GfT Gesellschaft für Tribologie e.V.

Tribology in Germany

Cross-sectional technology for the reduction of CO_2-emissions and the conservation of resources

The term “tribology “

In 1966, Sir Peter Jost, first established the term “tribology”:

> *“Tribology is the science and technology of interacting surfaces in relative motion and of related subjects and practices“*

Friction, wear and lubrication, the key elements of tribology, aim to control the use of friction, to reduce wear over a long service life and to remove motion resistance and wear by means of lubrication. Solutions for the challenges posed by tribology require a holistic system analysis with an interdisciplinary conception.

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Brief summary of the GfT Tribology Study 2019

***TRIBOLOGY**, the science of friction, lubrication and wear is a cross-sectional technology of economic significance. As basic technology, it promotes energy efficiency and resource conservation through the reduction of friction and wear as well as the use of CO_2-neutral fuels (e-fuels, hydrogen, etc.).*

Less CO_2-emissions through friction reduction

Friction reduction, particularly in mobility, is, apart from recuperation, the core element for improved energy efficiency. It reduces CO_2-emissions and decreases the dependency on energy imports. The proportion of friction losses of the primary energy consumption is 23% - the realistic long-term and total reduction potential of primary energy consumption generated by friction losses amounts to 8.6%. Results provided by the research cluster Low Friction Powertrain yielded that engine friction losses offer a reduction potential of 30%. This would translate into a fuel consumption reduction of 0.94 l/100 km or 12.1% along with additional reduction potentials for transmission, wheel bearing, auxiliary units etc. of the powertrain. If the calculated 12.1% fuel consumption reduction was applied to the fuel quantity sold with the fully exploited friction reduction potentials, the fuel quantity consumed in Germany could be reduced by 2.2 million tons of gasoline (or 2.98 billion liter) amounting to 6.92 million tons less CO_2-emissions. The diesel consumption could be reduced by 4.68 million tons (or 5.5 billion liters), translating into approx. 14.95 million tons of decreased CO_2-emissions. Altogether almost 22 million tons of CO_2 or 6.4% of the CO_2-reduction projected by the German government for 2030 could be saved by friction reduction alone without affecting the utility value.

Other friction reduction potentials of lubrication technology, particularly through low-viscosity oils and/or lubricants with high viscosity index interacting with the surface topography, offer numerous additional opportunities for the reduction of CO_2-emissions based on high functional safety. Reducing frictional resistance in the powertrain is a core task of future mobility and should be pursued independently of the respective drive technology as such.

Reducing the fuel consumption through lowering the engine oil viscosity by only 1% would yield calculated savings of 1.7 million tons of CO_2-emissions based on the total 170 million tons of CO_2-emissions generated by German road traffic annually.

Transferring the generally expected proportion of total friction losses of primary energy consumption, the reduction potential calculated for Germany alone would amount to 208 million tons of CO_2 thus corresponding to 60% of the greenhouse emission reduction targeted by the German government for 2030.

Beyond friction reduction, tribology is embedded in systems of recuperating energy from exhaust heat offering additional fuel saving potentials between 5% and 10%.

E-mobility

Electric powertrains may not require engine oils but they use specific lubricants and functional fluids, such as lubricant greases for roller bearings, coolants (for battery, e-motor and power electronics) and transmission fluids (e.g. for high-speed planetary gear sets). This will require new developments because such transmission oils, coolants and greases come in contact with electrical modules, sensors and circuits, and also with insulating materials or special polymers. In addition, every energy saving generated by friction reduction will increase the range at constant battery capacity.

Air pollution control

Approx. 90% of all particulate matter emissions in road traffic are not generated by the exhaust of combustion engines but by the abrasion from tires, brakes and road surfaces (non-exhaust emissions). Generally, this is not any different for battery- or fuel-cell-powered vehicles; recuperation performance will only slightly reduce the load on the brakes. Trams and trains also contribute to particulate matter emissions with pantographs (current collectors), wheel tires (even if made of steel!) and brakes. Here, tribology can make a significant contribution to the reduction of particulate matter by means of more wear-resistant materials while maintaining all other functional properties.

CO_2-neutral energy

Mastering tribology for components coming into contact with alternative fuels is a key issue for a successful market launch. Common approaches for tribology solutions encompass coating technologies and new alloys. CO-neutral e-fuels, in particular e-gases, such as hydrogen and methane will have direct impact on the formulation of engine oils. Implemented research results of tribology studies provide the hydrogen industry with the every-day-use of wear-free and long-life components suitable for end users. New material developments must feature low abrasive wear to ensure minimum hydrogen contamination with particulate matter. The application in combustion engines requires new, water-soluble engine oils. Resistance against hydrogen embrittlement and "affordable" alloys are other demanding requirements.

Environmental protection

In proportion to the fuel quantity consumed in Germany, the lubricant quantity corresponds to approx. 1%. Raw materials for long-life lubricants can be synthesized from biomass, whereby various synthesis routes allow for the use of esters, polyglycols and hydrocarbons. Compared to mineral oil products, bio-lubricants feature lower friction and burden the ecosystem significantly less.

Substitutes for Prohibited Substances

Due to the environmental and chemicals policy of the European Union, a pressure arises for the substitution of proven and established coatings or materials as well as for many usual functional lubricant additives. In this concern, tribology provides a contribution to the development of alternative solutions in metallurgy and lubricant technology that also meet the functional and toxicological requirements.

Research

Contrary to the past, tribology no longer receives special and autonomous funding within the research bodies German Research Foundation (DFG) and Federal Ministry of Education and Research (BMBF), although, as an omnipresent cross-sectional technology, it made significant contributions to meet technological and ecological demands.

After several years of low public funding commitment, the Federal Ministry of Economics and Energy (BMWi) has established "Research Field Tribology" in 2017, which cross-sectorally joins all important players from science and industry under the umbrella of a research network focusing particularly on the objective of preventing CO_2-emissions by the reduction of friction.

Tribology has been part of the curriculum at many colleges and universities, but it has not been taught in sufficient magnitude and depth. Therefore, it is absolutely necessary to promote disseminating the basics of friction, wear and lubrication in the degree programs of technical studies.

Basic research is the essential driver for new developments in tribology. Today, most significant tribology test instruments with international penetration have their origin in Germany.

The complete version of the study (published in German) can be found on the website of the GfT .

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