not making any recommendations for one company's products or services over another.

### Spot measurements:

The following companies supply glass tubes with a discolouring medium:

Kitagawa (www.komyokk.co.jp )
Dräger (www.draeger.com )

### Checks against legal exposure limits:

An 8 hour average concentration can be measured by several methods. Much used are active carbon badges, supplied by several companies including 3M (www.3M.com) Other ways to measure an 8 hour average concentration is by adsorption on Tenax tubes (www.sgab.com) or the use of colour change films (www.piezoptic.com)

### Styrene monitoring equipment with data acquisition:

Several types of portable equipment are available in which measured data can be stored: Photo-Ionisation Detection (PID) is a detection principle with very fast response and a broad measuring range. PID equipment can be supplied by Rae Systems (www.raesystems.com) or Ion Science (www.ionscience.com) Other portable equipment is supplied by Draeger (www.draeger.com) (Draeger PAC III) or Check-it (www.c-it.nl )

Infra-Red (IR) analysis or gas chromatography (GC) can also be used, especially in case where more than one volatile gas has to be measured. In most cases this equipment is used for scientific analyses only since it is too expensive for everyday use.

| Monitoring method / Use of method | Kitagawa; Draeger tubes | Carbon; Tenax; PiezOptic Badges | PID PAC III Check-it IR | Biological monitoring |
|---|---|---|---|---|
| Quick estimate | Yes | No | No | No |
| Check against TLV value | No | Yes | Yes | Yes |
| Full workday evaluation | No | Yes | Yes | Yes |
| Real-time operator training | No | No | Yes | No |
| Process information | No | Yes | Yes | No |
| Occupational hygiene report | No | Yes | Yes | Yes |
| In combination with personal protection | No | No | No | Yes |
| Accuracy | No | Yes (+/- 10%) | Yes | Yes |

*Above: Which monitoring method you use depends on your selection criteria.*


*Above: Combined Photo-Ionisation Detection (PID) and gas monitoring system. Below: portable styrene monitoring system using glass tubes*



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