LUBRICATION OF PLASTIC COMPONENTS IN THE STEERING SYSTEM AND BRAKES

More and more automotive components are now being made of plastic. Plastics generally allow parts to be built with lower weight and, due to the enormous variety of ways in which plastic materials can be shaped, many designs have only now become feasible. Because of the possible interaction between plastics and lubricants, it makes sense to consult an expert on the lubrication of plastics, such as Klüber Lubrication, at an early stage, especially when developing safety-relevant components such as electric power steering or electromechanical brakes.

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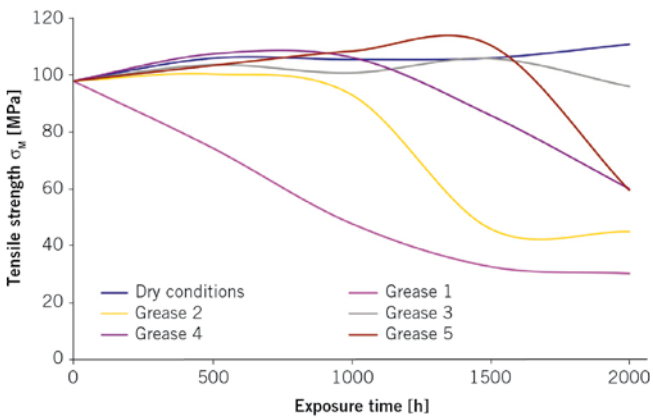
INITIAL SITUATION

The wrong choice of lubricants may cause damage to plastic components. It can occur typically as swelling, stress cracking, thermal oxidation or chemical corrosion, leading in most cases to a change in the material's mechanical properties. Systematic testing has identified several lubricant components, i.e. certain base oils, additives and thickeners, that provoke specific types of damage in plastic materials. However, lubricants have also been found to improve the characteristics of plastics. Some base oils, for example, can delay or even prevent stress cracking in a material.

Despite all the knowledge gained up to now, the lubrication of thermoplastic materials is a task that should not be underestimated when developing lubricants. This is due not only to the many interaction possibilities already mentioned but above all also to the large number of substances and their combinations that may be contained in both the lubricant and the plastic. Moreover, the lubricant development engineer may only know the general family designation of the material, although more detailed information would be important – for example, whether the plastics are copolymeric or homopolymeric, whether they have a high or low viscosity or are blended with glass fibres. The plastic manufacturer's specific product information material will normally have to be obtained to confirm the material's nature. The complex nature of the issue "plastic and lubricant" may become obvious in an illustration of the effects of different lubricants on the mechanical properties of polyamide, ❶, and a polyoxymethelene homopolymer, ❷.

Polyoxymethylene (POM) is a technical plastic material widely used in the automotive industry. Its most important characteristics are probably its low thermal expansion, low static electricity generation and resistance to many chemicals. For tribological applications, the low coefficient of friction and high wear resistance are also relevant. The downside is a certain susceptibility to stress cracking under strong mechanical load. We have to differentiate between homopolymeric and copolymeric POM materials. While copolymers show better chemical resistance than homopolymers, in a direct comparison they have disadvantages in mechanical strength. Copolymers are therefore preferred in most cases where endurance strength is the principal concern. This shows how important it is to know precisely which POM type is used. Under strong mechanical loads, POM materials show a tendency to stress cracking, which normally increases under the



❶ Different types of lubricant can have a strong effect on the mechanical characteristics of polyamide, as shown in exposure tests (up to 2000 h at 140 °C); the diagram is based on the change in tensile strength

❷ Polyoxymethylene homopolymer after storage under dry conditions (left) and after exposure to lubricant (right), 1000 h/100 °C

❸ Typical tension crack damage

influence of lubricants, ❸. In some cases, the use of specific oil types can help to delay the formation of cracks, but at the expense of mechanical strength. The POM material needs to have a certain minimum viscosity for this effect to occur. In cars, POM materials are used, for example, to make indicator or light switches, window lifters, door lock mechanisms or joint sockets.

CONSIDERATIONS RELEVANT FOR PRACTICE

For tribologists, the development of innovative automotive components that have to work reliably in the long term even under extreme environmental conditions constantly raises new objectives. In many cases, the development of a suitable new lubricant can even be crucial to a projected technical solution. A typical example is electric power steering (EPS). This technology has gradually been replacing hydraulic power steering for several years. Instead of a hydraulic pump, electric power steering assemblies have an electric motor that uses energy only when steering assistance is actually needed.

In our example, the gears of a drive unit of an electromechanical power steering system consist of a worm made of steel and a worm wheel made of polyamide 6.6, ❹. Depending on the car design, this worm gear assembly is located either in the engine compartment or further up the steering column. As different temperatures occur at either location, the requirements to be met by the lubricant vary accordingly. For gears in the engine compartment, a high-temperature grease which protects the plastic against excessive thermally induced oxidation must be used. For gears mounted further up the steering column, a grease specially developed for gears in that position, called Klübersynth LE 44-31, may be used. This grease has a low coefficient of friction and offers very good wear protection on steel/plastic material combinations.

The electromechanical brake offers another example of the challenges tribologists have to tackle in the development of new components. An electromechanical brake is made up of vertically mounted thrust bearings, a ball screw and planetary gears. A lubricant had to be developed that does its job at each of the lubrication points with friction bodies made of different materials. For the long-term lubrication of these heavily loaded brake units based on drive-by-wire technology, Klüber has developed a high-temperature grease called Klübersynth BR 46-82. This grease not only meets the requirements of material compatibility but will also handle the high mechanical requirements and long-term temperatures with peaks of up to 250 °C.

OUTLOOK

At Klüber Lubrication in Munich, intensive research is carried out for the development and testing of lubricants for customers' requirements. Klüber has more than 100 test rigs to examine the compatibility and performance capabilities of lubricants. Both DIN ISO tests and customer-specific trials on original components and materials are performed there.

Especially in the automotive sector, where safety aspects are the main priority, this substantial outlay for developing and testing lubricants for specific applications is extremely important. The use of a suitable lubricant is vital in attaining problem-free component performance over the expected lifetime. Through early cooperation between automotive component and lubricant manufacturers, innovative and cost-efficient solutions based on conventional chemistry can be obtained. Klüber supports R&D engineers in the development of automotive components by offering tribological solutions for new materials and their combinations as well as for extended performance requirements.

❹ Electromechanical power steering system with a worm made of steel and a worm wheel made of polyamide 6.6

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