CASE STUDY:

High-Temperature PEEK XT Extends Downhole Pump Life

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BACKUP RINGS INJECTION MOLDED FROM INDUSTRY'S FIRST TRUE HIGH-TEMPERATURE PEEK WITHSTAND SEVERE SERVICE CONDITIONS LONGER

Summary: 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.

Performance challenge: 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.

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

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. *(Photo 1)*

Drake Plastics is a leading manufacturer of stock shapes, injection molded parts and precision machined components made from ultra high-performance polymers. The company's expertise covers a range of advanced materials including PEEK and polyamide imides that provide exceptional bearing and wear characteristics even without additives.

One of its customers in the oil and gas industry approached Drake's application engineering team to explore options for extending the service life of downhole pumps during temperature excursions approaching 170°C. The critical components were the backup rings, traditionally made from standard PEEK grades. However, the mechanical properties of PEEK required to maintain the integrity of the rings fell short when operating environment exceeded 150°C.

Solution: After evaluating material candidates that would retain their strength in the rings at the targeted temperature and mechanical load levels, Drake's team recommended KetaSpire® PEEK XT. The technology behind the new grade developed by Syensqo (formerly Solvay)* raises the bar on the upper temperature limits of the PEEK polymer.

Because of the physical loads on the rings, higher strength than the unfilled grade of XT 920 afforded was also seen as a benefit. Performance and processing evaluations led to the specification of the 30% glass reinforced grade designated PEEK XT 920 GF30. The XT 920 polymer inherently has greater mechanical property retention than traditional PEEK at the higher service temperatures, and glass-fiber reinforcement further boosts its structural strength for the components.

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Among polyether ketones, PEK, PEKK, and PEKEKK traditionally have been considered as higher performance alternatives to PEEK. The differences in their polymer structures as indicated by their chemical designations lend unique performance and processing characteristics to each of these members of the polyether ketone family.

The differentiating attribute of the 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 other semi-crystalline polyether ketones *(Table I)*. In actual service, this adds up to more resistance to the steam, hot water, H2S and CO2 encountered in the downhole environment.

HIGH-TEMPERATURE PEEK XT IS A TRUE PEEK POLYMER

PEEK XT technology has same ether-to-ketone ratio of standard PEEK, with all the attendant advantages over other polyether ketones. In addition, it imparts both higher service temperature resistance as well as thermal stability during melt processing. The latter characteristic helps preserve the material's mechanical properties during high temperature molding and extrusion, adding to its performance consistency.

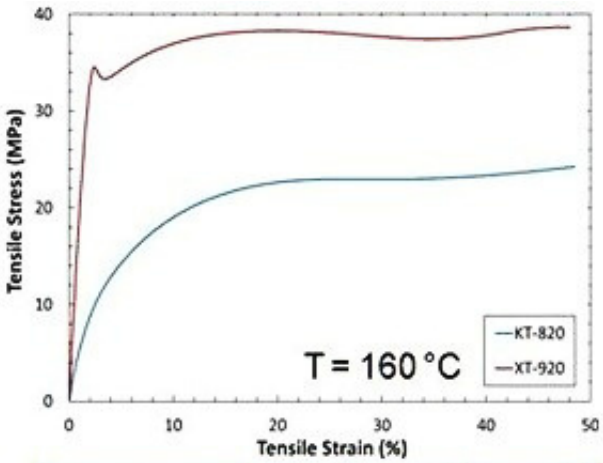
Table I: Polyketone Performance Comparison

	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

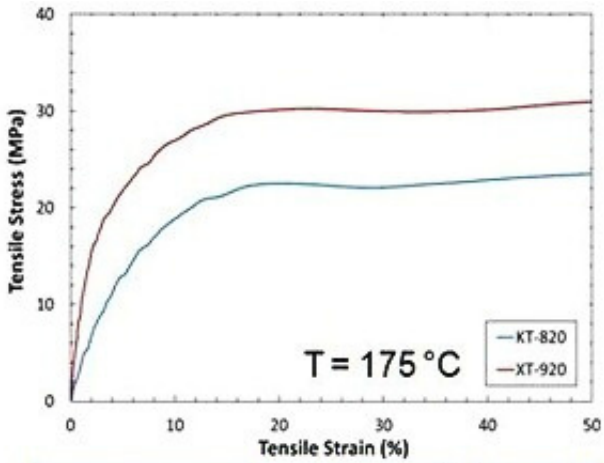
*Data Source: Syensqo (formerly Solvay)**

HOW DOES PEEK XT COMPARE TO TRADITIONAL PEEK ON PERFORMANCE?

Commercialized as KetaSpire® PEEK XT 920, the material is the industry's first true high-temperature polyetherether ketone. It exhibits a significant boost in mechanical properties up to 175°C *(Fig. 2)*, exceeding the capabilities of traditional PEEK. This provided the key to meeting the thermal requirements of the backup ring produced by Drake, 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, formerly Solvay*)*

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.

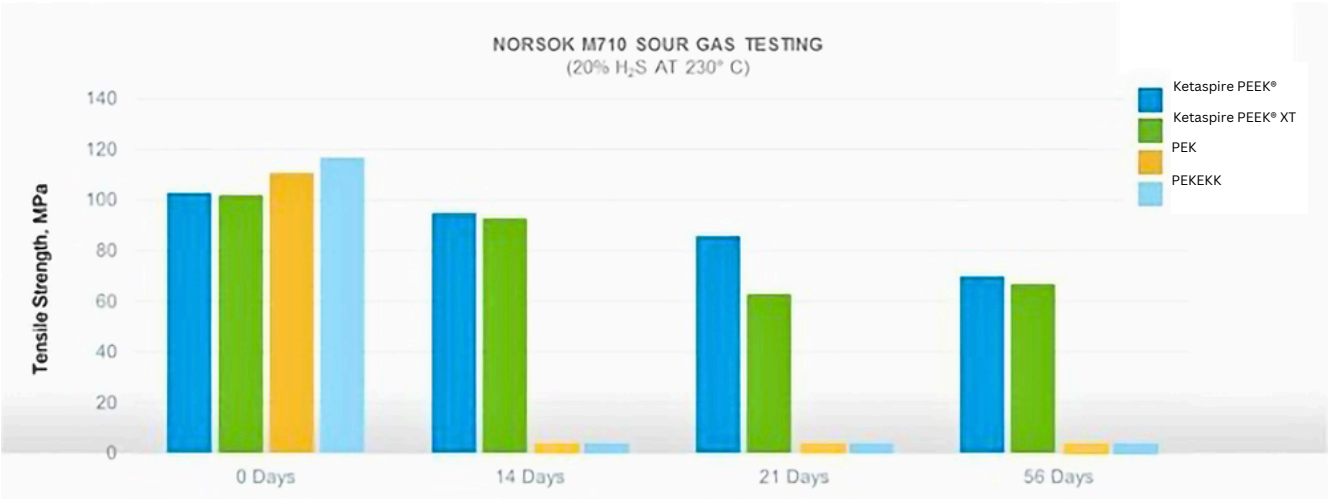


Fig. 3: *The performance of KetaSpire® PEEK XT in corrosive sour gas testing is similar to that of standard PEEK and significantly better than that of PEK and PEKEKK. (Graphic: Syensqo, formerly Solvay*)*

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.

WHAT PEEK XT GRADES ARE AVAILABLE AS SEMI-FINISHED SHAPES AND MACHINED OR MOLDED PARTS?

High-temperature PEEK XT is available in an unfilled grade and in glass and carbon fiber reinforced (GF/CF) formulations. Special wear and friction grades are under development. Drake Plastics offers all extrusion and molding grades in machining-efficient sizes of semi-finished shapes, and in injection molded parts. The company also CNC-machines precision components from the shapes.

In injection molding, XT PEEK also exhibits lower melt viscosity after shear when compared with PEK or PEKEKK. This melt flow benefit facilitates the production of consistently high quality complex molded parts.

WHAT ARE TYPICAL APPLICATIONS OF PEEK XT IN OIL AND GAS EQUIPMENT?

In addition to load-bearing and wear-resistant backup rings, seals and similar components, the overall properties of PEEK XT open applications in connectors, torch heads and wire insulation.

**Syensqo is the new corporate designation for the former Solvay Specialty Polymers business.*

DRAKE

Drake Plastics Co, Ltd. is a Syensqo-approved Torlon PAI injection molder with over 25 years' experience in extruding, injection molding, post-finishing and machining ultra high-performance polymers. Its expertise includes Torlon PAI, Vespel® PI, PEEK, high-temperature PEEK, PEK and PEKK, Ryton® PPS, PAEK and Ultem PEI. The company also serves precision machining customers worldwide with an unmatched size range of semi-finished machinable shapes in multiple grades of these advanced materials.