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Ventilation systems for nuclear facilities — In-situ efficiency test methods for iodine traps with solid sorbent —

Part 2: Radioactive CH_3I method

Systèmes de ventilation pour les installations nucléaires — Méthodes d'essai in situ de l'efficacité des pièges à iode à sorbant solide —

Partie 2: Méthode au CH_3I radioactif

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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A list of all parts in the ISO 16659 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

In nuclear facilities, iodine traps are usually present within ventilation systems to limit radioactive gaseous iodine releases into the environment or to prevent radioactive iodine transfer to protected areas (such as control room for example) in accordance with the principles of ISO 17873[1] and ISO 26802[2] or other relevant documents (see References [3], [4], [5], [6] and [7]. The ability of these devices to trap gaseous radioactive iodine is primordial, particularly when they support the safety demonstration. The IAEA in paragraph 4,127 of Specific Safety Guide No. 53 (SSG-53)[8] recommends demonstrating the efficiency of the adsorption material in iodine traps and periodically testing iodine traps in-situ.

ISO 16659 series provides different in-situ test methods to determine the efficiency of radioactive iodine traps in ventilation systems of nuclear facilities. This series deals with iodine traps with solid sorbent, mainly impregnated activated carbon, the most usual solid sorbent used in ventilation systems of nuclear facilities, as well as other sorbent submitted to special conditions (e.g. silver loaded zeolites in case of high temperature).

ISO 16659–1 is the general part of this series and describes common general provisions applicable to all methods.

This document is about an in-situ testing method for measuring the efficiency of iodine traps using radioactive methyl iodide ($CH_3{}^{131}I$) as a tracer.

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Ventilation systems for nuclear facilities — In-situ efficiency test methods for iodine traps with solid sorbent —

Part 2: Radioactive CH_3I method

1 Scope

This document specifies a test method using radioactive methyl iodide ($CH_3{}^{131}I$) as a tracer to determine the in-situ decontamination factor of an iodine trap. An in-situ test allows to reach the global efficiency of the trap characterized by the sorbent efficiency but also by the implementation of the trap within the ventilation duct) while the intrinsic efficiency of a charcoal is characterized in a laboratory by ISO 18417[9] (or other national standards such as ASTM D3803[10]).

This document provides general and common requirements for this method to assess the efficiency of an iodine trap, but also, the tools requirements, accuracy and the provisions needed to ensure safety of the workers, public and the environment during the test.

This reproducible method can support nuclear facility operators as a reference method to compare the decontamination factor evaluated by this method to reference values (e.g. safety criteria, national legislation, etc.).

Because of the use of a radioactive tracer, some precautions should be applied.

Firstly, this method is usually used for ventilation systems with monitoring of gaseous iodine releases in environment in accordance with the national regulations.

Secondly, this method is not used to determine the decontamination factor of iodine traps used in ventilation systems with air release in rooms with potential presence of workers (e.g. control room). For those rooms, a non-radioactive method is preferred.

This document can apply to installations with low inventory of radioiodine equipped with iodine traps (e.g. small laboratories). In this case, some provisions can be adapted but always in accordance with the national regulations.

Finally, this document mainly deals with iodine traps using impregnated activated carbon. However, this method can be used with some adaptations to other solid sorbent as inorganic sorbent (e.g. zeolite – aluminium and silica base usually doped with silver nitrate – or impregnated catalytic supports[11][12]).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2889, *Sampling airborne radioactive materials from the stacks and ducts of nuclear facilities*

ISO 16659-1:2022, *Ventilation systems for nuclear facilities — In-situ efficiency test methods for iodine traps with solid sorbent — Part 1: General requirements*

ISO 20042, *Measurement of radioactivity — Gamma-ray emitting radionuclides — Generic test method using gamma-ray spectrometry*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in in ISO 16659-1 apply.

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

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

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

4 Method

4.1 General

This method employing radioactive iodine encompasses all physical phenomena associated with iodine retention during the test (physical adsorption, chemical adsorption, isotopic exchange and short-term desorption). This method is relevant to determine a decontamination factor of a high efficiency iodine trap (a decontamination factor superior to several thousand is typically achievable for a new sorbent).

Concerning the methyl iodide form (CH_3I) of radioactive iodine used as a tracer in this method, it is important to notice that it is generally not the most present gaseous iodine form in nuclear facilities, in particular, in reactors where the molecular form (I_2) is more common. But the interest of using such a tracer is that methyl iodide is the most penetrating form for an iodine trap.

So, because all the physical phenomena are tested and considering the use of methyl iodide as a tracer gives conservative decontamination factors, this method is relevant to support nuclear facility operators to compare the decontamination factor to CH_3I but also I_2 reference values (e.g. safety criteria). This method is widely encountered in PWRs even if different iodine species are present.

Moreover, due to its chemical properties compared to I_2, this CH_3I method is easier to implement in facilities (less contamination of the test equipment, less damage to equipment (corrosion), easier transport of test equipment, use of less fragile materials (stainless steel instead of glass)) and leads to less worker contamination.

Concerning the test conditions (ambient conditions) which can differ from those encountered during incidents or accidents (high temperature, high relative humidity, etc.), it is important to notice that the decontamination factor determined with this method may not be directly transposed as a reference value for the estimation of radiological consequences for population. Nevertheless, this document gives a reproducible method to precisely evaluate the decontamination factor of an iodine trap and thus to reveal its full ability to trap gaseous iodine when high decontamination factors are reached or its possible degradation over time due to ageing phenomena.

Finally, this method does not lead to a saturation of the iodine traps by the radioactive iodine tracer (the quantity injected is extremely low compared to the trapping capacity) and so is compatible with the safety of the nuclear facilities.

4.2 Principle of the method

The principle of the method (see Figure 1) consists in:

a) the injection of gaseous radioactive iodine-131 (CH_3I form) into the ventilation duct;

b) the measurement of the quantities of CH_3I present upstream and downstream of the iodine trap (sampling in ventilation duct, trapping radioactive iodine in charcoal cartridges and gamma spectrometry counting of the charcoal cartridges);

c) the calculation of the decontamination factor and the comparison to a reference value.

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