High-Performance Polymers Withstand New ATF ULV25 Fluid in Transmission Applications

Solvay Specialty Polymers offers a broad range of high-performance plastics with a proven track record of replacing metal in demanding transmission applications such as thrust washers, thrust bearings, needle bearing replacement rings, check balls and seal rings. Along with their strong mechanical and thermal capabilities, Solvay's materials are well-known for their exceptional chemical resistance to a range of strong acids, bases, organics, fluids and other chemicals.

Recently, Solvay conducted a study to assess the compatibility of several high-performance polymers with Ford's ultra-low viscosity 25 (ULV25) automatic transmission fluid (ATF), Spec #WSS-M2C949-A, a free-flowing transmission fluid that enables transmissions to operate more efficiently. Materials testing included the Amodel® polyphthalamide (PPA), Torlon® polyamide-imide (PAI), and KetaSpire® polyetheretherketone (PEEK) grades listed in Table 1.

Table 1: Specialty Polymers tested for ATF ULV25 compatibility

Grade	Properties
Torlon® 4203	High-strength grade, unfilled
Torlon® 4275	Wear-resistant grade, designed for high speeds
Torlon® 4301	Wear-resistant grade, high compressive strength
KetaSpire® KT-880 SL30	Wear-resistant grade, high melt flow, dry and lubricated
Amodel® A-1133 HS BK 324	33 % glass fiber, heat stabilized
Amodel® AT-6130 HS NT	30 % glass fiber, toughened

Procedures for Immersion Test

ISO tensile bar samples and ASTM compression blocks were molded using Solvay's recommended processing guidelines and best molding practices. Tensile bars were pre-drilled with a hole in one bar tab end and strung together with stainless steel wire with individual bars separated by a stainless steel washer. This allowed for fluid flow between each bar. Perforated stainless steel sheet was fabricated into a holding cage for each compression block.

Sample bundles were placed into a pressure vessel and fluid was added to cover the samples. The vessel was sealed, purged with a nitrogen blanket and heated to 150 °C (302 °F). At prescribed intervals (500, 1,000 and 1,500 hours), the vessel was allowed to cool to room temperature where upon sample bundles were removed for measurements and mechanical testing. Measurements made of a 5-bar sample set included weight, thickness, and width. Measured sample sets were placed back into the vessel for future measurements throughout the immersion conditioning. The vessel was then sealed, nitrogen purged and placed back into the oven until the next pull cycle.

Tensile bars and blocks were cleaned of residual oil with paper towels and sealed in aluminum foil-lined pouches. Samples were tested at room temperature per ISO 527 for tensile properties, ISO 178 for flexural properties, and ASTM D695 for compression properties.

Figure 1: Compression modulus

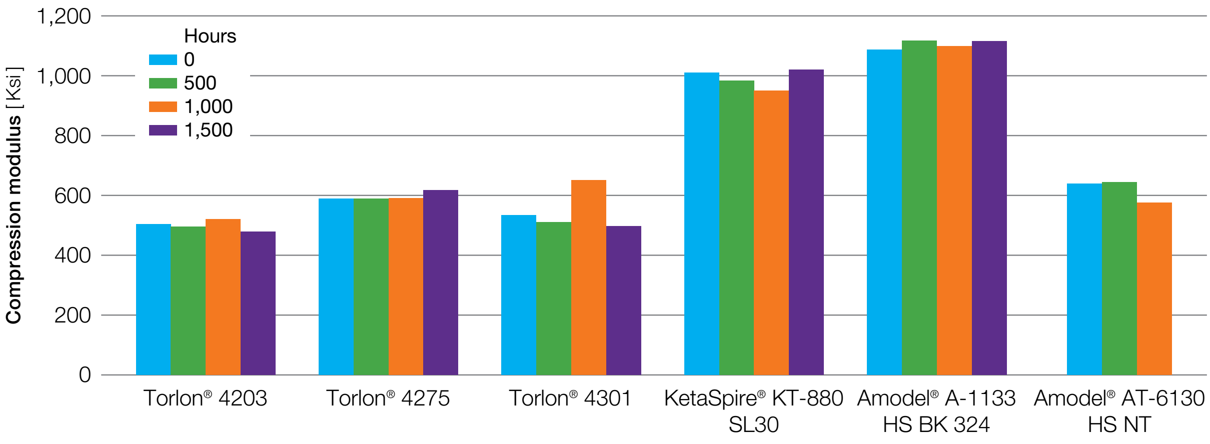


Figure 2: Compression stress

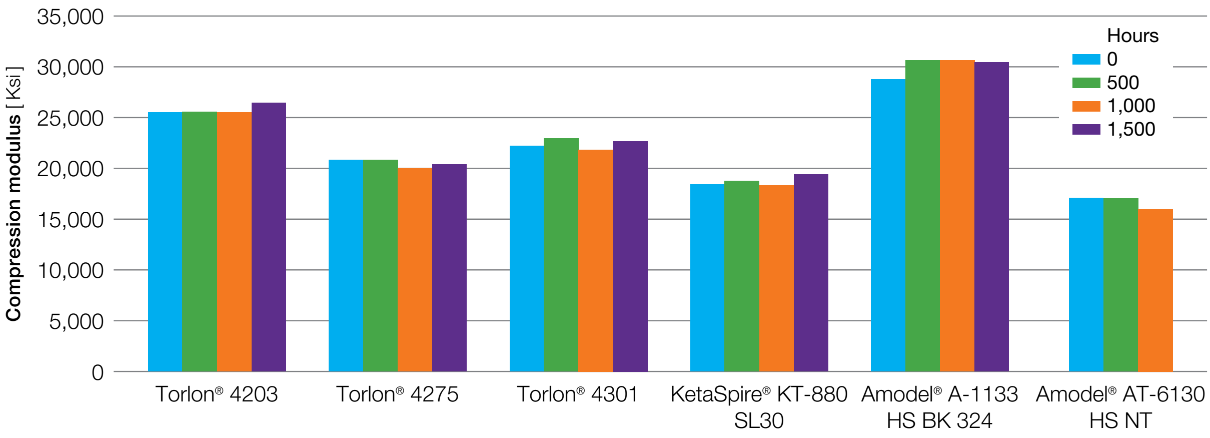


Figure 3: Flexural strength

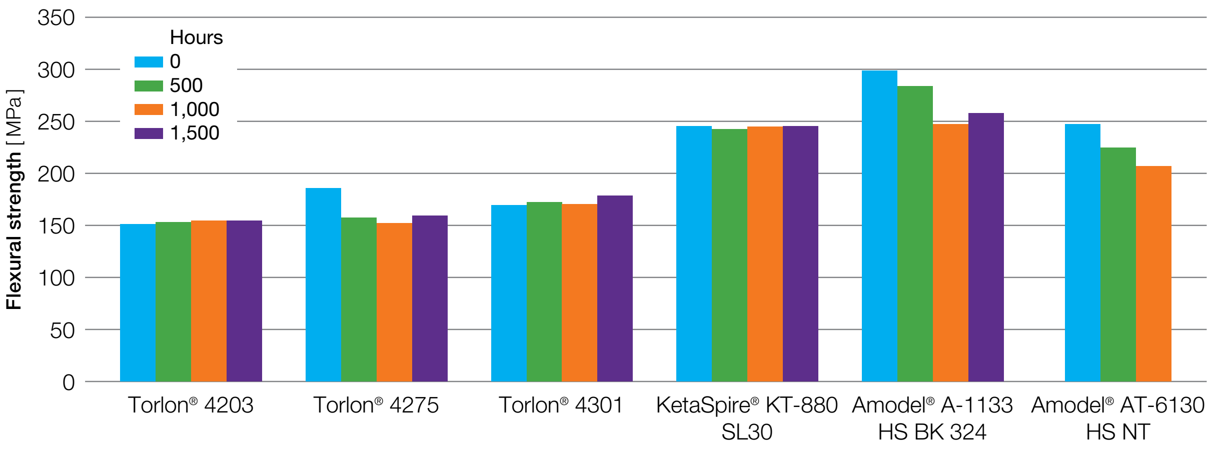


Figure 4: Tensile elongation

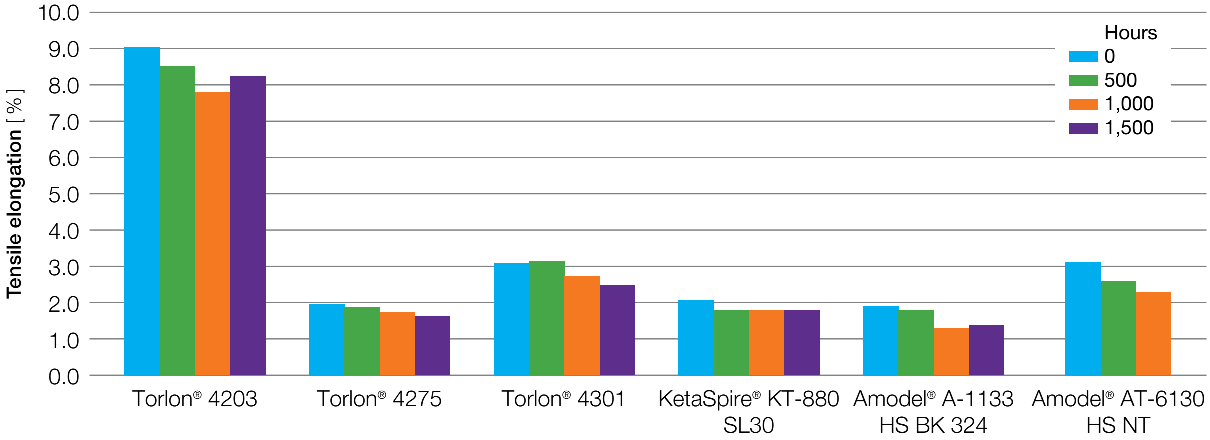


Figure 5: Tensile modulus

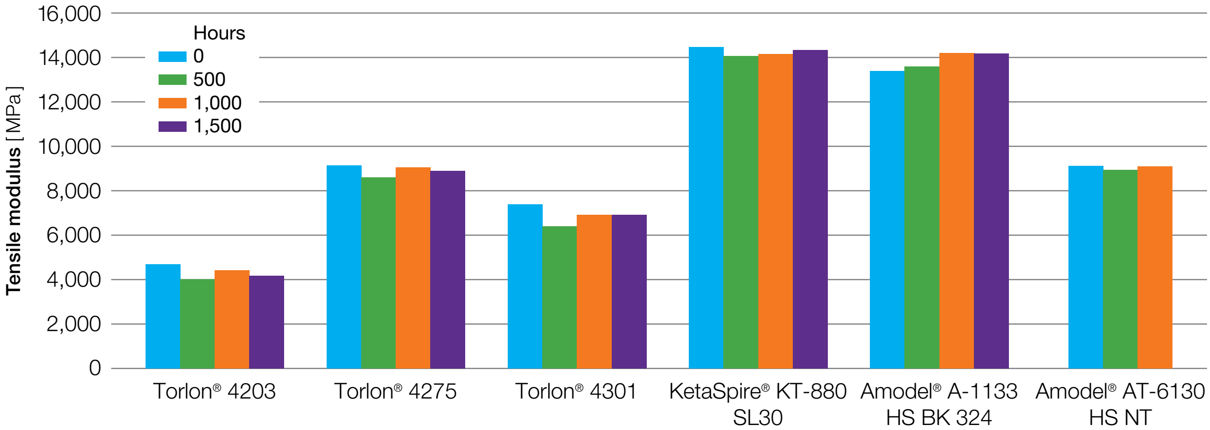
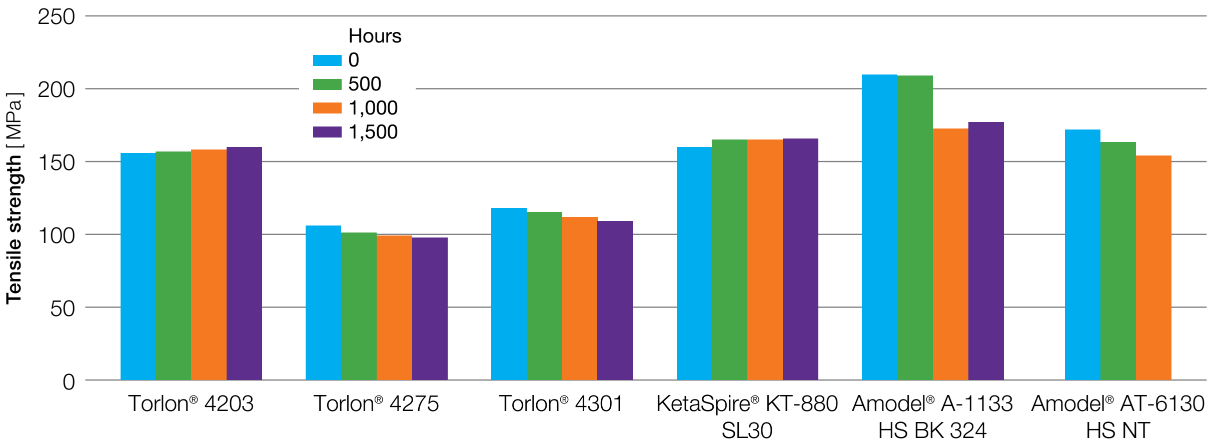


Figure 5: Tensile strength



Experiment Results

Several mechanical properties were measured and compared to the starting control for each material. Both Torlon® PAI and KetaSpire® PEEK exhibited excellent chemical resistance to the ATF ULV25 fluid across these property measurement tests. In the same experiment, Amodel® A-1133 HS BK 324 and Amodel® AT-6130 HS NT were mildly affected, showing a loss in tensile strength of approximately 16 % at 1,500 hrs and about 10 % at 1,000 hours. This loss appears to taper off as the test progressed. A similar trend is observed in flexural strength at about 14 % for Amodel® A-1133 HS BK 324 at 1,500 hours and about 16 % for Amodel® AT-6130 HS NT at 1,000 hours. Compression stress appears to have minimal change throughout the duration of the test.

Conclusions

It is widely known that PAI and PEEK materials provide excellent chemical resistance due to their polymer composition, making them an excellent fit in transmission applications such as seal rings, check balls, fork shift levers, pads and thrust washers. Similarly, PPA's high retention of mechanical properties is due to the aromatic nature of the resin, giving it a boost over conventional polyamide for use in solenoids and sensors. Based on the testing, all three of these high-performance polymers show strong compatibility to Ford's new automatic transmission fluid, ATF ULV25, and are expected to meet the requirements of leading automakers in the future.

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