Studies towards the development of a standard for anthraquinone determination in the workplace air

Małgorzata Szewczyńska, Elżbieta Dobrzyńska, Joanna Kowalska
Central Institute for Labour Protection – National Research Institute (CIOP-PIB), Poland
jokow@ciop.pl

Standardization plays an important role in the economy and is a guarantee of quality in ensuring safety and health in the working environment. Hazardous chemicals are a challenge in this area and occupational exposure assessment requires the development of new methods for their determination.

Anthraquinone, commonly used in the paper and dye industry, is a carcinogenic substance with hazard class „Carc. 1B" according to the Regulation EC No1272/2008. It can affect humans when inhaled.

In Poland, the maximum allowable concentration value for the inhalation fraction of anthraquinone was proposed at 0.5 mg/m3. Therefore, research has been undertaken to develop a method for its determination in the workplace air. It is based on collection of the inhalation fraction onto a glass fiber filter, extraction with dichloromethane and analysis by gas chromatography-mass spectrometry. The method has been validated according to EN 482:2021 for linearity, sensitivity, selectivity, precision and accuracy.

As a result, a draft standard will be created, which, once established by the Polish Committee for Standardization, will become a Polish Standard for air purity protection.

Acknowledgements

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Central Institute for Labour Protection – National Research Institute
Department of Chemical, Aerosol and Biological Hazards
Czerniakowska 16, 00-701 Warsaw, Poland

Małgorzata Szewczyńska, Elżbieta Dobrzyńska, Joanna Kowalska

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Background

Standardization plays an important role in the economy and is a guarantee of quality in ensuring safety and health in the working environment. Hazardous chemicals are a challenge in this area and occupational exposure assessment requires the development of new methods for their determination.
Anthraquinone (AQ), commonly used in the paper and dye industry, is a carcinogenic substance with hazard class "Carc. 1B" according to the Regulation EC No1272/2008 [1]. It can affect humans when inhaled.
In Poland, the maximum allowable concentration value for the inhalation fraction of anthraquinone was proposed at 0.5 mg/m^3.
Therefore, research has been undertaken to develop a method for its determination in the workplace air.

Physico-chemical properties of anthraquinone (CAS 84-65-1) [2]

State of aggregation	Solid
Properties	Crystalline, yellowish, faint odour
Chemical characterisation	Combustible substance, poorly flammable
Solubility in water	Practically insoluble in water. Concentration: 1.4 mg/l (temp. 25 °C)
Molar mass	208.22 g/mol
Melting point	286 °C
Boiling point	380 °C
Density	1.44 g/cm^3

Figure 1. IOM Sampler and pump on worker (personal dosimetry).

Procedure

The method is based on a collection of inhalable fraction of anthraquinone on glass fiber filter (25 mm) using the IOM Inhalable Sampler (Fig. 1), then extraction of AQ with 5 ml of dichloromethane.
Gas chromatography-mass spectrometry technique and the use of HP-5MS column (30 m x 0,25 mm x 0,25 µm), an oven temperature ramp program from 100°C to 300°C and selected ion monitoring mode were chosen for the determination. The calibration range of AQ was 7,2 ÷ 144,0 µg/ml.

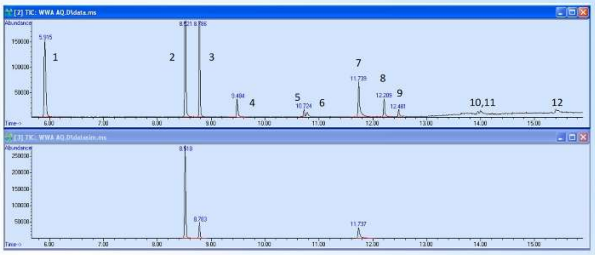

Figure 2. Chromatogram of standard solution of AQ and coexisting substances. GC/MS, HP-5MS column, oven: 100 °C (4 min), Δt 20 °C/min to 300 °C (2 min).

1 –naphthalene; 2 - acenaphthylene; 3 – acenaphthene; 4 – fluorene; 5 - phenanthrene; 6 – anthracene;
7 – anthraquinone; 8 –fluoranthene; 9 – pyrene; 10 - benzo(a)anthracene ; 11 – chrysene; 12 - benzo(k)fluoranthene

Results

This method makes it possible to determine the concentration of potassium bromate in the air at workplace within the concentration range of 0.05 to 1.00 mg/m^3 (air sample volume of 720 L) - in ranges corresponding to 0.1 ÷ 2 times the maximum permissible concentrations in the workplace air. The established chromatographic conditions enable the simultaneous determination of anthraquinone and polycyclic aromatic hydrocarbons. The average recovery obtained for antraquinone was 0.98.
The method has been validated according to EN 482:2021 [3] for linearity, sensitivity, selectivity, precision and accuracy.

Validation data

Limit of detection (LOD)	0.09 ng/mL
Limit of quantification (LOQ)	0.26 ng/mL
Recovery	0.98
Overall precision	6 %
Overall uncertainty	26 %

Conclusion

- ✓ Anthraquinone could be determined in the workplace air at the concentration range from 0.05 to 1.00 mg/m^3 by gas chromatography-mass spectrometry.
- ✓ Air samples can be taken for determination of AQ by means of IOM Inhalable Sampler with glass fiber filter.
- ✓ The developed quantitative method for determining the inhalation fraction concentrations of anthraquinone in the workplace air can be used to assess the occupational risk in the presence of this carcinogen.
- ✓ As a result, a draft standard will be created, which, once established by the Polish Committee for Standardization, will become a Polish Standard for air purity protection.

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