Reducing Reactions

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Understanding chemical stability in plastic parts

Chemical exposure can wreak havoc on plastic parts. Depending on the application, plastics can be exposed to a wide variety of chemicals at different temperatures and for various lengths of time. Some chemicals are absorbed by the polymer, and some attack the polymer. Both of these situations result in a change to the material properties.

Chemical exposure needs to be considered in virtually every field where plastic parts are used. Some things you may not even consider as chemicals can still have an effect on the material, including water and sebum. Other chemicals include fuel, oil, exhaust gas, water glycol, battery acids, sunscreen, cleaning agents, and foodstuff such as wine, coffee and grease. The vast range of chemicals, and the difference in temperature, concentration and length of exposure makes accounting for chemical exposure a challenge. Added to these factors, the material properties that are needed for different applications vary as well. For example, a structural part under the hood of a vehicle needs to retain its mechanical properties, however a soft-touch part on a handheld device needs to also retain color and haptics.

Effects of Chemicals – physical and chemical

When chemicals react with plastics, the effects can be physical, chemical, or a combination of the two. Physical changes occur when components of the chemical agent migrate into the plastic part, causing a change in material properties. It can be as simple as a change in dimension (swelling), or a more complex interaction that causes a change in appearance or the material's performance.

Physical effects depend on how much and how quickly the components migrate into the plastic part, and how strong the interaction is.

When nylon materials absorb water, there is a change in dimension, and it also causes a shift to lower temperatures of the glass transition, causing a significant reduction in strength and stiffness at room temperature. Meanwhile, water-based liquids like wine and coffee can migrate into the polymer and cause staining.

Components that dissolve in the plastic part can potentially react with the polymer and cause chemical degradation. This creates irreversible changes in the material properties, although it normally requires higher temperatures and longer exposures for the reaction to occur. Certain chemicals, such as engine oils or greases, are not stable themselves. When they begin to degrade, the degradation products can aggressively attack the plastic part.

Stability in the face of chemical exposure is largely driven by the chemistry of the polymer backbone. DSM has worked to develop a number of materials with very high chemical stability. Our Xytron™ (PPS) product has very good intrinsic stability against most chemicals used in under-the-hood automotive applications. Within our polyamide materials, aromatic polyamides like that found in ForTii® (PPA) typically outperform aliphatic polyamides like polyamide 6 and polyamide 66. ForTii® Ace shows particularly excellent resistance against strong acids, outperforming regular PPAs.

Chemical resistance – a key requirement in automotive applications

Stability against various types of oils – including engine oil, transmission oil and greases – is an important requirement in many automotive applications. Parts may only be exposed to oils incidentally, or they may need to withstand prolonged contact at high temperatures. The oils used in vehicles often have complex compositions, including additives meant to improve the performance of the oil. The oils themselves, their degradation products, and the additives can all be aggressive to plastic.

The charts in this section show the stability of our Stanyl® grade in a number of different oils. When we test the interaction between the oils and the thermoplastic material in a nitrogen environment, no deterioration of properties is observed – meaning that the basic composition of the oils is not aggressive to the Stanyl polymer. In an oxygen environment, we see very different chemical behavior. Oils that show strong oxidation, as demonstrated by high oxygen uptake, are much more aggressive to the material. This demonstrates that the root cause for differences in chemical stability can sometimes be determined by the stability of the chemical itself.

Most DSM products include extensive tables that provide guidance on the resistance of the grade against a wide variety of chemicals. This provides our customers with a first indication as to whether they should expect a high level of reactivity. For many of our materials, we have even more specific data on their resistance to the specific chemicals used in different application areas.

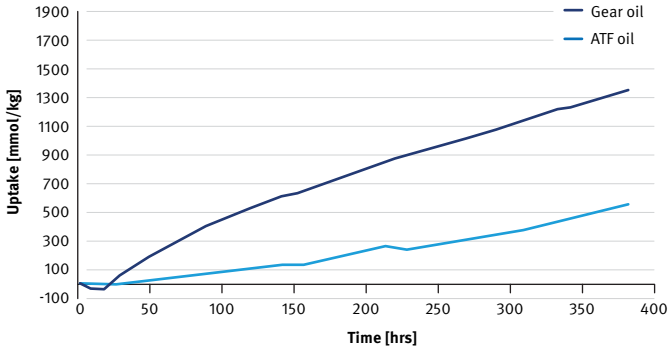

Figure 1— Oxygen uptake at high temperatures for different types of oils

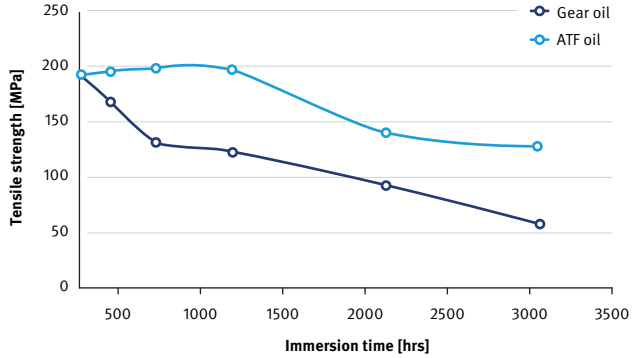

Figure 2— Retention of tensile strength for Stanyl TW200F5 in two different oils used in transmissions

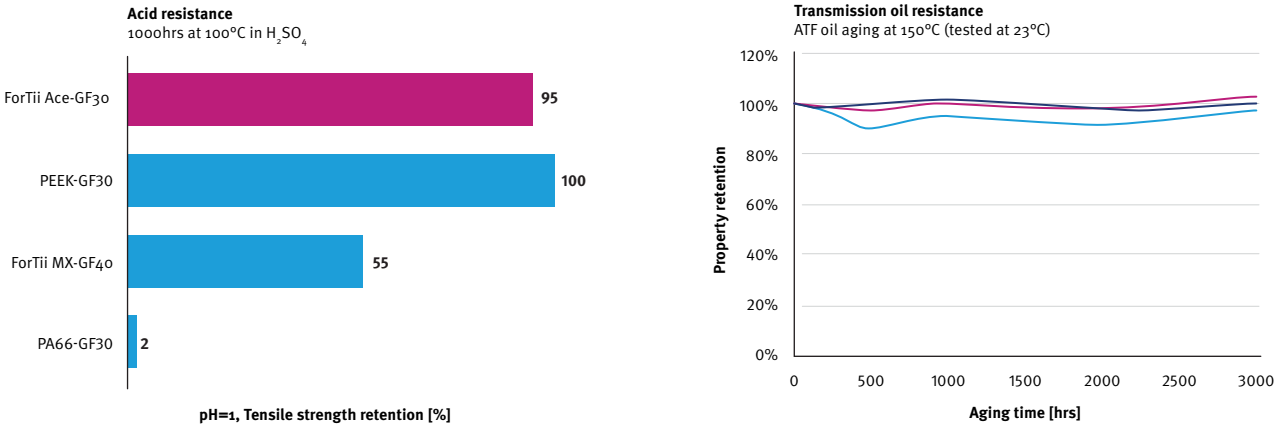

Figure 3— Comparing chemical resistance of ForTii and ForTii Ace to other polymer families

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