High-performance Polymer Extends Downhole Pump Life

Backup Rings Molded from the Industry's First True High-Temperature PEEK Withstand Tougher Service Conditions

Bearing failures in downhole pumps can result in significant process interruptions and extra costs for unscheduled maintenance. Backup rings injection molded by Drake Plastics in Syensqo's 30% glass filled KetaSpire® PEEK XT resin retain higher mechanical properties at elevated temperatures to extend the service life of the equipment. The new PEEK formulation also offers improved melt stability which preserves the material's overall properties during high temperature processing versus conventional PEEK polymers.

Oil and gas downhole equipment has to function under aggressive and highly variable mechanical, thermal and chemical conditions that can shorten the useful life of components. At the same time, operators are continuously seeking to extend the time between shutdowns, avoid unexpected interruptions, and reduce overall maintenance costs. This has led to a search for higher performance materials as a way to achieve longer term reliability.

A case in point is Drake Plastics' recent collaboration with an oil and gas equipment customer to evaluate a new high-temperature polyether ether ketone (PEEK) grade for backup rings used in downhole pumps. (Fig. 1)

Fig. 1: Backup rings for downhole pumps, injection molded in KetaSpire® PEEK XT from Syensqo, the first true high-temperature polyetheretherketone for use in aggressive environments such as the oil and gas industry. (Photo: Drake Plastics)

Drake Plastics is a leading manufacturer of stock shapes, injection molded parts and precision machined components, using ultra high-performance polymers such as a PEEK and polyamide imides that provide exceptional bearing and wear characteristics even without additives.

"Our customer approached us to see if we could supply backup rings that would exceed the thermal resistance of the standard grades of PEEK traditionally used in pump components," says Wayne Free, Drake's Global Sales

Manager. “Based on our long-standing history with their high-end materials for severe service applications, we turned to Syensqo’s specialty polymers experts. After a review of the operating environment of the backup rings, they recommended KetaSpire® PEEK XT, a new grade that raises the bar on the upper temperature limits of the polymer. Performance and processing evaluations led to the specification of 30% glass reinforced PEEK XT 920 as the best solution for achieving the thermo-mechanical properties the customer targeted for this application.”

Performance Beyond PEEK

In the engineering community, high-performance grades of PEEK traditionally equate to various polyether ketones including PEK, PEKK and PEKEKK. The differences in their polymer structures lend different performance characteristics to each of the materials.

The differentiating attribute of a true PEEK polymer is its 2:1 ether (E)-to-ketone(K) ratio. The polymer structure provides a higher level of chemical resistance and process stability compared to the other semi-crystalline polyether ketones (Table I). In actual applications, this performance edge affords more resistance to steam, hot water, H2S and CO_2 that characterizes the downhole environment.

PEEK XT technology utilizes the same ether-to-ketone ratio of standard PEEK, and imparts higher temperature resistance and melt stability during processing. The latter characteristic helps preserve the material’s mechanical properties during high temperature molding and extrusion, adding to its performance consistency.

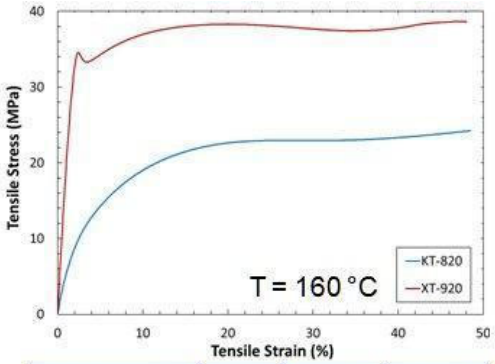
	KetaSpire® PEEK	KetaSpire® PEEK XT	PEK	PEKEKK	PEKK
Glass Transition Temp, °C	150	170	160	170	160-165
Melting Point, °C	340	385	373	387	360
Chemical Resistance	4	4	2	3	2
Ether to Ketone Ratio	2:1	2:1	1:1	2:3	1:2
Processability	5	5*	3	2	4

Table I: Polyketone Performance Comparison.
Processability rated on a scale of 1 to 5, with 5 as optimum.
** Same as standard PEEK at 20°C higher process temperature. (Table: Syensqo)*

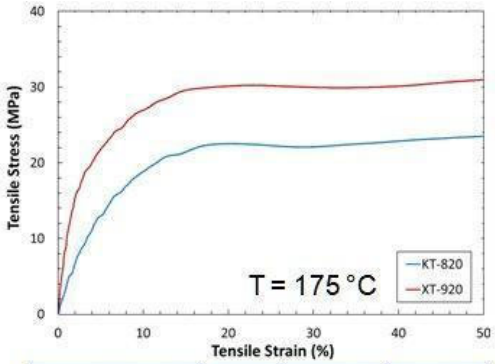
“Building on the proven performance benefits of our KetaSpire® PEEK portfolio in many demanding application areas, our polymer scientists were convinced that they would be able to raise the bar even higher,” explains [Vijay Gopalakrishnan, PhD Head of Condensation Polymers R&D] for Specialty Polymers at Syensqo. “Although PEEK has served the O&G industry for decades and has had many applications in downhole equipment, the challenge was to push the performance envelope to more extreme temperatures in the presence of corrosive chemicals – conditions which can quickly change as drilling and extraction activities progress.”

Higher Property Profile at Elevated Temperatures

The result is KetaSpire® PEEK XT 920, the industry’s first true high-temperature polyetherether ketone. It exhibits an important boost in durable mechanical properties, including tensile modulus and tensile strength, at temperatures up to 175°C (Fig. 2). This was an essential advantage in the case of Drake’s backup ring, where standard PEEK fell short of the required 170°C.



ASTM D638	Temp	KetaSpire® PEEK	KetaSpire® PEEK XT
Tensile Modulus (MPa)	160°C	700	2790
Tensile Strength (MPa)	160°C	24	35



ASTM D638	Temp	KetaSpire® PEEK	KetaSpire® PEEK XT
Tensile Modulus (MPa)	175°C	360	1050
Tensile Strength (MPa)	175°C	22	31

Fig. 2: KetaSpire® PEEK XT shows much higher retention of properties at elevated temperatures than standard PEEK. (Graphic: Syensqo)

In NORSOK sour gas testing at 20% H2S and 230°C, PEEK XT showed high mechanical fatigue strength comparable to standard PEEK, and outperformed PEK and PEKEKK (Fig. 3). Similar results were recorded after brine/HC testing at 300°C.

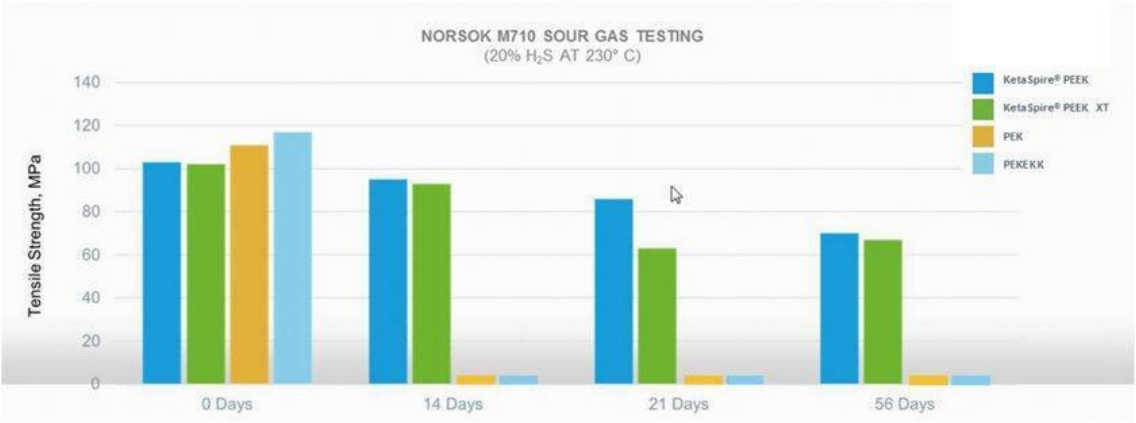


Fig. 3: The performance of KetaSpire® PEEK XT in corrosive sour gas testing is similar to that of standard PEEK and significantly better than that of PEK and PEKEKK. (Graphic: Syensqo)

In addition, KetaSpire® PEEK XT features higher electrical properties up to 250°C, improving the dielectric strength of the polymer by 50% and increasing its volume resistivity by an order of magnitude.

At the same time, with 20°C higher glass transition temperature (Tg) and 45°C higher melt point (Tm) than standard PEEK, it still maintains its lower melt viscosity after shear when compared with PEK or PEKEKK (Table II), and thus offers better flowability for complex parts in injection molding.

Melt Viscosity after Shear	KetaSpire® PEEK XT-920 NT	PEK	PEKEKK
VR40* [430°C]	1.1	1.4	1.9
VR40* [450°C]	1.4	2.3	4.2

Table II: Melt viscosity of KetaSpire® PEEK XT compared to PEK and PEKEKK.
** Ratio of melt viscosity after 10 and 40 minutes of shear at approximately 50 s-1.*
(Table: Syensqo)

Broad Portfolio for Demanding Applications

The innovative high-temperature PEEK XT polymer is available in a broad portfolio of material grades from neat, glass and carbon fiber reinforced (GF/CF) compounds to coarse and fine powders, all custom-engineered to the requirements of different applications and conversion processes. Its processability was evaluated with injection molding, sheet extrusion and film samples produced from commercial compounds.

Besides backup rings and other bearing or sealing components, potential applications also include connectors, torch heads and wire insulation. Special wear and friction grades are under development.

“Our market-driven material technology and Drake’s expertise in specialty polymer processing have once again pushed the boundaries of PEEK performance in the aggressive environment of the oil and gas industry,” adds [Brian Quance Sales & Applications Engineer at Drake Plastics]. “With KetaSpire® PEEK XT 920, the legacy of true PEEK has successfully been extended to an unequaled new level of high temperature resistance.”

Further Reading

www.syensqo.com/en/brands/ketaspire-peek/high-temperature-peek