Resilon® Polyurethane

Proprietary high-performance material for hydraulic sealing

distributed by

High-performance polyurethane for long sealing life

Parker's proprietary Resilon polyurethane delivers unequalled resilience, strength, and thermal stability -- translating into superior sealing performance in critical engineering applications. The chemical nature of Resilon polyurethane's backbone polymer (PPDI) produces unique dynamic properties which make it a stand-out choice for long life in hydraulic applications involving high cyclic loading.

Contact Parker to learn about how the extended capabilities of Resilon can deliver longer seal life.

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Product Features:

- Performs where other polyurethanes fail
- Expanded temperature range
- Improved strength and wear-resistance extends seal life
- Resists extrusion over a broad pressure range
- Compression set resistance helps seal maintain lip contact under rapid changes to pressure and load
- Water resistant (4301) and extrusion resistant (4304) formulations available

ENGINEERING YOUR SUCCESS.

PPDI-based Resilon® formulation

Delivers best overall sealing performance for heavy duty hydraulics

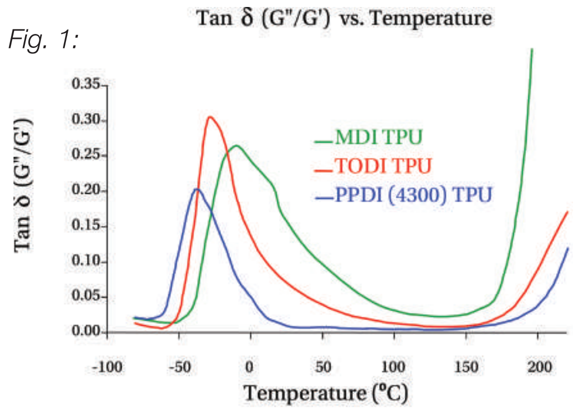
Three Basic Types of Sealing Grade Materials
There are three base formulations or chemical backbones used in compounding modern thermoplastic polyurethane (TPU) seal materials. They are:

- MDI (diphenylmethane diisocyanate)
- TODI (diphenyldiisocyanate)
- PPDI (p-phenylenediisocyanate)

All three produce the abrasion resistance and long wear benefits that are typical of any good polyurethane seal material. There are other physical properties though, such as heat resistance, compression set resistance, and rebound/resilience, which are major concerns in critical hydraulic applications which require effective, long-term sealing. It is in these latter performance areas that the characteristics inherent in MDI, TODI or PPDI formulations become most apparent. This unique Parker-developed PPDI-based formulation – Resilon – yields the best over-all sealing performance of all commercially available TPU formulations currently on the market.

Superior Heat Resistance
Rheometric examination of the dynamic behavior of MDI, TODI, and PPDI (4300) were measured under tensile mode and produced the data shown in the chart at right. The low tangent delta, tan δ, values of Resilon PPDI across the practical application range indicate a lower ratio of energy absorbed as heat to energy returned as resilience. In addition, the higher temperature upturn of the Tan δ value verifies the higher softening temperature for the Resilon PPDI formulation.

Fig. 1:



Resilon's internal heat build-up (hysteresis) is much lower across the entire temperature range of operation (-40° to +275°F)

Superior Resilience/Rebound
Resilon (4300) also has superior resilience/rebound characteristics compared to other available TPU materials. Quick rebound is a major advantage in applications likely to experience severe shock loads and momentary pressure spikes. In addition, Resilon's enhanced resilience/rebound characteristics allow the sealing lips of rod or piston seal profiles to conform to the moving seal interface with greater rapidity, maintaining critical sealing lip contact.

Applications
Recommended for piston seals, rod seals, wipers and O-rings for all types of light, medium and heavy-duty hydraulic cylinders, shock absorbers, off-road, industrial and construction equipment.

Resilon® Polyurethane Materials

Typical Physical Properties	4300A90	4301A90	4304D60
Hardness, Shore, pts	92A	90A	55D
Tensile Strength at Break, psi	8625	7129)	6521
Ultimate Elongation, %	560	514	556
100% Modulus, psi	1793	2029	2940
Compression set at 158°F, %	28.9	24.8	32.2
Rebound, %	63	45	46
Service Temperature Range, °F	-65 to +275	-35 to +225	-65 to +275

EPS 5202 03/2011 TMR 500/POD

Technical Data

Typical Physical Properties

Property	ASTM	DIN
Hardness (Shore A)	88	88
Tensile Strength (psi)	4267	6545
Ultimate Elongation (%)	607	662
Rebound (%)	57	
Compression Set (%, 22 Hrs. 70°C)	24	
Specific Gravity	1.10	
Operating Pressure (psi)*	3,500 (10,000†)	
Operating Temperature Range	-65 to 212°F (-54 to 100°C)	

NOTE: The above are typical values and should not be used as specification limits.

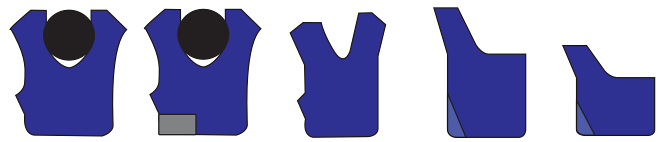
* Pressure limitations are a function of the extrusion gap and may change if wear rings are used. Consult Catalog EPS 5370 or contact your authorized Parker distributor for further details.

† BD PolyPak profile with back-up operating pressure to 10,000 psi.

Warning: For safe and trouble-free use of these products, it is important that you read and follow the Parker Seal Group Product Safety Guide, Publication No. PSG 5004, available at www.parker.com, or by calling 1-800-C-PARKER.

Material/Profile Availablility

Parker's P5065 compound is offered in a wide range of profiles and sizes. Shown here are a few popular profiles commonly used in the agricultural industry.



Both the BS U-cup and BD PolyPak employ secondary lips that improve stability and sealing performance while featuring Parker's knife-trimmed primary sealing lips for the ultimate in leakage control. Parker's BD PolyPak is available with a backup for higher pressure applications (up to 10,000 psi).

Parker's SHD and SH959 wipers are industry-proven profiles that will retrofit into many non-Parker excluder glands.

See the back cover for hardware dimensions of popular sizes.

Parker P5065 Outperforms the Competition

Wear Resistance Characteristics of P5065 Outperform Competition in Independent Laboratory Test

An independent, third party laboratory recently conducted life cycle testing on Parker's P5065 compound, comparing the leakage performance and wear resistance against a popular competitive urethane. Two cylinders were fitted with Parker BD PolyPaks, while two identical cylinders were fitted with similar profiles from Competitor A.

Test Parameters

Pressure	1350 psi
Temperature	Ambient
Stroke Speed	2 in/sec
Stroke Length	5 in

Duration	20,000 continuous cycles
Lubricant	Chevron 1000 THF

Test Results

After 20,000 cycles, leakage results showed that the cylinders incorporating Parker's P5065 compound did not leak any measurable amount of oil; there was merely oil visible on the wiper. In contrast, the cylinders incorporating Competitor A's urethane showed significant leakage accumulation, as follows:

Total Leakage (mL)

	Competitor A	Parker P5065
Cylinder 1	1.25	no measurable amount
Cylinder 2	0.40	no measurable amount

When the cylinders were torn down to inspect the seals, the reason for Parker's superior leakage performance became clear. Post-testing images show that the Parker seals have retained much of their original geometry (See Figure 1), while Competitor A's seals have been severely worn away on their dynamic surface, resulting in loss of interference, the disappearance of the secondary lip, and ultimately, shortened cylinder life due to seal leakage.

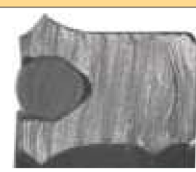
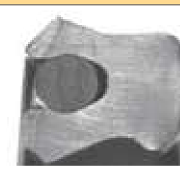
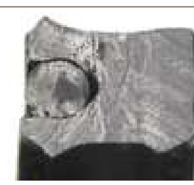
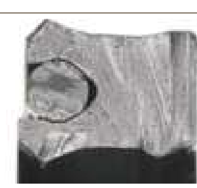
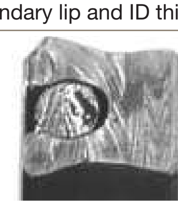
	Parker	Competitor A
Original profile		
After Testing: Cylinder 1		 Notice disappearance of secondary lip and ID thinning
After Testing: Cylinder 2		 Notice disappearance of secondary lip and ID thinning

Figure 1. Before and after images of seals

From these images and supporting measurements, it is clear that Parker's P5065 compound outperforms Competitor A both in leakage control and wear resistance.

Low Temp Characteristics Outperform Competition in Side-by-Side Testing

In order to simulate cold temperature start-ups between long runs of machine time in agricultural equipment, Parker recently conducted an in-house procedure to compare P5065 to a competitive urethane. Side-by-side testing of P5065, Parker's low temperature urethane, was compared in a BS U-Cup profile to a commonly used competitor seal for agricultural applications. After more than 150,000 cycles at 2,000 psi, Parker's P5065 emerged as the clear winner.

A two-pod Chew Test Stand was used to perform the testing. The test was performed twice, with the first test having the P5065 seal in pod 1 and the competitor seal in pod 2. The second test had the seals switched in the pods to eliminate any affects that hardware differences may have had. Each pod is covered by an environmental box, whose temperature can be set and controlled by either heating or cooling.

Procedure
After the test seals are measured and installed, and the air bled from the pods, an 11 step test procedure is followed to complete the testing as shown below.

Test Steps

Step	Description	Temp.	Cycles & Pressure
1	Room temp. startup	Room	100 @ 0 psi, 100 @ 2,000 psi
2	Cold box	-20°F (4 hour soak)	100 @ 0 psi, 100 @ 2,000 psi
3	Hot cycling	150°F	50,000 @ 2,000 psi
4	Room temp. startup	Room	100 @ 0 psi, 100 @ 2,000 psi
5	Cold box	-20°F (4 hour soak)	100 @ 0 psi, 100 @ 2,000 psi
6	Hot cycling	150°F	50,000 @ 2,000 psi
7	Room temp. startup	Room	100 @ 0 psi, 100 @ 2,000 psi
8	Cold box	-20°F (4 hour soak)	100 @ 0 psi, 100 @ 2,000 psi
9	Hot cycling	150°F	50,000 @ 2,000 psi
10	Room temp. startup	Room	100 @ 0 psi, 100 @ 2,000 psi
11	Cold box	-20°F (4 hour soak)	100 @ 0 psi, 100 @ 2,000 psi

Test Results
Upon completion of the procedure, the Parker seals have 6% less cumulative leakage, on average, than the competitor seals over the entire test. By comparing the two materials side by side in a procedure designed to simulate a common source of cylinder leakage in many agricultural applications, it can be clearly seen that Parker P5065's low temperature characteristics and superior wear resistance make it the seal material of choice.

Cold Environment Operation is Critical
The operation and storage of agricultural equipment in cold environments makes low temperature seal performance a critical factor in material selection. One way to determine how well a seal material will perform across a wide range of temperatures is to measure its dynamic modulus. In Figure 2, Parker's P5065 compound and Competitor A's material are subjected to a Dynamic Modulus Analysis (DMA).

An elastomer's Dynamic Modulus can be separated into two different components; the Storage Modulus and the Loss Modulus. The Tangent Delta, shown in the plot, is the ratio of the Loss Modulus to the Storage Modulus. This translates to be the ratio of the energy absorbed, or "lost," by the material as heat to the energy used by the material to return to its original shape, providing sealing force.

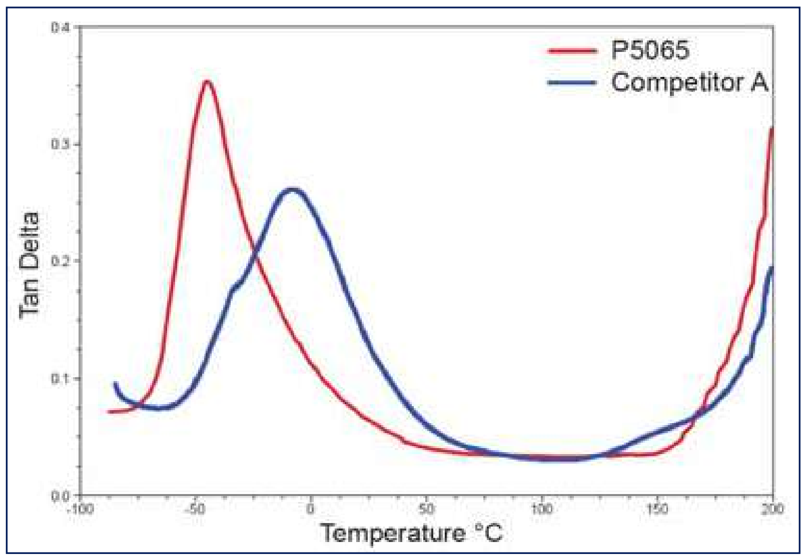


Figure 2. Dynamic Modulus Analysis

The Significant Features of the Tangent Delta Plot

- The temperature value of the low temperature peak relates to the material's capability to maintain its elastic properties at lower temperature. A material with a peak at lower temperature is better for low temperature applications. In this regard, Parker P5065 outperforms Competitor A.
- The magnitude of the Tangent Delta over the operating temperature range relates to the ratio of the material's energy lost as heat to the energy maintained as a restoring force. As such, a lower curve is better than a higher curve. Parker's P5065 has an operating range of -65°F to 212°F (-54°C to 100°C). Across the vast majority of this range, Parker P5065 outperforms Competitor A.
- The constant width or flatness of the curve over the application temperature range relates to constant dynamic properties. A longer, flatter, and lower curve is most desirable. In this regard, Parker P5065 outperforms Competitor A.
- The high temperature upturn of the material is associated with the material's softening. A curve upturn at higher temperature relates to higher temperature capability and is significant even if this occurs outside the material's recommended operating range. Once again, Parker P5065 outperforms Competitor A.