TORLON® 4435 Delivers Unmatched Performance in Non-Lubricated, High PV Conditions

TORLON polyamide-imide (PAI) is widely recognized for long-lasting performance under severe service conditions. That's because TORLON PAI combines exceptional strength at high temperatures – up to 260°C – with excellent resistance to creep, wear and chemicals including organic solvents. These performance attributes have made TORLON resin a popular choice for rotating and sliding components used in automotive and industrial applications, such as bearings and bushings, seal rings, wear pads and piston rings.

With the introduction of TORLON 4435, Solvay Advanced Polymers can now offer unmatched wear performance at high PV's without external lubrication. In addition to its groundbreaking wear performance, this material offers excellent mechanical properties, including high strength and heat resistance.

Test Conditions

To demonstrate TORLON 4435's unparalleled performance, it was tested alongside competitive friction and wear grades of a thermoset polyimide (PI) and polyetheretherketone (PEEK). While these other products are known for their performance under certain extreme conditions, the high PV's and lack of lubrication in these tests were designed to identify the top performer under the most extreme conditions.

Testing was conducted on thrust washers made using processing methods typical for each material – both TORLON 4435 and PEEK were injection molded and the thermoset PI was machined from 1.25-inch rod stock.

PV's ranged from 50,000 to 100,000 ft-lb/in^{2}min with velocities ranging from 50 ft/min to 800 ft/min. No external lubrication was used in order to evaluate material performance under the most extreme conditions. This provided data applicable to situations where lubrication is impossible or undesirable, as well as an understanding of performance levels in situations where lubrication is lost.

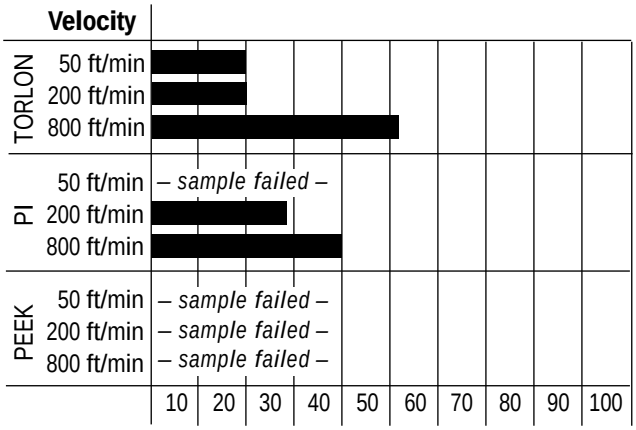
Wear Performance

Results from the study are are shown in Figure 1. At low velocity (50 ft/min) and high pressure (2000 psi), both the PEEK and thermoset PI samples failed while the TORLON 4435 performed quite well.

At medium velocity (200 ft/min) and medium pressure (500 psi), TORLON 4435 showed a lower wear factor than the thermoset PI sample while the PEEK sample failed. At high velocity (800 ft/min) and low pressure (125 psi), the PEEK sample once again failed, but the other materials continued to provide good wear performance ratings.

Figure 1

Wear Performance at 100,000 PV



Mechanical Properties

To further evaluate the suitability of each product for extreme conditions, their mechanical properties were evaluated (see Table 2). The failure of the thermoset PI sample at low velocity and high pressure is due to the material's low mechanical properties. The PEEK sample melted under the same conditions, despite its high melting temperature, because its

mechanical properties decline significantly above its glass transition temperature of 145˚C. Meanwhile, TORLON 4435, with its excellent mechanical properties and high glass transition temperature of 280˚C, withstood these conditions with excellent wear performance.

A Well-Rounded Choice

While performance under applicable conditions is essential, other factors such as ease of production and overall component cost are important in material selection. Although the wear performance of the thermoset PI sample ran a close second to TORLON 4435 in most conditions, PI's higher material expense, lower mechanical properties and inability to be injection-molded limit its attractiveness.

Of the three materials tested, TORLON 4435 is the only one that can be processed by standard methods such as injection molding, extrusion and compression molding without the need or added expense of additional machining. This combined with its high mechanical properties and unique ability to withstand the conditions described in this bulletin make it an excellent choice for high PV applications.

Table 2

Comparison of Typical Mechanical Properties

	TORLON 4435	PI	PEEK
Tensile Strength, MPa (ksi) ASTM D1708	107 (15.5)	62 (9.0)	141 (20.4)
Tensile Modulus, GPa (Msi) ASTM D1708	9.6 (1.4)	2.6 (0.4)	— —
Elongation, % ASTM D1708	6.0	5.5	2.5
Specific Gravity, g/ml ASTM D792	1.59	1.42	1.48
Flexural Modulus, GPa (Msi) ASTM 790	15.2 (2.2)	3.2 (0.5)	8.1 (1.2)
Glass Transition Temp, ˚C (˚F) ASTM D3418	280 (536)	>280 (>536)	143 (289)
CLTE, µm/m˚C (µin/in˚F) ASTM D696	32 (18)	46 (26)	40/126* (22/70*)

*Above the T_g