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**PERFORMANCE STANDARD FOR
DETECTOR TUBE UNITS USED TO
MONITOR GASES AND VAPOURS IN
WORKING AREAS**

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PERFORMANCE STANDARD FOR DETECTOR TUBE UNITS USED TO MONITOR GASES AND VAPOURS IN WORKING AREAS

PURPOSE

This standard represents the requirements for detector tube units which are used to determine the concentration of gases and vapours in the framework of air analysis.

It is essential that detector tube units should be designed to give reliable results.

DEFINITIONS

Detector tube means a tube containing a chemically impregnated packing which indicates the concentration of a contaminant in the air by means of a chemically produced colour change.

Short-term detector tubes are tubes which are used for grab-tests (measuring time in the range of minutes).

Long-term detector tubes are tubes which are used for tests over an extended period of time (measuring time in the range of hours).

Detector tube unit means a device which consists of a detector tube and an aspirating pump.

Gas means gases and vapours.

Permissible concentrations in air are known in various countries as TLV, MAC, MAK, etc.

Design concentration means the concentration of the gas in air which is adopted as the permissible concentration.

Class A and class B type of detector tube. Detector tubes belonging to class A should fulfil higher accuracy requirements. Class B detector tubes are acceptable for less exacting measurements.

INFORMATION TO BE SUPPLIED BY THE MANUFACTURER

Manufacturers instructions shall be supplied with each aspirating pump and with each box of detector tubes and shall include the following:

For aspirating pumps:

- A statement that pump and detector tube together form a complete unit.
- Testing instructions for leakage before each occasion of use.
- Maintenance instructions.

For detector tubes:

- Directions that the aspirating pump should be tested for leakage before each occasion of use.
- The time required for the completion of one aspiration or the flow rate and permitted limits on these.
- Information on the general reactions involved in the system and the levels at which other gases and vapours including water vapour are likely to interfere.
- Where appropriate a warning that the contents of tubes are hazardous, together with disposal instructions.

Marking on the box of tubes:

- The names of the gases for which the tube may be used.
- The manufacturers batch number.
- The expiry date.
- Recommended storage temperatures.

REQUIREMENTS FOR DETECTOR TUBE UNITS

General

A detector tube unit consists of the detector tube and the aspirating pump.

Aspirating pumps

The aspirating pump assigned for the use with the detector tube must have the same flow characteristics as those of the pump used by the manufacturer in calibrating the tubes. Because pumps made by different manufacturers may not operate at the same rate even when they draw the same volume they cannot be interchanged.

Volume

The pump used with a given detector tube shall be capable of aspirating a volume of air within plus minus 5% of the volume stated by the manufacturer. A properly maintained pump shall be able to continue to draw this volume throughout its normal working lifetime.

Termination of pump stroke at short-term detector tube units

The pump should have suitable means for determining the termination of the pump stroke; for example: change of pump shape indicates opening position; gauge showing the pressure change in the pump chamber during the opening procedure; limiter chain showing the opening position of the pump chamber. (It is, for instance, not sufficient to use the stopping of the stain-progressing in the detector tube as a means for determining the completeness of a pump stroke; because of the possibility of fluctuations of the concentration under practical conditions the stop of stain-progressing may also occur before the completion of the stroke when the concentration drops.)

Leakage at short-term detector tube units

After plugging the pump inlet and evacuating the pump chamber the leakage per minute shall not be more than 3%.

Flow rate of long-term detector tube units

Suitable means must be made available to check or maintain the flow rate of the pump and to determine the total sampling volume (e.g. flow meter, calibrated peristaltic hoses).

DETECTOR TUBES

*General**Beginning of indicating layer*

The boundary between the indicating layer and any fixing element, inert packing, or cleansing layer shall be such that the difference between the longest and shortest length of the beginning of the indicating layer around the circumference of the tube does not exceed 2 mm.

Temperature range

The reaction which takes place in the indicating layer should not be influenced by temperature in the range from 10 to 30°C; that means in this range the accuracy should be obtained without using additional temperature correction factors.

Shelf Life

Detector tubes shall comply with the requirements of this standard for a period of 2 years provided that the storage temperature does not exceed 25°C.

Channeling (length-of-stain type detector tube)

At the design concentration and above, the maximum variation of stain-length around the circumference of the tube at the interface between the stained and unstained indicating layer

shall not exceed 20% of the average stain-length (average stain-length means average of the stain which is farthest extended and of the stain least extended).

SHORT-TERM DETECTOR TUBES

General

At the design concentration the test with short-term detector tubes should not take more than 10 minutes.

Measuring range

The measuring range has to cover the concentrations from 0.5 to 5 times the design concentration.

Indicating error

Class A	Class B	Class B
length-of-stain type detector tube	length-of-stain type detector tube	colour-intensity or colour-matching type detector tube
At the design concentration, twice, and five times this concentration the error should not be in excess of plus/minus 25%. At half the design concentration the error should not be in excess of plus/minus 35%	At the design concentration, twice, and five times this concentration the error should not be in excess of plus/minus 35%. At half the design concentration the error should not be in excess of plus/minus 50%.	At the design concentration, twice, and five times this concentration the error should not be in excess of plus/minus 35%. At half the design concentration the error should not be in excess of plus/minus 50%.
The measuring results should be within these specification limits with a confidence of 95%	The measuring results should be within these limits with a confidence of 95%	The measuring results should be within these specification limits with a confidence of 95%.

KIND OF EVALUATION

(STAIN-LENGTH, COLOUR-INTENSITY, COLOUR MATCHING)

Class A

Length-of-stain type detector tube

The stain-length is evaluated by scale printed on the tube. The tube has to yield a minimum stain-length such that the calibration point on the scale for a concentration equal to the design concentration of the gas shall correspond to a stain-length of at least 15 mm.

Class B

Length-of-stain type detector tube

The stain-length is evaluated by a scale, or single scale mark printed on the tube, or calibration chart, or calibration curve. The tube has to yield a minimum stain-length such that the calibration point on the scale (chart, curve) for a concentration equal to the design concentration of the gas shall correspond to a stain-length of at least 8 mm.

Class B

Colour-intensity or colour matching type detector tube. After completing the test at the fixed sampling volume of air the colour-intensity type detector tube is evaluated by comparing the stain with a series of colour charts. The colour-matching type detector tube is evaluated by determining the sampling volume at which the stain matches the given (single) colour standard.

For these types of tubes a sufficient number of colour charts or sampling volume combinations shall be provided to:

- cover 0.5 to 1.5 times the design concentration in increments not greater than 0.25 times this design concentration;
- cover 1.5 to 3 times the design concentrations in increments not greater than 0.5 times this design concentration;

- cover 3 to 5 times the design concentration in increments not greater than this design concentration.

LONG-TERM DETECTOR TUBES

General

A long-term detector tube should have an operation period of at least 1 hour; any longer operation period up to 8 hours is also acceptable.

Measurable range

The measuring range has to cover the design concentration. After the completion of the test the indication must be the measure of the absolute amount of gas reacted in the indicating layer; taking into consideration the sampling volume the final measuring result has to be the measure of the average concentration during the operation period.

Indicating error

Class A

At the design concentration and operation periods exceeding half of the maximum operation period the error should not be in excess of plus/minus 25%

This also counts for twice the design concentration and operation periods exceeding one fourth of the maximum operation period, or five times the design concentration and operation periods exceeding one tenth of the maximum operation period.

At one half the design concentration and one half the maximum operation period the error should not be in excess of plus/minus 35%

The measuring results should be within these specification limits with a confidence of 95%.

Kind of evaluation

(Class A and class B, stain-length)

The stain-length is evaluated by scale printed on the tube; the scale figures should - preferably - be stated in the absolute amount of gas (e.g. microlitre, microgram).

At the maximum operation period the tube should yield a minimum stain-length such that the calibration point on the scale for a concentration equal to the design concentration of the gas shall correspond to a stain-length of at least 15 mm.

The same stain-length which is obtained at the design concentration according to the preceding paragraph must be obtained at:

- twice the design concentration when the test is conducted at half the maximum operation period and,
- five times the design concentration when the test is conducted at one fifth the maximum operation period.

At an operation period of 1 hour and the design concentration the stain-length should not pass beyond the last scale mark.

At the maximum operation period and 0.5 times the design concentration the stain-length should reach or exceed the first scale mark.

QUALITY CONTROL

The manufacturer shall maintain a quality control system which enables him to meet the requirements of this performance standard. Upon the request of the tube user he has to make available.

- the quality control procedures including the calibration methods employed and,
- the effects (including reactions) on the operation and accuracy of the detector tube unit caused by specific environmental conditions.