Nordtest method

NT FIRE 051
Approved 2000–04

1(4)

FIRE EXTINGUISHING FOAM, ENVIRONMENTAL AND HEALTH PROPERTIES:
HAZARD EVALUATION

Key words: Fire extinguishing foam, hazard evaluation, aquatic toxicity, biodegradation, bioaccumulation, inhibition of nitrification

0 PREFACE

Test methods and requirements for fire extinguishing foams are specified in various standards such as ISO 7203 and EN 1568. These standards consider environmental and health hazards only briefly. This Nordtest method provides a methodology for detailed and systematic evaluation of environmental and health hazards of fire extinguishing foams. The general requirements specified in this method are based on Directives issued by the European Union, while certain requirements (Section 8) are aimed for e.g. foam concentrates claimed to be environmentally adapted. The method has been circulated for comments within the Nordic countries and to some major foam manufacturers in Europe. The experience with the method may assist development of future work within the CEN standardisation of foam concentrates.

1 INTRODUCTION

Fire extinguishing foams are designed to achieve control and extinction of fires in order to save life and protect property and environment in emergency situations. Fire extinguishing foam (fire fighting foam or foam) is prepared with an aggregate of air filled bubbles formed from a foam solution used for fire fighting. Foams are especially important in the extinguishing of fires involving liquids which have a specific gravity lower than that of water. Most flammable liquids cannot be extinguished by cooling alone. Foam extinguishes fires by cutting off the ignition source and supply of oxygen to flammable vapours.

Foam is designed to be used with large quantities of water and may end up in the ground water and surface water or enter sewer systems. Concern has been expressed regarding the environmental impact of foams because of their episodic large-scale use and their frequent use in training exercises.

The formation of expanded foam in large quantities due to the content of surfactants may cause harmful effects in the aquatic environment. Foam that enters the sewer system can have an adverse effect on biological waste water treatment plants (WWWT) and may pass forward to the biological stage of WWWTs and reduce the efficiency of e.g. the nitrification process.

Nitrification may be inhibited by concentrations of chemicals which would not inhibit other important biochemical reactions. Thus, study of the nitrification process provides results useful for the evaluation of the possible influence of foam. Furthermore, components in some types of foams are not readily broken down and are almost biologically persistent. Evaluation of possible environmental hazards may be a complement to technical classifications of fire extinguishing performance of foams.

2 SCOPE

The method is intended for systematic evaluation of environmental and health hazards of fire extinguishing foam. The method provides additional procedures and requirements for foam concentrate and diluted foam solutions, simulating environmental concentration following foam use. For optional classification of foam concentrates various additional requirements can be combined. The method shall be regarded as a complement to existing standards which focus on the technical properties of foam.

3 FIELD OF APPLICATION

The method specifies evaluation of the environmental properties of fire extinguishing foams intended for use as low-, medium- and high expansion foams.

Note: In general, most foams fall into one of the categories: protein foam concentrates (P), fluoroprotein foam concentrates (FP), synthetic foam concentrates (S), alcohol resistant foam concentrates (AR), aqueous film-forming foam concentrates (AFFF), film-forming fluoroprotein foam concentrates (FFFP).

4 PRINCIPLE

Fire extinguishing foam is evaluated with respect to environmental and health hazards according to official requirements for single chemical substances in the foam concentrate. Apart from this primary evaluation the method provides additional requirements for diluted foam solutions depending on the type of foam or use of foam. These evaluation pro-
cures are based on requirements for various properties either of substances in the foam concentrate or dilutions thereof. Internationally accepted test procedures provide the basis for the evaluation.

5 REFERENCES

Directive 1999/45/EC (with amendments) on the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparations.

Directive 67/548/EEC (with amendments) on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances.

ISO/TR 15462:1997(E); Water quality – Selection of tests for biodegradability.


OECD Guideline 201: Algae, Growth Inhibition Test.


OECD Guideline 203: Fish, Acute Toxicity Test.

OECD Guideline 301 A: DOC Die-Away Test.

OECD Guideline 301 B: CO₂ Evolution Test.

OECD Guideline 301 C: Modified MITI Test (I).

OECD Guideline 301 D: Closed Bottle Test.

OECD Guideline 301 E: Modified OECD Screening Test.

OECD Guideline 301 F: Manometric Respirometry Test.


OECD Guideline 302 C: Inherent Biodegradability: Modified MITI Test (II).


6 DEFINITIONS AND ABBREVIATIONS

For the purposes of this method the following definitions and abbreviations apply:

CAS No: a unique registration number for substances (CAS Registry Numbers) provided by the American Chemical Society.

foam concentrate: a liquid concentrate which when mechanically mixed with water and air forms a foam useful for fire extinguishing. See also EN 1568, Definitions.

LC₅₀/EC₅₀: Median lethal concentration / Median effect concentration. The concentration of a substance or substances that, when a population of test organisms is exposed to it, is estimated to be fatal to 50 % of the test organisms, or show 50 % effect compared with reference organisms, under the stated conditions of the (aquatic) test.

standard foam solution for use: Solution of foam concentrate prepared using the foam concentrate at the supplier’s recommended concentration with water (usually to 3 % or 6 v/v %). Foam solution can be prepared either as pre-mix or in-line by proportioning with water.

hazard: The inherent potential of a substance to harm human beings or the environment. The hazard depends on the properties of the substance.

IUPAC: International Union of Pure and Applied Chemistry

mass fraction: percentage by weight of substances in a preparation, often expressed as w/w %.

nitrification: the oxidation of ammonium salts by bacteria. Usually the end product of such an oxidation is nitrate.

substances: chemical elements and their compounds as they occur in the natural state or as produced by industry.

7 GENERAL REQUIREMENTS FOR ALL TYPES OF FOAMS

The evaluation of possible hazards requires documentation of toxicological and ecotoxicological properties of the substances in the foam concentrate. Internationally accepted test procedures shall be used and documented. Additional requirements and test procedures are specified in Sections 8 and 9.

Note: This evaluation requires access to a detailed product formulation, where all the ingredients are cited by name according to IUPAC and if appropriate using their CAS No. The content of all ingredients and known impurities shall be given as mass fraction.

7.1 Health hazards

Foam concentrate shall be subject to classification according to regulations concerning health hazards within Directive 1999/45/EC with amendments.

Note: For preparations covered by this method dangerous substances are evaluated on the basis of their health effects such as very toxic, toxic, corrosive, sensitising carcinogenic, mutagenic or toxic for reproduction.
7.2 Environmental hazards
Foam concentrate shall be subject to classification according to regulations concerning environmental hazards within Directive 1999/45/EC with amendments.
Note 1: For preparations covered by this method dangerous substances are evaluated on the basis of their environmental effects such as very toxic to aquatic organisms or toxic to aquatic organisms and may cause long-term adverse effects in the aquatic environment.
Note 2: The same requirements as regards environmental hazards apply to substances that have been scientifically shown to form environmentally harmful degradation products under relevant conditions.

8 EVALUATION OF HAZARDS FOR CERTAIN TYPES OF FOAMS AND/OR CERTAIN USE OF FOAMS
Evaluation in accordance with this Section is intended to support possible additional requirements depending on the type of foam or use of foam. The evaluation procedures referred to are based on requirements for various properties either of substances in the foam concentrate or dilutions thereof. Test procedures are specified in Section 9.
Note: The requirements in Section 8 are not intended to be applied to all types of foams. Depending on the type of foam and/or use of the foam specific requirements can be designed by applying an additional element or by combining various elements.

8.1 Requirements for substances in foam concentrate
8.1.1 Acute aquatic toxicity
The foam concentrate shall not contain any substance which has an aquatic toxicity (LC50 / EC50) \(< 1 \text{mg/L}\), according to 9.1, and at a total mass fraction \(> 0.25\%\).

8.1.2 Bioaccumulation
The foam concentrate shall not contain any substance, at a mass fraction \(> 0.25\%\), which has a potential for bioaccumulation according to 9.2.
Bioaccumulation potential shall be considered if a substance has a partition coefficient n-octanol/water log \(K_{OW}\) \(\geq 3.0\), except in the case that the bioconcentration factor (fish) \(\leq 100\).
Note 1: If a substance is readily biodegradable according to 9.3.1 bioaccumulating testing is not required.
Note 2: The partition coefficient n-octanol/water applies only to pure, water soluble substances which do not dissociate or associate and which are not surface active. Bioaccumulation for surfactants shall be determined by the bioconcentration factor.

8.1.3 Biodegradability
8.1.3.1 Ready biodegradability
The foam concentrate shall not contain any substance, at a mass fraction \(\geq 0.25\%\), which is not readily biodegradable according to 9.3.1.
Note: This requirement does not relate to insoluble polymers.

8.1.3.2 Inherent biodegradability
The foam concentrate shall not contain any substance, at a mass fraction \(\geq 0.1\%\), which has a low inherent degradability \(< 20\%\) according to 9.3.2.
Note: This requirement does not relate to insoluble polymers.

8.2 Requirements for further diluted standard foam solution for use
This paragraph provides requirements for inhibition of microbiological activity when the standard foam solution for use is further diluted to concentrations which may be representative for discharge into the environment in conjunction with use.

8.2.1 Inhibition of microbiological activity
Inhibition of microbiological activity is tested with diluted foam solutions on activated sludge. Foams which may affect the bacteria nitrification step in waste water treatment plants shall be tested according to 8.2.1.1.

8.2.1.1 Inhibition of nitrification
The standard foam solution (in the highest concentration) for use is tested according to 9.4.1. The calculated inhibition of nitrification of activated sludge micro-organisms shall not exceed 20% inhibition (EC20) at 20% dilution.
Note: The requirement EC20 at the specified rate of dilution is in accordance with recommendations from the Swedish EPA (report no. 4547).

9 TEST PROCEDURES
All tests shall be performed in accordance with internationally validated reference methods.
Note: Examples are methods approved by ISO or OECD Guidelines. If corresponding methods are used, the similarities/differences of the method must have been verified by an independent body.
9.1 Acute aquatic toxicity
Aquatic toxicity shall be determined in accordance with OECD 201, OECD 202 and OECD 203.
Note 1: The tests shall be carried out on the three species in conformity with the criteria of Annex VI to Directive 67/548/EEC (Algae, Daphnia and Fish), unless the highest hazard classification relating to acute aquatic toxicity has been assigned after testing on one of the species.
Note 2: Minimum test duration for Algae is 72 h, for Daphnia 48 h and for Fish 96 h.

9.2 Bioaccumulation
Bioaccumulation potential shall be determined in accordance with OECD 107 or 117 (partition coefficient n-octanol/water) or bioconcentration factor (fish) in accordance with one of the methods in OECD 305 (A-E).

9.3 Biodegradability

9.3.1 Readily biodegradable
Ready biodegradability shall be determined with one of the test methods in OECD 301 (A-F).
Note 1: For the purpose of the requirements in Section 8, the 10-d window in accordance with OECD 301, Annex 1, is not applied.
Note 2: For substances where the chemical structure is known, the theoretical oxygen demand (ThOD) can be calculated and this value should be used instead of the chemical oxygen demand (COD).

9.3.2 Inherently biodegradable
Inherent biodegradability shall be determined with one of the test methods in OECD 302 (A-C).
Note: For substances where the chemical structure is known, the theoretical oxygen demand (ThOD) can be calculated and this value should be used instead of the chemical oxygen demand (COD).

9.4 Inhibition of microbiological activity

9.4.1 Inhibition of nitrification
The inhibition of nitrification shall be determined in accordance with EN ISO 9509.
Note: Methods which show concordant results, e.g. SNV 4424 (Screening Method) are also accepted for determination of the inhibition of nitrification.

10 TEST REPORTS AND DOCUMENTATION
a) Name and category of the fire extinguishing foam according to Section 3
b) Concentration of standard foam solution for use
c) Name and address of the manufacturer or supplier of the fire extinguishing foam
d) Applicable test reports according to Section 9
e) Names and addresses of the test laboratories where the tests have been performed
f) Name and address of the independent body and responsible person performing the hazard evaluation according to this method.

INFORMATIVE REFERENCES
EN 1568 Parts 1–4: 2000, Fire Extinguishing media – Foam concentrates.
Nordtest Method NT FIRE 023 Fire extinguishing foam concentrates: Performance.
PARCOM: Decision 96/3 on a Harmonized Mandatory Control System for the Use and Reduction of the Discharge of Offshore Chemicals.