UTAC CERAM

Smokes toxicity & opacity

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Smokes toxicity & opacity

Overview about the fire tests for interior materials in different transport means				
	Buses [ECE R 118]	**Rail vehicles [EN 45545-2]**	**Ships [SOLAS Chapter II-2]**	**Aircrafts [FAR/JAR/CS 25.853]**
Horizontal burning rate	ISO 3795 (horizontal mounted components)	No test	No test	FAR/JAR/CS 25.853 b(5) (cabin and cargo compartment)
Vertical burning rate	ISO 3795 (vertical mounted components)	EN ISO 11925-2 (Filter materials)	ISO 6940/41 (drapes and hangings)	FAR/JAR/CS 25.853 b(4) (cabin and cargo compartment)
Heat release rate	No test	ISO 5660-1 (most materials)	ISO 5660-1 (fire-restricting materials in high speed crafts)	FAR/JAR/CS 25.853(d) (cabin compartment)
Smoke density	No test	ISO 5659-2 (most materials)	ISO 5659-2 (most materials)	FAR/JAR/CS 25.853 (d) (cabin compartment)
Smoke gas toxicity	No test	ISO 5659-2 (most materials)	ISO 5659-2 (most materials)	BSS 7239/ABD 0031 (cabin compartment)
Calorimeter test for seats	No test	ISO 9705-2 (passenger seats)	ISO 8191-1/-2 (upholstered furniture)	FAR/JAR/CS 25.853(c) (upholster furniture)

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- **Two families of smoke opacity evaluation methods exist :**
  - **Direct methods : based on the measurement of the smoke extinction coefficient or other similar optical parameter.**
  - **Indirect methods : relate the mass of fuel needed to produce soot via a fuel characteristic factor.**

- **An appropriate model should be chosen to correlate opacity with the loss of visibility. Visibility assessment is an essential parameter of fire safety.**

- **Difficult to assess the variability of effects within populations : as safety criteria for a visibility of 10 meters, an extinction coefficient around 0.3 m^{-1} to 0.15 m^{-1} for a reflective system can be considered.**

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- To correctly measure the toxic effect of smoke, it is necessary to define which effect to study: disability or lethality. It is needed to determine the maximum potential toxic materials could be present. For example, the most common species may account for 90% of the lethal potential of fumes, but only 50% of their irritant potential.

- The kinetic aspect of production is also essential. Some products release very large amounts of toxic substances in the first few minutes, while others release less, but longer. It is then difficult to determine in which case the fumes present the most danger for people.

- Current methods are mainly based on indirect evaluation : smoke analyzis and comparison of obtained results with criteria, using models taking into account the combined effects of the different parameters (e.g. doses received during a dedictaed period or as a total quantity during full time)

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Civil navy (France)

- The determination of smoke toxicity is performed by Fourrier Transform Infrared Spectrometry (FTIR) coupled to the ISO 5658 smoke chamber.
- The measurement is made at a fixed time point, located after the maximum smoke density in the chamber, at a given point in the chamber. In this case, some gaseous species can condense on the walls and are therefore no longer measurable. The number of gases analyzed is not very important.

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Military Navy (France)

- Smoke toxicity is considered in the choice of materials used on military ships, particularly submarines. The principle is described in STANAG 4602.
- In military vessels, and in particular submarines, evacuation is impossible due to military constraints. The standard thus concerned is the most severe available at the present time.
- The test consists of burning a small quantity of material and analyzing the gases produced. The degradation model is the NF X 70-100-2 tubular furnace, but it is used at 350 °C and 800 °C. These two temperatures are representative of the pyrolysis and live combustion temperatures of a material, thus reproducing two phases of fire.
- 20 gases are analyzed at 350°C and 15 to 800°C. Then a toxicity index is calculated from the concentrations obtained, expressed in ppm/100g/m3, weighted by their relative lethality index.

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Aeronautics (France)

- In aeronautics, tests are described in FAA FAR 25. These tests are taken over and specified by the main manufacturers in the form of their own reference standards, in particular for toxicity. The Boeing, Airbus and Bombardier standards are very similar.
- The toxicity test consists in measuring the average concentrations in different species after 4 minutes of test and during 15 minutes. The methods used can be the classical splash techniques for which sampling is described in standard NF X 70-101.
- The species studied, which vary according to the manufacturer reference frames, take into account at least CO, CO2, SO2... The measurements made are individually compared to clean thresholds and are not used in a toxicity model.

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Rail Transportation (France)

- Rail transport was very early subjected to smoke toxicity requirements, for several reasons: firstly, primary fireplaces can come from elements brought by passengers: luggage... In this case, it is essential that the materials present do not increase the toxic risk of smoke. Secondly, the time required to stop the train and evacuate, as well as the small volumes of air available, make it necessary to limit the toxic potential of the combustion fumes.
- The approach adopted in this context is described in standard NF F 16-101 (now replaced by EN 45545). Each material present in the train, and more particularly those in the vicinity of passengers, is subjected to tests for reaction to fire, opacity and smoke toxicity.
- The smoke toxicity test is based on NF X 70-100. 7 gases are studied: CO, CO2, HCl, HBr, HF, HCN and SO2. A toxicity index is then calculated.
- The limits of the masses of materials to be tested and the applicability of the tests depend on the risk inherent in the type of rail vehicle (berths, tunnel traffic, etc.) as well as the location of these materials in relation to passengers, the toxic potential of the smoke...