European Committee of
Organic Surfactants and
their Intermediates

A Sector Group of **Cefic**

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The Relevance of the 10d Window in the Context of the Assessment of ready Biodegradability for Surfactants

Introduction

The rationale behind the ready biodegradability tests is that any chemical passing these tests would be rapidly broken down during sewage treatment and in most aerobic ecosystems. For such an approach to be valid, tests have to be extremely stringent. The stringency of the ready biodegradability tests is primarily ensured by precluding the use of acclimatized microorganisms, even though this is a natural phenomenon, and by minimizing the initial biomass concentration which delays the onset of biodegradation and limits the microbial diversity.

Ready biodegradability tests use batch cultures, and initial concentrations of the test substance are in the range of 2 to 100 mg/L. In these tests, degradation of an organic chemical can only be brought about by microorganisms which are capable of growing on the test substance. Growth of microorganisms on a single chemical usually results in an S-shaped biodegradation curve composed of a lag period, a logarithmic growth phase and a stationary phase (Schlegel, 1993[1]). In microbiology, the logarithmic growth-phases are generally specified with maximum specific growth rates (μmax) or doubling times ($t_{½} = \ln 2/\mu max$).

In ready biodegradability tests, the time window concept has been introduced as a simple alternative to quantify the rate of biodegradation. In order to pass the test, over 60% biodegradation has to be achieved within a period of 10 days immediately following the attainment of 10% biodegradation. An estimation of growth rates from biodegradation curves obtained in for instance ready biodegradability tests is only possible and valid when a single water-soluble chemical substance is studied.

Surfactants and the 10-d window

Surfactants generally occur as substances of multicomponent character with different chain-lengths, degree and / or site of branching or stereo-isomers, even in their most purified commercial forms. All surfactants are chemicals in which a hydrophilic group is linked to a lipophilic moiety.

In the concept of ready biodegradability, both in OECD Guidelines and in EU methods, the 10 day window is applied. In principle, the 10 day window criterion is introduced in order to make the test more stringent. This principle is usually successfully applied to standard testing on individual substances.

Typically, surfactants are mixtures of homologues. The biodegradation kinetics (lag period, growth rate, yield etc.) of the individual compounds in a mixture are not necessarily the same. The biodegradation of a surfactant consisting of homologues is therefore an addition of different biodegradation curves. It is thus possible that individual compounds meet the ten-day time window criterion whereas the biodegradability curve of the mixture of homologues suggests that the surfactant is not readily biodegradable (Richterich and Steber, 2001[2]). If a test on the mixture is performed, and it is anticipated that a sequential biodegradation of the individual structures is taking place, then the 10-day window should not be applied to interpret the results of the test.

Nevertheless, in the particular case of surfactants, the 10 days window criterion should not be considered as a requirement for determining the desired stringency. There are many conceptual and technical reasons to support this statement.

- Surfactant degradation is generally characterised by multiphase kinetics that may be inevitable with a mixed microflora and possibly a multi-component substrate.
- Some surfactants yield, during their degradation, intermediate metabolites which may have catabolic kinetics (rates) different from the parent product.
- Some metabolites interfere with the degradation process by inhibiting transformation of the parent molecule.

This constraining clause must not interfere with the aim of the ultimate biodegradability test, which is to assess the capability (in percentage terms) of a product to be fully degraded into simple compounds during a 28-day period.

Conclusion

The above scientific arguments demonstrate that the 10-day window should be disregarded for the evaluation of the ready biodegradability of technical surfactants representing mixtures of closely related homologues and isomers with a very similar biodegradability profile. This proposal is supported by the fact that the EU Scientific Committee on Toxicity, Ecotoxicity and the Environment (CSTEE) adopted an "opinion on the proposed ready biodegradability approach to update the detergents legislation (2004/648/EC[3]) " stating that keeping the 10-day window is not deemed necessary for assessing ready ultimate biodegradability of surfactants in detergents (CSTEE, 1999[4]). The rationale behind this statement was recognition of the fact that surfactant degradation is generally characterized by multiphase kinetics resulting from the multi-component nature of substrate. As the application of the 10-d window criterion is not scientifically justified for surfactants [CSTEE, 1999; OECD, 2005[5]], it is recommended that surfactants surpassing the 60 % (resp. 70 %) limit value within the standard test duration of 28 days are considered as readily (bio)degradable substances.

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[1] Schlegel HG (1993) General Microbiology 7th edition. Cambridge University Press.

[2] Richterich K and Steber J (2001) The time-window – an inadequate criterion for the ready biodegradability assessment of technical surfactants. Chemosphere 44 1649-1654.

[3] Regulation 2004/648/EC of the European Parliament and of the Council of 31 March 2004 on detergents

[4] European Commission (1999) Scientific Committee on Toxicity, Ecotoxicity and the Environment. Opinion on proposed 'ready biodegradability" approaches to update detergents legislation. Opinion adopted at the 12th CSTEE plenary meeting 25-11-1999.

[5] Annex I to OECD Guideline for Testing of Chemicals, Proposal for revised introduction to the OECD guidelines for testing of chemicals, section 3, April 2005