

# ARMORLENE®

HLX BRONZE-FILLED PTFE

## COMPARATIVE TEST REPORT

This paper describes comparative product testing of Hallite's ARMORLENE® HLX bronze-filled PTFE against three competing, market leading bronze-filled PTFE materials. Tests were performed by Hallite product specialists at the company's testing facilities in the UK to determine the performance characteristics of Hallite ARMORLENE® HLX PTFE in the Hallite P54 piston seal. Competitor products were evaluated under the same test conditions for comparative purposes. Test conditions were based on industry best practices which incorporated a combination of parameters proven effective in previous Hallite test programs coupled with the company's thorough understanding of customer requirements.

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Mineral Oil

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# Armorlene® HLX Bronze-Filled PTFE

### Reciprocating Tests

Reciprocating tests were conducted in a double-acting manner by having the test seal assembled onto a moving piston with pressurized chambers on each side. In the laboratory, heating bands were applied to the outside of the test tube to heat the oil. This is a proven method for laboratory testing at elevated temperatures. All test seals were subjected to the same conditions.

This test configuration accommodated monitoring temperature, speed, the ability to hold pressure, section loss during the test, and resistance to extrusion. All seals held pressure during the test, but after 100,000 cycles differences in the loss of section measurements were identified.

Hallite ARMORLENE® HLX experienced material loss comparable to Competitor A, but considerably less than Competitors B and C.

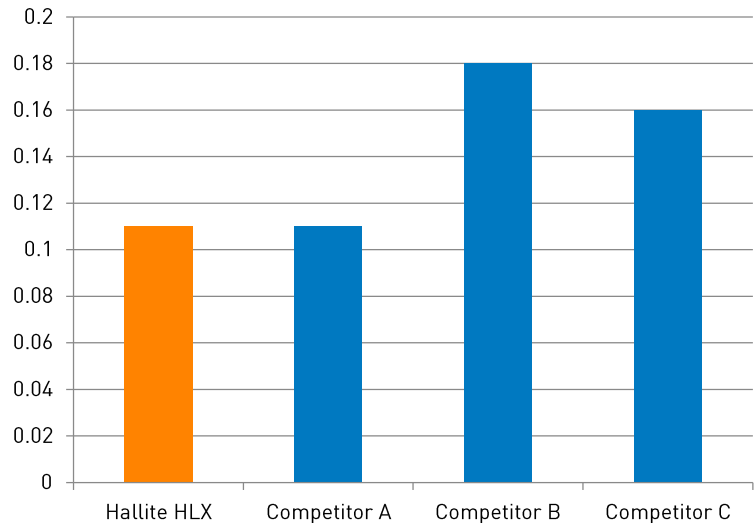


Image 1: Reciprocating Test Rig

Table 1: Reciprocating Test Conditions

Temperature	+100°C (+212°F)
Speed	0.3m/s (12"/s)
Stroke	0.5m (20")
Duration	100,000 cycles
Distance	100km (62 miles)
Extrusion gap	0.32mm (0.013")
Pressure	0/350bar (5,076psi) cyclic
Bore diameter	80mm
Tube Type	Honed

Comparative Section Loss After 100,000 Cycles (mm)



Graph 1: Reciprocating Tests Results of Comparative Section Loss After 100,000 Cycles (mm)

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### Staging Pulse Tests

Pulse tests were conducted using customized test pods composed of a piston mounted within a cylindrical case allowing pressurized fluid to be applied to either side of the piston seal. This was repeated for 250,000 cycles to measure material robustness. Like the reciprocating tests, fluid was heated using external heater bands. The test seal's ability to hold pressure was monitored throughout the duration of the test. When the test concluded, the visual assessment revealed that all of the bronze-filled materials were comparably resilient. **The visual assessment looks worse for the Armorlene® HLX, but looks can be deceiving.** A quick dimensional check showed extrusion of similar volume among all of the tested materials, but, more importantly, in Competitor A and Competitor C the extrusion detached and fell into the cylinder fluid. **Hallite's Armorlene® HLX was the only one to remain intact which demonstrates an 'elastic capability' not present in other PTFE materials and gives the best 'system' performance compared to competitors.**



Photo 2: Pulse Test Rig

Table 2:

#### Pulse Test Conditions

Temperature
+100°C (+212°F)
Pressure
400bar (5,800psi)
Extrusion Gap
0.5mm (0.020")
Duration
250,000 cycles

#### Pulse Test Results of Comparative Extrusion After 250,000 Cycles



Hallite Armorlene® HLX



Competitor A



Competitor B



Competitor C

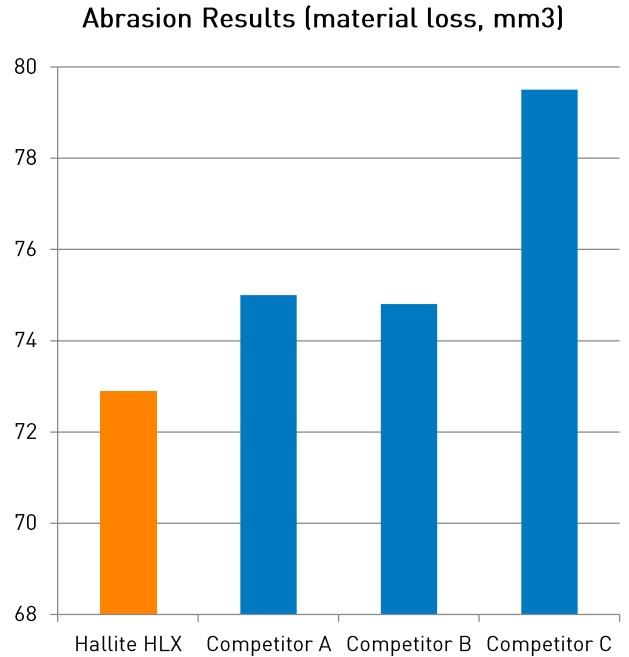
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### Abrasion Tests

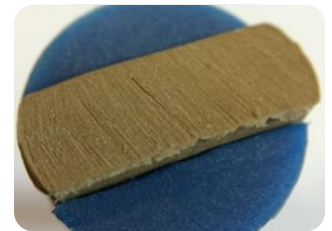
Abrasion testing consisted of a rotating drum with red oxide paper for a calibrated rough surface. This allowed the material to be pushed onto this surface as it was rotated and measured how much material was lost – a measure of wear resistance. This simulation represented a much more rigorous seal wear environment than a real-world field application to enable calibrated laboratory equipment to test materials at the same speed and paper roughness.

As shown in the photos below, a sample holder was designed to grip a section of the seal and make the test possible. In addition, due to the soft nature of PTFE, the force applied to the test piece was reduced to allow a test of 'reasonable' duration. This enabled a consistent and comparable test. **The results concluded Armorlene® HLX performed better under this abrasion test than the current benchmark.**



### Conclusion

When comparatively tested against competitors, Hallite's Armorlene® HLX bronze-filled PTFE material offers customers comparable performance to market leading, best-in-class PTFE material and even surpassed them in certain test conditions. This latest addition of Hallite Armorlene® HLX PTFE to the Hallite material portfolio provides customers with a trusted alternative supplier of premium PTFE continuing Hallite's 100 year tradition of bring customers high quality, high performance hydraulic sealing solutions.



*Hallite Armorlene® HLX  
in sample holder*