A discussion on recent lube trends in Africa

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Evolution of base oil grades

In the last decades, a steady shift from API Group I to Group II base oils was observed globally, which was anticipated by more and more demanding engine oil specs. The graphic representation in Figure 1 for North America is exemplary for the world.

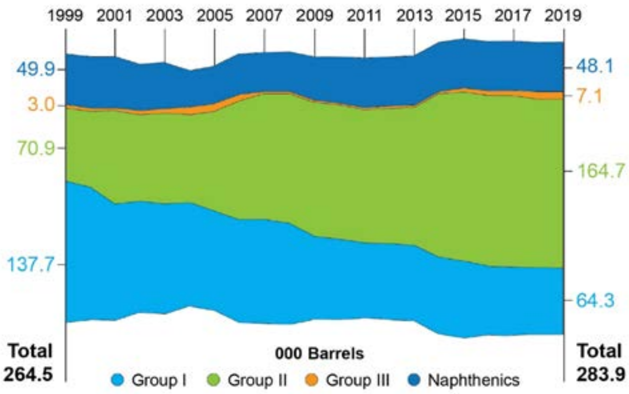

***Figure 1:** North America base stock capacity shifts (includes the USA, Canada, and Mexico) [1]*

In comparison to the global average of 182 or 590 motor cars per 1000 people for the EU28, the motorisation rate in Africa is low at 42 motor vehicles per 1,000 inhabitants (inh.). The automobile market in Africa, which accounts for 2.5% of world manufacturing, depends on used cars imported from abroad. By 2050, Sub-Saharan Africa will account for roughly half of the world's population growth, which is expected to increase by 1 to 2 billion people. The development of transportation will be hampered by outdated infrastructure and poor upkeep. It should be mentioned that e-mobility is prohibited by frequent outages and shoddy networks. For Africa, there will likely be a significant midterm growth in demand for vehicle lubricants. 23.9 million metric tons of automobile lubricants were used worldwide in 2019. Around 700,000 metric tons of finished lubricants are needed in Africa for industrial purposes, and about 1,000,000 metric tons are needed for automotive and transportation purposes. Due to their greater motorisation, Egypt (312,000 metric tons) and South Africa (135,000 metric tons) are the top national users.

The lubricant applications move globally to higher performing base oils and multi-grade formulations by gradually improving performances (e.g., Group II+ or III+, but the annotation "+" is a marketing term and not defined by American Petroleum Institute). "Synthetics" such as polyalphaolefins (PAO, Group IV), esters (Group V), and polyakylene glycols (PAG, Group V), as well as new "bio-olefins are high-performance base stocks, which are also predicted to have a bright future [2]. However, the average age of motorised vehicles in Africa is over 20 years, and the market is dominated by second-hand imports from overseas. As a consequence, the average demand will stick to older API or ACEA specifications and not call for synthetics or Group III/III+ automotive lubricants. The average climate in Africa poses questions about the need for a wide range of multigrade engine oils. Apart from applications in new machinery and motorised vehicle imports, the overall remaining market won't call for synthetics in the next decades. On the other hand, policies for cleaner cars and fuels will raise the demand and close the gap between Africa and the rest of the world for high-performance engine oils.

Two-stroke motorcycle oils

In developing nations, the first and most accessible step toward motorisation is the use of two-stroke motorcycles. The exhausts are not only a daily annoyance but also significantly contribute to air pollution and contaminate water since the lubricants directly burn with the gasoline. Because of this, esters or polyglycols as well as synthetic 2-stroke lubricants, were substituted for 2-stroke oils based on mineral oils relatively early in Europe. Esters and polyglycols, in particular, have "clean burning" qualities. Two-stroke motorcycles are either prohibited or have been replaced by e-scooters in some Asian nations. With an estimated 950 million people living in metropolitan areas in Africa by 2050, this development is unavoidable.

Other global trends for lubricants

In general, lower viscosity oils reduce engine friction and improve fuel economy [3,4]. SAE 0W-16 and down to ultra-low viscosity oils SAE 0W-12 appeared in specific markets. Lower viscosity oils or fuels from biomass or captured CO_2 (e-fuels) reduce the CO_2 emissions of internal combustion engines (ICE) and their carbon footprint. Lowering the viscosity reduces viscous drag and improves lubrication, yet thins the oil film, decreasing the cleaning, cooling, and protective ability of the lubricating oil against wear and scuffing. For harsher conditions such as hot climates, overloading, overheating, bad fuel quality, fuel dilution, non-respect of drains, dusty conditions, or difficult terrain, a thicker or more viscous lubricating oil or formulations with viscosity indices will provide greater protection for the engine despite the decreased fuel efficiency. All circumstances taken together will favor Africa with more viscous lubricants.

Friction reduction can also be achieved under transient temperature operations by viscosity index (VI), which is a measure of a fluid's change in viscosity relative to temperature change. The viscosity index is improved by intrinsic viscometric properties of the base oil, like esters and PAGs, or by functionalised viscosity index improvers (high molecular weight polymers). As sub-zero temperatures do not widely occur in Africa, there is no primary need for VI improvers.

Waste management and re-refining

The main drivers to reduce the harmful effects of oils on the environment are the collection of old oils and the demand for bio-no-tox characteristics. Oil collection is mostly done to keep lubricants out of soils and water, not to conserve resources. Lubricants pollute 1 million liters of water every liter. In Africa, safe waste management of spent oil is not properly regulated or managed. These gradual measures are likely to limit spills and "wild" disposals in Africa, given the undeniable connection between oil and water and soil quality. The safe collection of used oils and supplies to re-refineries not only creates business opportunities but also protects the environment as well as ensures healthy lives, and promotes the well-being of all as per sustainable development goal #3 of the United Nations. An infrastructure of re-refineries, which can be small as 20.000 metric p.a., will limit unaccounted and wild disposals of used oils.

Figure 1 illuminates that from a global view, the Group III lube consumptions were stable over decades, and the synthetics were marginal. Group I and II are typical base oil outputs of re-refineries.

Environmentally acceptable lubricants (EAL)

EALs are the political consequences of spilling water and soil as well as the fact of a high unaccounted release of lubricants to the environment. Around 1990 in Europe appeared, the first environmentally acceptable lubricants, "EAL" (preferably hydraulic and 2-stroke engine oils), also met eco-toxicological properties. Today, the most important schemes for EALs are:

a) European ecolabel as per EC/2018/1702,
b) The second issuance of the U.S. Vessel General Permit (VGP, 2013) and the next revision is expected as Vessel Incidental Discharge Act (VIDA) as well as
c) Biolubricants as per EN16807.

They commonly require an accelerated, ultimate or ready biodegradation (full mineralisation) or short persistence in the environment when spilled, and high limits of toxicities for aquatic species, like fish, daphnia, and algae, as well as alternatively a content of renewables. "Biolubes" are today available for all classes of lubricants and operate safely, e.g., are fit for purpose [5]. VGP2013 has made USA EALs mandatory for water-sea interfaces and ports. The price tag of synthetic bio lubes is 5-10 times of mineral oils.

Sustainability and content of renewables

The European "bio-lubricants" specification EN16807 tests fully formulated products and require content of renewables of >25%. On the other hand, the third issuance of European Ecolabel for lubricants (2018/1702/EC) and the U.S. Vessel General Permit 2013 do not require content of renewables. Significant parts of Africa lie in the so-called geographic "Jatropha belt," in which this plant grows naturally. The oils of Jatropha nut (C18:1-OH) or Lesquerella (C20:1-OH; C18:2-OH) seed, or castor bean (C18:1-OH) contain mainly non-edible hydroxy-fatty acids [6], from which estolides, secondary esters, can be synthesised, but also biodiesel. Another source of income may arise from C18 fatty acids, which can serve as renewable resources for synthetic esters. The lifecycle analysis (LCA) of palm and soja oil is disadvantageous with respect to fossil resources [7]. This limits export but not national use. Re-refining is another element of sustainability as per SDG #12.4&12.5. Unless they do not interfere with the food chain, biogenic resources offer additional income to farmers and rural regions.

Industrialisation, population and wealth growth, and other factors will all increase demand for transportation, preferably powered by internal combustion engines due to shoddy grids. The lubrication market in African nations is different from the traditional European and American automotive markets because of the differences in geographic and socioeconomic demand as well as the make-up of the vehicle pool, according to current trends. Due to the warm climate, VI improvers will never be in high demand, and the prevalence of a large number of used cars calls into question the viability of synthetics. The comparatively warm climate does, however, provide opportunities for sustainable lubricants made from biogenic resources because oil-producing plants may flourish there more easily. Therefore, the lubricants market in Africa is predicted to have a diverse and unique nature compared to the rest of the world.

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Authors

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Dr. Raj Shah is a Director at Koehler Instrument Company in New York, where he has worked for the last 27 years. He is an elected Fellow by his peers at IChemE, CMI, STLE, AIC, NLGI, INSTMC, Institute of Physics, The Energy Institute and The Royal Society of Chemistry. An ASTM Eagle award recipient, Dr. Shah recently coedited the bestseller, "Fuels and Lubricants handbook", details of which are available at ASTM's Long-Awaited Fuels and Lubricants Handbook 2nd Edition Now Available (https://bit.ly/3u2e6GY). He earned his doctorate in Chemical Engineering from The Pennsylvania State University and is a Fellow from The Chartered Management Institute, London.

Dr. Shah is also a Chartered Scientist with the Science Council, a Chartered Petroleum Engineer with the Energy Institute and a Chartered Engineer with the Engineering council, UK. Dr. Shah was recently granted the honourific of "Eminent engineer" with Tau beta Pi, the largest engineering society in the USA. He is on the Advisory board of directors at Farmingdale university (Mechanical Technology), Auburn Univ (Tribology), SUNY, Farmingdale, (Engineering Management) and State university of NY, Stony Brook (Chemical engineering/ Material Science and engineering). An Adjunct Professor at the State University of New York, Stony Brook, in the Department of Material Science and Chemical engineering, Raj also has over 550 publications and has been active in the energy industry for over 3 decades. More information on Raj can be found at https://bit.ly/3QvfaLX

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