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Tekoči naftni proizvodi - Biomaziva - Priporočila za terminologijo in opis značilnosti biomaziv in biološko razgradljivih maziv

Liquid petroleum products - Bio-lubricants - Recommendation for terminology and characterisation of bio-lubricants and bio-based lubricants

Flüssige Mineralöl-Erzeugnisse - Bio-Schmierstoffe - Empfehlungen für die Terminologie und Charakterisierung von Bio-Schmierstoffen und bio-basierten Schmierstoffen

Produits pétroliers liquides - Bio-lubrifiants - Recommandations pour la terminologie et la caractérisation des biolubrifiants et des lubrifiants provenant de la biomasse

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Foreword

This document (CEN/TR 16227:2011) has been prepared by Technical Committee CEN/TC 19 “Gaseous and liquid fuels, lubricants and related products of petroleum, synthetic and biological origin”, the secretariat of which is held by NEN.

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This document has been prepared under a Mandate M/430 of the European Commission, addressed to CEN for the development of European standards for bio-lubricants in relation to bio-based product aspects. It has been prepared by CEN/TC 19/WG 33 “bio lubricants”, the secretariat of which is held by DIN.

Introduction

The main reason of the recent interest in bio-lubricants is due to the origin (i.e. use of bio-based raw materials) or to the biodegradability of the final products, needed for instance in case of leakages or technically intended losses. The use of bio-based raw materials could be beneficial with reference to two current problems: fossil resources depletion and climate change. Today, regarding the latter issue, we have to manage the carbon in order to avoid its accumulation in the atmosphere. Efficient use of all available resources and responsible utilization of renewable carbon is a way to participate in this reduction.

Lubricants are important materials which contribute significantly to environmental protection: thanks to their tailor-made properties they reduce energy losses and wear in machines and aggregates.

The global manufacture of lubricants in all applications only uses a small part of the entire consumed mineral oil: in Europe, it only makes up around 1 %. The major fraction (> 80 %) of the residual fossil material is used for energy production, predominantly for transportation and heating purposes. Besides crude oil, biomass is an additional raw material source for lubricants.

The currently available biomass is consumed in different segments: food and feed production, power and heat generation, biofuel production and industrial applications (e. g. production of paper, fine chemicals). Due to the limited capacity of ecosystems, the utilization efficiency of renewable resources and availability issues have to be addressed across the whole bio-economy landscape. The eco-efficiency in this competitive use (e. g. energetic use vs. manufacture of goods) should always be in focus.

According to various scientists [1], it would appear appropriate to use agricultural raw materials predominantly in a cascade of uses, instead of burning them directly in furnaces or engines. That would mean, for example, first producing a bio-lubricant from biomass: around 1 t to 2 t of bio-lubricants can be produced per hectare of agriculture land. The bio-lubricant thereby stores CO_2 in the form of vegetable carbon and removes it from the atmosphere. It would be desirable to trap this CO_2 in the lubricant for as long as possible. Finally, after maximum utilization including recycling when achievable and appropriate, the lubricant can then be used either as energy source or – after re-refining – as downshifted base oil – to return the bound carbon to the natural cycle in the form of CO_2.

In order to ensure responsible and environmentally conscious use of natural (fossil and renewable) resources, a clear and unambiguous terminology is of particular importance.

The approach which is published in this report is focused on the view of the customer: *Are the referred criteria for "bio-lubricants" potentially provable for the formulated product?* The statement of this report is: *Every announcement with regard to biodegradability, toxicity and bio-based content should be measurable through the final product in hands of the customer.*

Finally, this approach intends to enhance the reputation of "bio-lubricants" and the confidence of the customer in this product group, even if no official eco-label stands for the correctness of declarations.

The criteria for "bio-lubricants" published in this Technical Report are not contrary to the European Ecolabel for Lubricants, but complementary.

1 Scope

This Technical Report gives information about bio-lubricants and recommendations for bio-lubricant (and bio-based lubricant) related terminology. These recommendations are based on a discussion of commonly used terms in this field.

This Technical Report also briefly describes the current test methods in relation to the characterization of bio-lubricants. It presents recommendations for related standards in the field of biodegradability, product functionality, impact on greenhouse gas emissions and the amount of different renewable raw materials and/or different bio-based contents used during manufacturing of such bio-lubricants forming one product group.

The criteria of the European Ecolabel for Lubricants ("EEL") [2] include the terms discussed in this paper.

NOTE 1 The European Lead Market Initiative ("LMI") [3] defines the term "bio-based" as described in Table 1. It is important to mention that "bio-based" does not imply "biodegradable". In addition, "biodegradable" does not imply the use of "bio-based" material.

NOTE 2 For the purposes of this European Technical Report, the term "% (m/m)" is used to represent the mass fraction.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
renewable resource
resource replenished by natural processes at a rate comparable to its exploitation rate

2.2
biomass
material of biological origin excluding material embedded in geological formations and/or fossilized

NOTE This definition refers to the well-known short-cycle of carbon, i. e. the life cycle of biological materials (e. g. plants, algae, marine organisms, forestry, micro-organisms, animals and biological waste from households, agriculture, animals and food/feed production).

2.3
bio-based
derived from biomass

NOTE "Biomass based", "bio-sourced", "biogenic" and "from renewable resource" are equivalent terms to bio-based.

2.4
bio-based product
product wholly or partly bio-based

NOTE The bio-based product is normally characterised by the biomass content. For the time being 25 % (*m*/*m*) is recommended as a minimum content of biomass in the final product formulation.

2.5
bio-based carbon content
amount of carbon in a sample that is of recent origin, as evidenced by its ^{14}C isotope content

NOTE 1 Materials contained in a sample are carbon-based compounds in which the element carbon is attached to other carbon atoms, hydrogen, oxygen, or other elements in a chain, ring, or three-dimensional structure.

NOTE 2 The amount of bio-based carbon in the material or product is often expressed as a percentage of the mass of the total organic carbon of the product.

NOTE 3 For developing the market for bio-based products, there is an obvious need for ways to distinguish bio-based products from non-bio-based products. As bio-based products can be made with a mix of bio-based and non-bio-based (e. g. from fossil oil) components, the bio-based content criteria is of high importance. Test methods used at present for that matter are almost always based on ^{14}C measurement as specified in the US standard test method ASTM D 6866 [12]. In Europe, such methods are currently being developed further for applications such as solid recovered fuels (EN 15440 [24]). However, these methods have not yet been applied to the whole range of bio-based products, such as liquids, and assembled products. A horizontal standard that can be adequately applied to measure bio-based carbon content in all sorts of products is hence needed.

2.6
biomass content
mass fraction of bio-based material in a sample, including all molecular ingredients of biomass, besides carbon f.e. oxygen, nitrogen or hydrogen

NOTE Claims of biomass content are difficult to verify due to lack of standards. Effectively, with ASTM D6866 [12] only the content of ^{14}C content can be measured. In contrast, no standard is actually known for the determination of the oxygen content.

2.7
biocompatible
compatible with human, animal and vegetable tissues and interface with biological systems without having toxic or negative physiological effects

2.8
biodegradable
high amount of the final formulated product will be biodegraded after a certain time

NOTE According to well accepted test methods (like OECD 301 or adequate ISO standards) a high amount of the final formulated product will be biodegraded after a certain time (in case of OECD 301 more than 60 % after 28 days).

2.9
bio-based lubricant
lubricant wholly or partly bio-based

2.10
possible impact to the environment
end-of-life aspects connected with total loss or waste

NOTE 1 Especially for the end-of-life management of bio-lubricants, it is important to differentiate between total-loss lubricants and collectable lubricants. For this reason, an indication of biodegradability via an appropriate marking is a good contribution towards more clarity.

NOTE 2 The numbers shown in Figure 2 can give an impression of the different end-of-life scenarios of lubricants.

NOTE 3 For the time being, recycling of lubricants is focussed on mineral oil; due to relatively low volumes, vegetable oils or ester oils within the collected used oils are tolerable, but not treated individually to get back the single component.

2.11
fit for purpose
fit for use
judged as usable in a specific application

NOTE In this sense, the term 'fit for purpose' describes the legal responsibility of the manufacturer, as well as the responsibility of the user. In cases where specific standards are available and accepted, those criteria should be used; the best example of this would be the International Standard ISO 15380 [14] for bio hydraulic fluids

3 Public perception

The “bio-“ prefix is often considered as a synonym of good for the environment, or in another situation, good for health. The prefix "bio", when associated with lubricants, can be perceived as an indication of

biodegradability by the consumers. In other words, a “bio-lubricant” is expected to biodegrade (to break down in the environment). On the other hand, the term bio-lubricant also strongly conveys the idea of natural origin, as “bio” is taken as an indication of the biological world. An analogy is the term “biofuel” – universally taken as implying a fuel derived from renewable resources.

However, as we have seen before, all the different classes (Table 1) are actually present in the marketplace. This is a cause for concern, as it can be the source of misleading information and confusion for the final consumers.

The dissemination of confusing, ambiguous or misleading information should be prevented in order to not jeopardize the success of such schemes as well as the credibility of industry itself. Claims of biodegradability should be supported by appropriate standards.

In some cases, bio-lubricants refer to biocompatible lubricants that interface with biological systems having toxic or negative physiological effects.

Often bio-lubricants are perceived as low performance lubricants. It should be recognized, that modern high performance bio-lubricants can meet and even exceed the performance of conventional lubricants in the market.

Table 1 — common use of the term “Bio” with regard to lubricants

Origin of material	Biodegradability	Example	The meaning of the prefix "bio-"
Renewable	Rapidly biodegradable	Rapeseed oil, tri-methylol-propane-trioleate (TMP-O)	Biodegradable and bio-based
Non-renewable	Biodegradable	Di-isotridecyl-adipate (DITA)	Biodegradable
Renewable	Non-biodegradable	Hydrocarbons from process "Biomass-to-Liquid" (BtL)	Bio-based
Non-renewable	Non-biodegradable	White oil for food grade lubricants	Biocompatible

4 Commonly used terms

4.1 General

Ecological aspects are gaining importance in our society. Bearing in mind that our environment is becoming increasingly contaminated with all kinds of pollutants, any reduction is welcome. From an environmental point of view and compared to a number of other chemical products, lubricants are not particularly problematic. However, a large proportion of the lubricants is released into the environment either during or after use. This may be technically desired (total-loss lubrication) or a result of mishaps such as leaks, emissions, spillages or other problems.

Lubricants and functional fluids are omnipresent due to their widespread use and they thus enter the environment in small, widely-spread amounts and rarely in large, localized quantities. The terminology used in connection with "environmental compatibility" shall be split between subjective and objective criteria:

a) Subjective criteria (non-measurable):

   1. environmentally friendly;
   2. environmentally compatible;
   3. environmentally acceptable;
   4. environmentally adapted;

b) Objective criteria (measurable or provable), for example:

   1. biodegradability;
   2. use of renewable raw materials;
   3. water solubility, water pollution;
   4. ecological toxicity and physiological safety;
   5. performance, approvals, oil change intervals;
   6. efficiency improvements, lower energy consumption, emission reduction in use;
   7. environmental awards (EEL).

Additionally, criteria of Life Cycle Assessments (LCA) are to be considered.

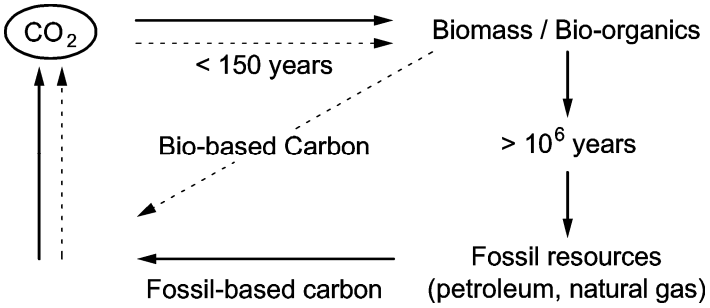
As a consequence of the current ambiguity, the same word is used to designate lubricants, products with very different properties, where all the possible combinations are present (see Table 1).

The bio-lubricants' base oils can be made from both biomass and fossil resources. Lubricants made from biomass can be rapidly, slowly, or not biodegradable; their base oils can be natural (unchanged renewable material) or synthetic (chemically modified biomass). Bio-lubricants can be a combination of both natural and synthetic base oils.

The term bio-lubricant then identifies lubricants which are derived from organic matter constituting living organisms and their residues [4]. Biomass is considered as a renewable resource. A renewable resource is replenished by natural processes at a rate comparable to its exploitation rate. The carbon content of such lubricants is derived from the so-called short carbon cycle (expected time of less than 150 years; see Figure 1, [5]). Most industrial lubricants are presently produced starting from fossil resources which are non-renewable as they cannot be replenished at a rate comparable to the exploitation rate (long carbon cycle, expected time frame to convert biomass to petroleum, gas and coal: > 10^6 years).

4.2 Current situation

Worldwide mineral oil and its derivatives are dominating the lubricants market. But this triumphant progress is limited to the last century. Historically, the friction and wear decreasing properties of natural oils and fats were well known and used in many different ways. In this respect, the development in the last 30 years of biodegradable lubricants based on natural oils is a return to traditional materials – even if the market share today only amounts to a few percent.



Key

Long carbon cycle (> 10^6 years)

Short carbon cycle (< 150 years)

Figure 1 — Global carbon cycling

The market share of “bio-lubricants” amounts to approximately 1 % in Europe. In some countries in Western Europe (Netherlands, Austria, Switzerland, Scandinavia, Germany) the market share is significantly higher, it is published for Germany at approximately 4.3 % [6].

It is assumed that about 40 % to 50 % of the lubricants sold in Europe are lost in the sense that they are not collected/not collectable. The environmental impact is largely caused by this amount of lubricants which is not properly disposed of. This figure includes total-loss applications, the residual oil in millions of oilcans and oil filters, spillages during topping-up, leaks, drips from separated oil-line and hydraulic couplings, accident losses and all manner of emission losses. Concawe Report No. 5/96 [7] gives an overview of the different kinds of loss (see Figure 2).

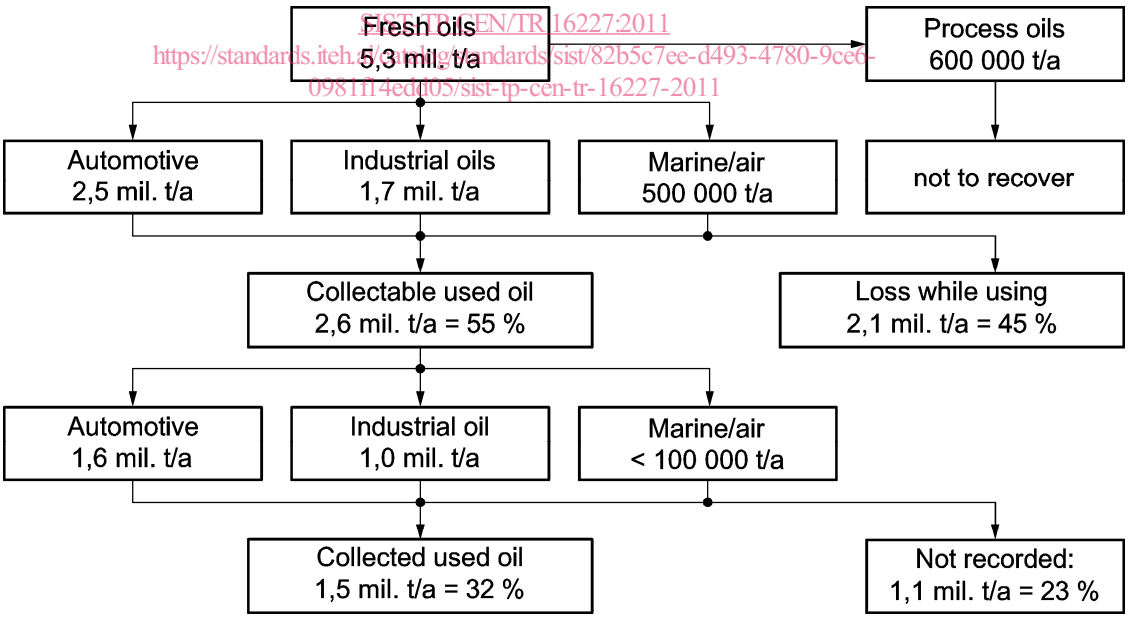


Figure 2 — Lubricants and their different kind of losses