Sustainability in lubricants: a look at how regulatory agencies can play their role

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Introduction

Much of the world has moved towards sustainable practices within the last fifteen years thanks to the contributions of various industries. Throughout this trend, the lubricants industry's efforts towards sustainability have held the greatest impact on the natural environment with the reduction of greenhouse gas emissions into the atmosphere. Lubricants - being this industry's titular main trade - manipulate tribological factors in mechanical systems to prevent wear, thus enhancing longevity and saving resources with their embedded carbon footprint. Additionally, energy is also saved with reduced friction which consequently reduces CO_2 emissions in the use phase (scope 3, downstream) [1]. The baseline for the sustainable future of products is not in dollars or in Euros, but in CO_2 and CO_2 equivalents and their monetary values in terms of EU-ETS or carbon offsets.

However, to meet the growing eco-conscious interest, the lubricant itself must add new non-technical attributes to its portfolio, like "environmentally friendly," "climate neutral," "bio-sourced" and "sustainable." But how are these attributes defined?

New attributes and environmental claims need to be communicated and advertised. The communication of a sustainability commitment is one thing and communicating sustainability claims is another. The FTC will not promote the attributes related to sustainability, but, in the frame of the Green Claims Guide, will protect the public from deceptive or unfair business practices and from unfair methods of competition through law enforcement, advocacy, research, and education." In the future, SEC will ask for the disclosure of climate-related information from SEC registrants.

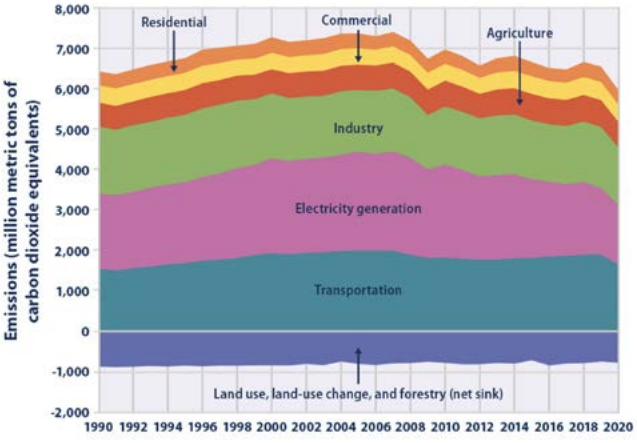

***Figure 1:** U.S. Greenhouse gas emissions and sinks by economic sector [2].*

This assessment can be quantified with real world carbon dioxide equivalent emissions since 2008. As seen in Figure 1, the US has steadily been decreasing its emission rates from a high point of 8.18 gigatons

of carbon dioxide equivalents in 2008 to a practical low point of 6.34 gigatons of carbon dioxide equivalents in 2021 - a decrease of 16.3% from 2005. The year of 2020 represents the actual lowest emission; however, it is most attributed to the pausing of economic activities because of the COVID-19 pandemic and still follows the general declining trend nonetheless [2].

The case of hydraulic fluids

Hydraulic fluids account for 9-12% of the total lubricant volume. Compared to electric drives, hydraulic systems are a more powerful mechanical solution for moving components and machines. Oak Ridge National Lab (ORNL) examined the emissions of CO_2 for fluid powered systems in the USA in 2008 and found that these systems consumed an average of 1.97 Quads out of a U.S. primary energy consumption of 98.6 Quads in 2008, which produced an estimated average of 288 megatons of CO_2 out of 5.745 megatons CO_2 (~5% of fossil CO_2 emissions of USA) and incurring expenses of near $40 billion for the industry [3]. Approximately 5% of this significant emitter of CO_2 will be in Figure 1 and be represented by a visible stripe. The ORNL researchers went further and organised the data into subsets of mobile hydraulics, industrial hydraulics, and the transportation of hydraulics as seen in Figure 2.

In 2017, approximately 31 megatons of CO_2 (or 3.9% of total CO_2 emissions) were released in Germany from the operation of fluid power systems with an energy demand of 66 TWh [4].

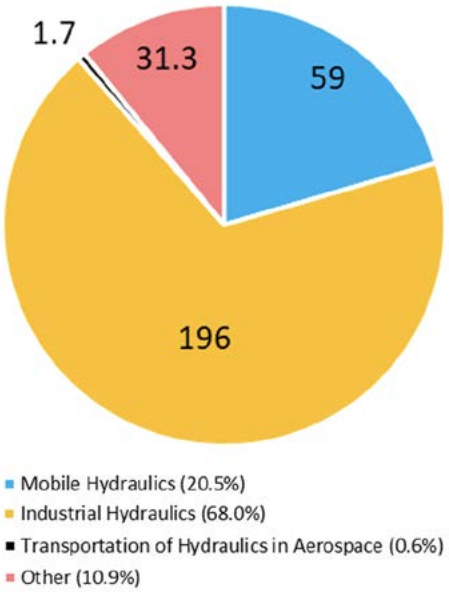

Figure 2: *Breakdown of average 2008 fossil CO2 emission by hydraulic subset in the USA, as determined by ORNL [3].*

Through these analyses, industrial hydraulics have proven to be a quite large and hidden emitter of CO_2. As such, the best way for hydraulic fluids and lubricants to create the greatest benefit for the climate is, if they were aimed at industrial hydraulics applications to decrease energy demand by fluids with less friction, which will save electricity and fuel costs as well as CO_2 allowances. The efficiency gains by switching to an energy-efficient or highly shear-resistant multigrade hydraulic fluid was assessed at an average of 10% [5] (see ASTM D7721-22).

U.S. FTC and U.S. SEC

"Green" marketing claims are voluntary disclosures. There is a growing risk that green claims are seen as greenwashing by U.S. FTC and European Commission. Further, the U.S. SEC is requesting future "climate-related information" and is underway to harmonise this reporting.

-U.S. FTC

Greenwashing, at its core, goes against the FTC's mission statement of protecting consumers from unfair and deceptive trade practices, as it tricks consumers into buying falsely advertised products - having them taken advantage of in the interest of the world's current trend towards sustainability [6]. The commission needs voluntary standardisation bodies to come together and make guidelines to help prevent greenwashing based on recommendations laid out in the Green Guides, to best help protect the consumer.

Furthermore, as these guides are also meant to encourage a fair and free market in the sustainable lubricant industry, the FTC has recently announced an extended public comment session on potential updates and changes to the Green Guides. With this 2023 revision, the commission hopes for feedback on the efficacy of the publication in how well it is benefiting the environment, the economy, and the consumers. This public comment period also gives agencies and marketers a chance to ease or tighten restrictions against them, given they can truthfully establish the modern reality of meeting certain claims such as "recyclable," "recycled content," "compostable," "ozone-friendly," or "sustainable" [7].

-U.S. SEC

The lubricants are concerned by the proposed rule 33-11042 published in March 2022 by The Securities and Exchange Commission (U.S. SEC). This SEC

release [8] requires the disclosure of climate related information, in which indirect emissions from upstream and downstream activities in a registrant's value chain (Scope 3) [8], § 229.1500 (r) and (2)(iii)], if material, or if the registrant has set a GHG emissions target or goal that includes Scope 3 emissions, in absolute terms, not including offsets, and in terms of intensity.

Within scope 3 emissions, or emissions from the value chain, which are defined as a result of downstream activities, like all other indirect emissions occurring along the value chain of an organisation, the scope 3 emissions of category 11 (Scope 3.11) are most relevant to tribology, as they represent the use phase (downstream). In their total life and a cradle-to-grave approach, vehicles with internal combustion engines emit during their use phase 80±5% of the CO_2 emissions through fossil fuel combustion [8]. Any reduction in friction impacts directly on these 80±5% CO_2 emissions.

The Need for standardisation of the quantification of environmental claims

The lubricants industry is on the road towards sustainability and have increased their efforts to reach these goals. These lubricants often come with taglines such as "renewable," "bio-based," "recycled," "environmentally friendly" or "sustainable" etc., when in fact they may not be or are under unclear certification schemes. Such misleading green claims often end up deceiving the consumer into purchasing an unsuited product and calls the U.S. FTC into action.

The rule governing question is: "Who has the power of authority to develop such certification schemes? " As per the U.S. FTC, the answer is clear. FTC accepts "voluntary consensus standards" or "technical standards" developed or adopted by voluntary consensus standards bodies, both domestic and international [see U.S. FTC circular no. A-119, revised, February 10, 1998; [9]]. "Voluntary consensus standards bodies" are domestic or international organisations, which plan, develop, establish, or coordinate voluntary consensus standards using agreed-upon procedures. This requirement fits with standardisation bodies, like ASTM, ISO, EN, DIN, etc.

Associations, such as API, ILSAC, ATIEL, ATC, UEIL, VSI, UNITI, GEIR, etc., are relevant stake-holders of the lubricant value chain and are underway draft factors that go into measuring the sustainability of a lubricant, but do they comply with attributes, like "voluntary" and "consensus"?

The development of these disparate frameworks embeds the risk of fragmentation, inconsistent and non-comparable criteria. To counter the insurgence of deceptive labels, there needs to be a definition of sustainability within the industry through standardisation which should focus on a reliable and valid scientific foundation on the chosen set of criteria.

ASTM D7721-22 "Practice for determining the effect of fluid selection on hydraulic system or component efficiency" is such an example. This practice from voluntary consensus standardisation bodies defines minimum technical requirements for conducting energy efficiency performance comparisons of two or more hydraulic fluids in controlled laboratory or field evaluations. The savings in energy consumption in kW-hr a year can be converted into saved CO_{2eq} emissions by using the local emissions factor of electricity or EPA's online calculator. Advertisements based on D7721 may be seen as safe harbor in view of FTC.

Sustainable lubricants

There is so far no scientifically accepted agreement on what a "sustainable" lubricant should entail as per the FTC's "Green Guides." The lack of sufficient evidence of sustainability claims thus hinders the research and development of sustainable lubricants due to the marketing risk unverified products can have on the commercial market. The sustainability journey just started and manifold strategies have surfaced within companies and organisations. A technical direction in the future must be made clear for sustainable lubricants throughout the industry to allow many of these businesses to continue and accelerate this journey.

Definitions are a great starting point in formulating a technical direction. However, industry, the public, and scientists in the field share varying viewpoints on what defines "sustainability," especially as it concerns lubricants. As such, the term remains diffuse and vague as many parties create a multitude of definitions and policies regarding sustainability. The United Nations seek to harmonise a definition among these parties with their seventeen sustainable

development goals (SDGs). These SDGs are wide and broadly formulated allowing for many parties to freely define their own roadmap as to what makes a sustainable lubricant. Although the SDGs still do not create a uniform consensus on a definition, they still declare many key attributes and require uniform and quantifiable measurements to keep the various companies and organisations in line with the FTC's fair business guidelines. They are as follows:

a. Sustainability in the upstream chain by sourcing renewable raw materials, which will be supplied in circular business models. This is achievable because lubricants represent overall only ~1% of fuel consumption.
b. Low carbon intensity or carbon neutral lubricants (base oils and additives), even with a negative footprint.
c. In-use benefits of low-friction lubricants results in avoided carbon emissions in the use phase.

Scope 4 (avoided emissions)

Friction is the worst enemy of efficiency. Efficiency is the ability of a machine or a system to maximise output at the minimal expense of energy. Universally, friction has been observed to hamper 20-33% of the total global primary energy consumption [1,9] – calling in the need for sustainable lubricants to increase energy savings. Proper implementation of tribology and lubrication sciences can annually deliver medium- to long-term carbon dioxide mitigations of 3.6-11.3 gigatons CO_{2eq}. during the use phase (downstream) and compete with carbon dioxide removal sinks [10]. The technical guideline for scope 3, category 11, requires only reporting from the use phase of sold (complete) products, such as vehicles. The GHG protocol does not deal so far with energy savings or avoided emissions, but only with reporting of emission mitigations. Even in November 2013 the World Resources Institute [11] made in a commentary on the fifth report of the Intergovernmental Panel on Climate Change (IPCC) the following proposal:

"Emission mitigations occurring outside the life cycle or value chain of a product but resulting from the use of that product. **Fuel-efficient tires, energy-efficient ball bearings**, etc. are examples of products (goods and services) avoiding emissions."

The Avoided Emissions Framework [12] orient the definition of these mitigations closer to the use phase and potential avoided emissions (PAE) as emission reductions that occur because of a solution, product, or service that provides the same or similar function as existing products in the marketplace, while its use emits significantly less Greenhouse Gas (GHG) emissions or enables emission reductions of a third party.

The usage of lubricants could serve as the "solution, product, or service" that is able to create these PAE in operational systems. However, claims on energy conservation can only be marketed, if widely recognised procedures for determining effective CO_2 reductions through frictional reductions and extended longevities are in place. The ASTM D7721-22 is such an example for conducting energy efficiency performance comparisons by evaluating experimental results between two or more hydraulic fluids.

Furthermore, by requiring this reporting on scope 3 downstream emissions, the U.S. SEC will unintentionally accelerate tribology and lubrication sciences as the research and development teams of competing businesses look to outclass each other. As investment in these sciences continue, lubricants will be constantly improved upon - leading to increased emission mitigations, which would be better for both the consumer and the environment.

Biodegradability

Biodegradability is a subpart of lubricant sustainability and plays more on environmentally friendliness in terms of a low persistence in waters and soils. The relationship between lubricant release and water quality has been known for many decades and is undisputed. Hydraulic fluids were the first biodegradable fluids and have since been held for more than 30 years in the market (at least in Europe).

U.S. FTC and EPA understand biodegradability as "full mineralisation." Primary biodegradation is obsolete over the definition of the U.S. Federal Trade Commission (FTC) from 2012. Claims on degradability mean, that the "entire product or package will completely break down and return to nature within a reasonably short period of time after customary disposal (§260.8), e.g., ready or ultimate biodegradation. Primary biodegradation is therefore not acceptable as a claim and only ultimate and ready biodegradation are in line with the present definition of FTC [13,14].

If a marketer claimed that their product was "100% Biodegradable", it would have had to first be verified by ASTM, ISO or OECD test methods following the EPA and FTC definitions.

Environmentally acceptable lubricants (EAL) meet the U.N. Sustainability Development Goals #3 & #6. The environmental criteria developed by U.S. EPA for the 2013 vessel general permit (VGP) [ ], is now superseded by VIDA [ ], include additional aquatic toxicities (fish, daphnia, algae) and bioaccumulation to define "environmentally acceptable lubricants (EAL)". This has nothing to do with the attribute of sustainability, but more with being a part of sustainability.

EALs are therefore defined by VGP/VIDA or in Europa by EU/2018/1702 and EN16807, to cite a few. EN16807 solely defines the term "bio lubricant". Such framework can be seen as safe harbors for the advertisement of specific environmental claims as per FTC´s §260.8.

Content of renewables

The prefix "bio" is applied to different subjects: "bio-based, bio-genic, biomass, bio-sourced, bio-compatible, bio-degradable" with "eco" also used as synonym.

The term "bio-lubricant" is solely defined by EN16807 and is not regulated or standardised in the USA. EN16807 equates "bio lubricants" with the term "bio-based lubricants".

Renewables are widely the basis for "green claims." Only the European biolube schema (EN16807) requires in general a content of renewables of >25% and the BioPreferred Program of the U.S. Department of Agriculture (U.S. DA) demands between 25% and 72% depending on the application. The bio-based content is determined by using ASTM D6866 or EN16640.

The content of renewables may be in opposition to FTC´s understanding when the transformation of renewable resources or synthesis processes needs the use of toxic chemicals and/or results in emission of hazardous pollutants [17]. Another negative point in the eyes of FTC is the huge water consumption at plantations and deforestation.

The common ground in the U.S. on biomass is the following definition [18]:

"Biomass means any organic matter that is available on a renewable or recurring basis."

Bio-based products as per EN16575 are wholly or partly derived from materials of biological origin, like plants and animals or other living organisms, so-called biological material, excluding materials embedded in geological formations and/or fossilised. Bio-based materials are not the same as biodegradable, compostable, or renewable resources. U.S. DA [19] defines a biobased product as follows:

(1) A product determined by U.S. DA to be a commercial or industrial product (other than food or feed) that is:
(i) Composed, in whole or in significant part, of biological products, including renewable domestic agricultural materials and forestry materials; or
(ii) An intermediate ingredient or feedstock.

The overlap between biomass and bio-based is visible.

Conclusion

The U.S. FTC has a significant role in safeguarding the future of sustainable lubricants. This encompasses eco-toxicological properties, low carbon intensity, greenhouse gas emissions and renewables as well as avoided emissions in the use phase. Through the establishment of specifications by voluntary consensus standard bodies, the Federal Trades Commission can uphold fair business practices among the industry, while ensuring that consumers benefit by being able to purchase products that truly meet their eco-conscious needs. The implementation of the reporting of scope 3.11 emissions by the U.S. SEC in the core heart of financial business will certainly boost tribology and lubrication sciences, especially when it will be mandatory. All of which benefits further with the reduction of CO_2 and greenhouse gas emissions in the atmosphere, as well as the limitation of pollution into the natural environment.

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