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Surface active agents — Bio-based surfactants — Requirements and test methods

Agents de surface — Bio-tensioactifs — Exigences et méthodes d'essai

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Contents

Page

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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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/91 Surface active agents

Introduction

Bio-based raw materials have been used for millennia in the manufacture of surfactants, e.g. the first surfactant used by mankind, was already completely bio-based – soap. With the advent of modern surfactants in the early 20th Century, petrochemical-based raw materials also became of interest. They offered the opportunity to tune the surfactant properties, in a broader sense, to their various applications.

The last decades have seen the emergence of new bio-based raw materials for surfactants. Some of the reasons for the increased interest lie in the bio-based products' potential benefits in relation to the depletion of fossil resources and climate change.

Acknowledging the need for common standards for bio-based products, with a focus on bio-based products other than food, feed and biomass for energy applications.

The standards of ISO/TC 91 on "Surfactants" aims at providing a common basis on the following aspects:

— common terminology;

— bio-based content determination;

— Life Cycle Assessment (LCA);

— sustainability aspects;

— declaration tools.

It is important to understand what the term "bio-based product" covers and how it is being used. The term "bio-based" means "derived wholly or partly from biomass". It is essential to characterize the amount of biomass contained in the product by, for instance, its (total) bio-based content or bio-based carbon content.

The bio-based content of a product itself does not provide information on its environmental impact or sustainability, which may be assessed through Life Cycle Inventory (LCI), LCA and sustainability criteria. In addition, transparent and unambiguous communication within bio-based value chains is facilitated by a harmonized framework for certification and declaration.

Surfactants are products which have the ability to reduce interfacial/surface tension, wet surfaces, suspend materials or emulsify oils and fats. In Europe, thousands of producers, manufacturers and nearly every inhabitant use surfactants every day in consumer or industrial applications. The surfactant-producing industry is composed of mainly multinationals. Downstream users are found in multinationals as well as SME's.

Surfactants may be produced from both fossil and renewable carbon feedstock. The amount of crude oil used for surfactant production is, however, low with less than 1 % of the total world's crude oil consumption.

Finally, the approach for these Technical Reports/Specifications/Standards intends to strengthen and harmonize the reputation of "bio-based surfactants" and the confidence of the customer in this product group.

An overview and considerations for the compilation of this document can be found in the ISO/TR 21681 [Surface active agents -- Bio-based surfactants -- Overview on surfactants containing biomass]. It will describe existing raw material sources with regard to their current usage in surface active agents, their source identification and conformation, and the options for communication same. It shall also include the current work on surfactants regarding their performances, their sustainability, the LCA approaches and end of life options.

Surface active agents — Bio-based surfactants — Requirements and test methods

1 Scope

This document sets requirements for bio-based surfactants in terms of properties, limits, application classes and test methods. It lays down the characteristics and details for assessment of bio-based surfactants as to whether they:

— are fit for purpose in terms of performance related properties;

— comply with the requirements regarding the health, safety and environment which apply to general surfactants;

— are derived from a certain minimum percentage of biomass; and

— comply with at least similar sustainability criteria as comparable (non-bio-based) surfactants.

The regulatory requirements applicable to surfactants are also applicable to bio-based surfactants.

NOTE EN 16575 defines the term "bio-based" as derived from biomass and clarifies that "bio-based" does not imply "biodegradable". In addition, "biodegradable" does not necessarily imply the use of "bio-based" material.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1772, *Surface active agents - Determination of wetting power by immersion (ISO 8022:1990 modified)*

EN 1890, *Surface active agents - Determination of cloud point of non-ionic surface active agents obtained by condensation of ethylene oxide*

EN 12458, *Surface active agents - Determination of stability in hard water*

EN 12728, *Surface active agents - Determination of foaming power - Perforated disc beating method*

EN 13955, *Surface active agents - Determination of Krafft point and solubility of ionic surface active agents*

EN 13996, *Surface active agents - Foaming power and antifoaming power - Turbine stirring method*

EN 14210, *Surface active agents - Determination of interfacial tension of solutions of surface active agents by the stirrup or ring method*

EN 14370, *Surface active agents - Determination of surface tension*

EN 14371, *Surface active agents - Determination of foamability and degree of foamability - Circulation test method*

EN 16640, *Bio-based products — Bio-based carbon content — Determination of the bio-based carbon content using the radiocarbon method*

EN 16575, *Bio-based products - Vocabulary*

EN 16751, *Bio-based products - Sustainability criteria*

EN 16760, *Bio-based products - Life Cycle Assessment*

EN 16785-1, *Bio-based products – Bio-based content - Part 1: Determination of the bio-based content using radiocarbon method and elemental analysis*

EN 16785-2, *Bio-based products – Bio-based content – Part 2: Determination of the bio-based content using material balance*

ISO 14040, *Environmental management — Life cycle assessment — Principles and framework*

ISO 14044, *Environmental management — Life cycle assessment — Requirements and guidelines*

DIN 53902, *Testing of surface active agents; determination of foaming power, modified Ross-Miles-method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 862 and the following 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

3.1
surfactant
organic substance possessing surface activity which, dissolved in a liquid, particularly water, lowers the surface or interfacial tension, by preferred adsorption at the liquid/vapour surface, or other interfaces

Note 1 to entry: "Substance" as defined in REACH[11]

[SOURCE: ISO 862:1995, Definition 1, modified — The term originally defined was "surface active agent" and "a chemical compound" is replaced here with "organic substance" at the beginning of the definition.]

3.2
bio-based surfactant
surfactant wholly or partly derived from biomass (based on biogenic carbon)

3.3
bio-surfactant
surfactant wholly based on biomass (based on biogenic carbon) produced either by chemical or biotechnological processing

3.4
degradation
transformation of a compound into smaller component parts due to the physico-chemical processes, which can occur due to abiotic processes such as oxidation and UV adsorption

3.5
biodegradation
transformation of a compound into smaller component parts by means of biological processes

3.6
ultimate biodegradation
breakdown of organic matter by micro-organisms in the presence of oxygen to carbon dioxide, water and mineral salts of any other elements present (mineralization) or in absence of oxygen to carbon dioxide, methane and mineral salts, and in both cases the production of new biomass

4 Generalities on surfactants

Surfactants are products which have the ability to reduce interfacial/surface tension, wet surfaces, suspend materials, or emulsify oils and fats. They make it possible to process, apply, clean or separate materials. Surfactants are widely used in consumer and professional products and for industrial applications. Surfactants are typically used on their own or in combination with other surfactants and other agents to fulfil the requirements of the respective applications.

Examples of applications for surfactants are:

— cleaning agent;

— foaming/defoaming agent;

— wetting agent;

— emulsifier;

— viscosity modifier;

— surface tension reducer;

— process aid;

— fabric softener.

NOTE For many applications to perform effectively, surfactants are essential (see for examples the website of the TEGEWA e.V. (**TE**xtilhilfsmittel" (textile auxiliaries), "**GE**rbstoffe" (tanning agents) and "**WA**schrohstoffe" (detergent raw materials))[1)].

5 Performance of surfactants

5.1 Generalities related to performance

Performance and properties of any molecule, including surfactants, is determined by its chemical structure and not by the origin of its raw materials.

This section gives a common set of technical properties characterizing the performance of surfactants including bio-based surfactants. Due to the absence of international surfactant specification standards, it is necessary to provide to potential users the means to qualify the bio-based surfactant products, especially for its technical performance. Additionally, there are a number of other factors which will determine the acceptance of a surfactant such as the Health, Safety and Environmental properties which are treated in another section of this document.

Surfactants are used in such a wide variety of applications that it is not convenient to evaluate separately their performance with respect to each application. Therefore, a practical approach is to define a set of measurable surfactant properties which enable technical specialists to select appropriate surfactants for their applications.

The following six intrinsic properties characterize the basic performance of a surfactant.

5.2 Technical performance properties

5.2.1 Chemical composition

The chemical composition determines the suitability of a surfactant in processes and applications. The chemical composition is described according to the GHS legislation [Globally Harmonized System of Classification and Labelling of Chemicals (GHS), UNECE, United Nations]

1) See www.tegewa.de for a more detailed brochure about typical use of surfactants.

5.2.2 Solubility

Solubility of surfactants in water depends very much on their hydrophobicity (Hydrophilic-Lipophilic Balance, HLB value [2]), their ionic character and water hardness. Whereas ionic surfactants exhibit a lower critical solution temperature (Krafft temperature), which can be determined by EN 13955, non-ionic surfactants show an upper critical solution temperature (cloud point, EN 1890).

NOTE Some non-ionic surfactants show also a lower critical solution temperature which can also be assessed by EN 13955.

Additionally, the solubility of surfactants, especially ionic surfactants, is influenced by water hardness. EN 12458 describes a suitable test method.

5.2.3 Surface and interfacial tension

The chemical nature of a surfactants and its concentration in a solvent (typically water) determines its behaviour at liquid-air interfaces (surface tension) and at liquid-liquid interfaces (interfacial tension), e.g. water and hexadecane. The degree of surface or interfacial tension reduction by addition of the surfactants indicates the use in different applications.

EN 14370 shall be used to measure the surface tension whilst EN 14210 describes one method for evaluation of interfacial tension.

5.2.4 Foaming power

One key performance property of a surfactant is its foaming power. Foaming itself depends not only on the type of surfactant, but also on the conditions of application. There are also many applications where foam is contradictory for the use.

A list of standardized test methods is shown below:

— EN 12728 which determines the foaming power under high shear conditions;

— EN 13996 which determines the foaming power of surfactants under rotation conditions;

— EN 14371 which determines the foaming power by means of circulation, also useful for defoaming power;

— DIN 53902 which determines the foaming power under free-flow conditions.

NOTE There are many other application-specific foaming tests available[3].

5.2.5 Wetting performance

When applying a surfactant, the first step is often the wetting of substrates. This could be either spreading across substrates like metals or penetration into substrates like textiles.

A suitable method to measure the wetting power for textiles like cotton is described in EN 1772. The spreading of surfactant solutions can be determined by contact angle measurements.

NOTE There is no standard available for contact angle measurement.

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2) Griffin, W.C., J. Soc. Cosmet. Chem. 1 (1946) 311-326 ; McGowan, J.C., Tenside Surf. Det. 27 (1990) 4, 229-230

3) Foam guideline, 2007, http://www.tegewa.de/en/publications/foam-guideline.html.