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Rubber process fumes components — Quantitative test methods

Constituant des fumées de procédé du caoutchouc — Méthodes d'essai quantitatives

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Foreword

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This document was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*.

Introduction

Rubber process fumes are emitted during the rubber manufacturing process. These rubber fumes have been the topic of many studies, for example ISO/TR 21275. ISO/TR 21275 gives a bibliographic study of 95 publications describing the compositions of fumes that could be emitted during the processing of rubber. The study also confirms that rubber fumes are a complex and variable mix of chemicals which have a wide range of possible sources and origins, including chemicals generated from the chemical reactions occurring in the rubber compounds during processing and curing. Some of these chemical substances can be hazardous. ISO/TR 21275 demonstrates the need for standardization of test methods to identify and quantify the hazardous chemicals to which the operators of the factories producing rubber articles may be exposed, allowing the identification and mitigation of potential health risks.

ISO/TS 17796 specifies a qualitative method (by thermodesorption – gas chromatography – mass spectrometry) for the identification of volatile components in rubber fumes, and is applicable to the screening of emissions from the processing of rubber compounds in the ambient workplace and storage environment. The document is an efficient tool for identifying hazardous substances contained in rubber process fumes.

If a hazardous component is identified in rubber fumes, then the most efficient way to eliminate risk for the operators is to substitute the substance or the process which generates the hazardous component.

In cases where there is no substitute, then the risk can be reduced by controlling the exposure of the operators to the hazardous component. Test methods are therefore necessary to quantify each hazardous substance.

Table 1 provides an overview of the diverse range of rubber components made from general manufacturing processes and dipped latex technology. The list of components is by no means exhaustive but helps to highlight the diverse areas and products in which rubber is used.

Table 1 — Range of rubber components

Types of products	Examples
Tyres	Passenger cars, trucks, racing vehicles, cycles, off-road tyres, inner tubes, curing bladders
Conveyor /transmission belting	Steel cord conveyor belting, repair material for conveyor belting, scrapers, mining conveyors, V-belts, flat belts, synchronous belts
Industrial hoses	Water hoses, high pressure hoses, welding hoses, hydraulic hoses, spiral hoses, offshore hoses, oil hoses, chemical hoses
Automotive products	Coolant hoses, fuel hoses, seals and gaskets, anti-vibration mounts, hydraulic hoses, fuel injectors, timing belts, window and door channelling, transmission and engine components, wiper blades, exhaust hangers
General mouldings/sheeting	Moulded seals and gaskets, anti-vibration products, floor coverings, sheeting, tube rings, roofing layers, subsoil water sheeting, roller coverings, protection linings, moulded micro-cellular products, composite profiles, rubberized fabric, micro-cellular rubbers/profiles, wire and cable jackets and insulations, glass sealants, pump impellors, roof membranes, pond liners, rail mounts, bridge bearings, military vehicle track pads
Medical/pharmaceutical products	Surgical gloves, medical tubing, MDI valve gaskets, catheters, dialysis products, surgical implants, prostheses, contraceptives, soothers, baby feeding teats and breast caps, blood transfusion tubing and valves, medical and antistatic sheeting and membranes, masks and respirators
Clothing	Boots/footwear, protective suits, household gloves, industrial gloves, footwear/boot heels and soling, cellular rubber soles, wet suits, diving suits, coated fabrics, sports footwear and clothing

Table 1 *(continued)*

Types of products	Examples
Food contact products	Food transportation (e.g. conveyer belts, hoses and tubing), food handling (gloves), pipe and machinery components (seals, gaskets, flexible connectors and diaphragm/butterfly valves), pumping system components (e.g. progressive cavity pumps stators, diaphragm pumps), plate heat exchanger gaskets, seals/gaskets for cans, bottles and closures
Potable water products	Pipe seals and gaskets, hoses, linings of pumps and valves, tap washers, membranes in pipes and filters, coatings on process plant, tank linings
Miscellaneous products	Adhesives, rubberised asphalt, high vacuum and radiation components, carpet backing, latex thread, sealants and caulking, toys

The rubber material used to make any particular product is not a single entity but is a complex compounded material referred to as a "compound" or "formulation", which can contain a large number of essential chemical ingredients. These ingredients include the base rubber polymer(s), reinforcing and non-reinforcing particulate fillers, process oils, vulcanizing agents, protective agents, process aids, etc. (all of which are available in many types and grades from many suppliers and can be included at different levels). The company or individual that designs a rubber formulation for a specific product has a vast number of ingredients to choose from and many formulations are therefore possible for a specific rubber product.

The processing route by which the majority of rubber components are manufactured includes mixing the ingredients together in a controlled manner to produce a rubber "compound" or "mix", shaping of the mixed compound to give the desired shape or form, then "vulcanizing" (also known as "cross-linking" and "curing") the compound to convert it to a condition where it has permanent properties and shape.

Rubber process fumes components — Quantitative test methods

1 Scope

This document gives guidance on the quantitative test methods to measure chemical components in fumes emitted during the manufacturing process of rubbers (including storage) and considered hazardous.

NOTE Quantification of the level of exposure allows selection of the correct type of protection for the operators and, after implementation of the protection, verification that the risk was eliminated by implementation of the selected protection.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

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rubber process fumes
variety of volatile substances emitted from rubber compounds into a workplace atmosphere as a result of industrial processing, the composition of which depends on the formulation of the compounds concerned, the process technology in use and the associated process parameters

4 General

The list of the hazardous substances which can exist in rubber fumes is established by using the results obtained by ISO/TS 17796 and also by the work done by rubber industries and others, regarding chemical reactions appearing during the process of the rubber. ISO/TR 21275 gives many examples.

NOTE 1 The study given in ISO/TR 21275 compiles and reviews published data with respect to rubber fumes emissions in the workplace. ISO/TS 17796 gives a method for the identification of volatile components in rubber fumes, and is applicable for a screening of emissions from the processing of rubber compounds in the ambient workplace and storage environment.

Many producers of rubber articles use their own techniques to determine the amount of hazardous substances in rubber fumes. Generally, those methods are based on individual internal development and/or on studies published by external laboratories. A standardized technique (including sampling) for the determination of the amount of hazardous substances in various rubber fumes is becoming increasingly important and is the logical complement to ISO/TS 17796.

The process is described in three steps:

a) identification of the hazardous substances which may be present in rubber process fumes;

b) identification of the test methods available for each of the hazardous substances; and

c) selection of the most suitable test method to quantify the identified substances.

Clause 5 provides an overview of the test methods for the quantification of selected hazardous substances in rubber fumes resulting from this process. For more information, see Reference [12].

NOTE 2 Application of this process will not only allow rubber companies to globally improve protection of workshop operators, but will also help small companies which do not have the resources to perform a selection of test methods. It will also simplify the work of policy makers.

5 Test methods for the quantification of selected hazardous substances in rubber fumes

Table 2 gives the list of hazardous substances that can be observed in rubber fumes and test methods to quantify their presence.

Table 2 — List of hazardous substances in rubber fumes and their test methods

Name of substance	Identified/evaluated test methods
Benzene	Recommended method: ISO 9487:1991 For information, other methods: — BS EN 14662-3:2005 — NIOSH 1501, Issue 3 — IS 5182 (Part 11):2006 — NIOSH 2549, Issue 1 — NIOSH 3700, Issue 2 — ISO 16000-29:2014
Acrylonitrile	Recommended method: BGIA 6041
Formaldehyde	Recommended method: ISO 16000-3 For information, other methods: — 3M 3721 Formaldehyde monitors — ASTM D5197 — 09e1 — MTA/MA-018/A89 — MDHS 78 — NIOSH 2016 — NIOSH 2541 — NIOSH 3500 — OSHA 52

Table 2 *(continued)*

Name of substance	Identified/evaluated test methods
o-Toluidine	Recommended methods: no international standards are available, but only methods from national safety and health organizations (OSHA, NIOSH and MDHS): — BGI 505-49E — OSHA 73 — NIOSH 2017 — PN-81/Z-04031/03 — WHOMDHS 75 — MDHS 75 — MDHS 96 — ISO 16200-1
2-Chloro-1,3-butadiene (CHLOROPRENE)	Recommended methods: NIOSH 1002 or OSHA 112
1,3 Butadiene	Recommended methods: NIOSH 1024 or OSHA 56 Other available method: Metropol 177
Isoprene	Recommended method: OSHA 7
Dibenzo[a,h]antracene Chrysene Benzo[k]fluoranthene Benzo[j]fluoranthene Benzo[e]pyrene Benzo[b]fluoranthene Benzo[a]pyrene Benzo[a]anthracene	Recommended methods: NIOSH 5506 and Metropol 332 For information, other methods: — NIOSH 5515 — MTA/MA039/A00 — OSHA 58 — NF-X-43–294 — BGIA 6272 — PN-Z-04240–4:1999 — NF-X-43–329 — ISO 12884:2000 — ISO 11338-1 and ISO 11338-1
N-nitrosodiethanolamine (NDELA)	Recommended method: BGI 505.36 (previously named ZH 1/120.36) For information, other method: TRGS 552
High volatile nitrosamines	Recommended method: DGUV 213-523 For information, other methods: — TRGS 552 — BGI 505-23 (previously named ZH 1/12023)
Low volatile nitrosamines	Recommended method: BGI 505-62 (previously named ZH 1/120.62) For information, other method: TRGS 552

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