Performance Testing Results

MM-2487-15 and Aeroshell 41 Comparison

MM Industrial Sales

MM-2487-15 is a High Dielectric Strength Synthetic Hydraulic Fluid designed for low-temperature usage. The objective of this report was to compare the anti-wear capabilities, viscometrics, oxidative stability, dielectric strength, and fluid cleanliness of MM-2487-15 with Aeroshell 41. The tests that were performed on these two fluids to evaluate their performance were:

A. Four-Ball Wear Test (ASTM D4172)
B. Viscosity vs. Temperature profile (ASTM D7042)
C. RPVOT (ASTM D2272)
D. Dielectric Strength Test (ASTM D877)
E. Particle Count (ASTM D7647)

A. The Four-Ball Wear test for MM-2487-15 yielded an average wear scar diameter measurement 38% better than Aeroshell 41.

Product	Wear Scar (mm)
MM-2487-15	0.45
Aeroshell 41	0.73

Performance Testing Results

MM-2487-15 and Aeroshell 41 Comparison

B. The viscosity profiles for the two fluids are almost identical. The kinematic viscosity values for MM-2487-15 are higher across the entire range because at the ISO standard temperature of 40°C, MM-2487-15 is formulated closer to 15 cSt with a viscosity of 15.2 cSt. Aeroshell 41 is lower at 13.7 cSt. Both fluids exhibit low-temperature fluidity down to -50°C. MM-2487-15 has a kinematic viscosity at -50°C that is 314 cSt higher than that of Aeroshell 41, but this is due to MM-2487-15 having a higher overall viscosity.

Viscosity Temperature (C)	MM-2487-15 (cSt)	Aeroshell 41 (cSt)
100	5.7	5.1
40	15.2	13.7
0	50.1	43.3
-25	179.0	141.1
-50	1420.6	1106.3

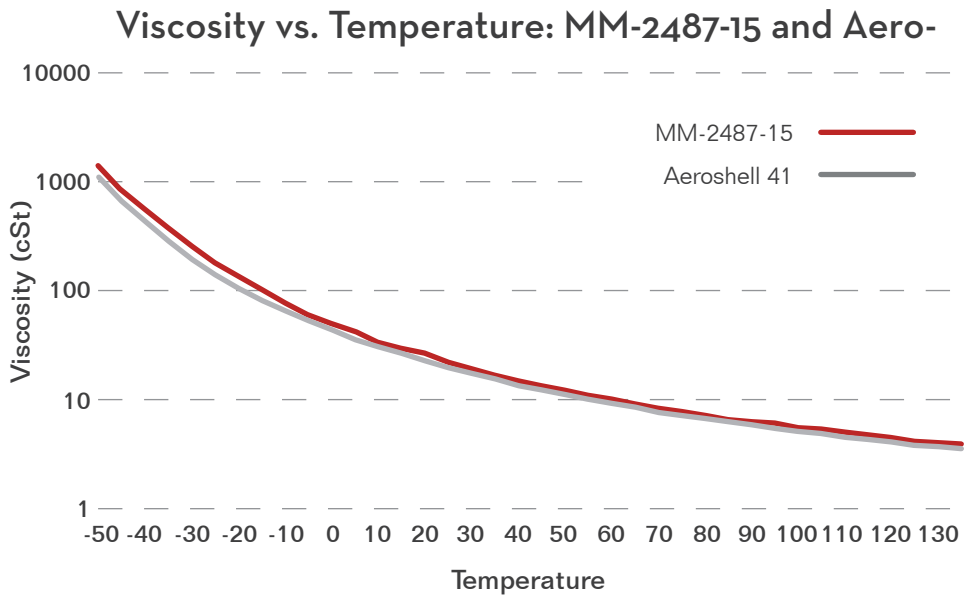

Figure 1. Viscosity vs. Temperature Profile for MM-2487-15 and Aeroshell 41 [-50 to 135°C]

Performance Testing Results

MM-2487-15 and Aeroshell 41 Comparison

C. Rotating Pressure Vessel Oxidation Test is an indicator of the oxidation stability or resistance to oxidation that a fluid has. The longer results will indicate longer fluid life and resistance to oxidative breakdown where fluids tend to create varnish and other deposits within the system.

MPOSP (Minimum Pressure Oxidative Stabilization Point) exceeds the initial pressure drop measurement to compare fluids to maximum limits.

The TAN (Total Acid Number) was measured for each of the two fluids after the RPVOT test had concluded which shows the fluids degradation and increased tendency for accelerated breakdown and corrosion.

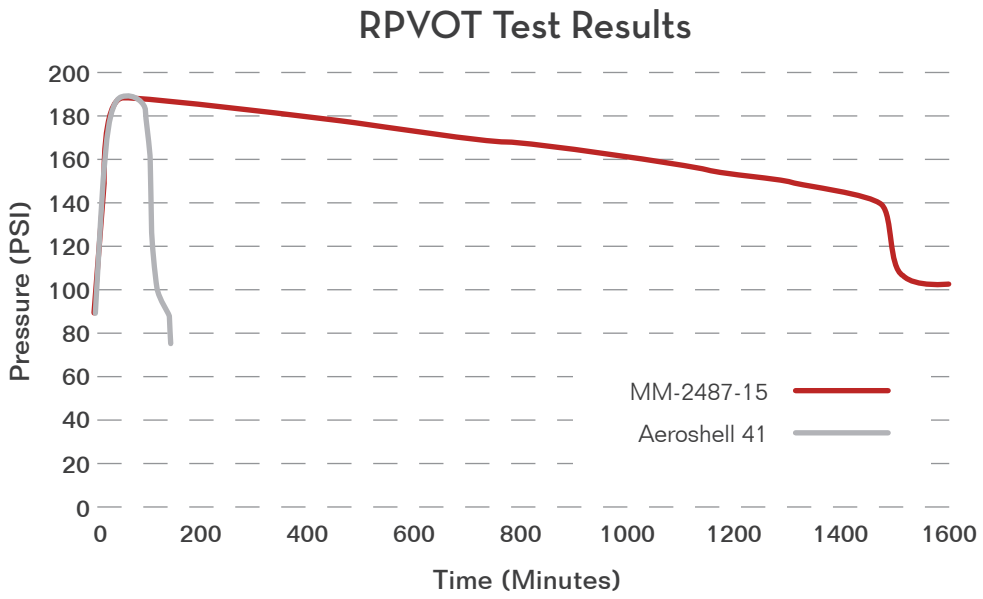

Figure 2 RPVOT Profile Comparison Chart for MM-2487-15 and Aeroshell 41

Product	25.4 psi Drop (minutes)	MPSOP (minutes)	TAN (mg of KOH/g)
MM-2487-15	957	1585	4.3
Aeroshell 41	101	138	5.4

Performance Testing Results

MM-2487-15 and Aeroshell 41 Comparison

D. Dielectric breakdown test is performed by ASTM D877 which measures the electrical stress that an insulating oil can withstand without breakdown. A breakdown is the point at which a spark is created between two electrodes as the voltage is increased and measured in kilovolts. Many factors attribute to achieving a high breakdown voltage and can be influenced by base oil selection, additives, oil purity and cleanliness. MM-2487-15 has consistently achieved results that are above average due to understanding and controlling several of these factors in the formulation and production process.

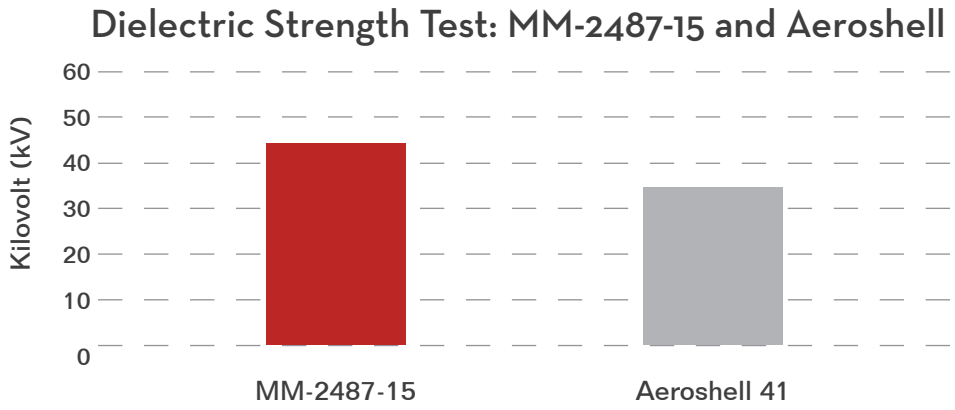

Figure 3. Dielectric Strength Test for MM-2487-15 and Aeroshell 41

E. The particle count is represented by the reference ISO Code and represents the number of particles in three standard sizes of 4, 6, and 14 microns. The Aeroshell 41 product is designed to be a "Super-clean" which is required in certain applications and military specifications for aeronautical use. The MM-2487 product is still a very clean ISO Code and will suit the intended application. The received ISO code will quickly increase unless precautions like filtration is used when fluid is transferred into storage tanks or to the point of use as well as using filtered particle and moisture breathers on storage tanks.

Particle Count (Microns)	MM-2487-15	Aeroshell 41
ISO Code (4/6/14)	18/16/12	16/15/12
4μ - (Particles/ml)	1,463	604
6μ - (Particles/ml)	546	192
14μ - (Particles/ml)	34	29

Performance Testing Results

MM-2487-15 and Aeroshell 41 Comparison

Discussion

This product has been designed to exceed the practical performance characteristics of hydraulic oil made for use in low-temperature environments requiring a high dielectric strength. Each performance test evaluated here leads to a lubricant that provides extended useful life, provides increased wear protections, ensures consistent operation at low-temperatures.

A. The Four-Ball wear scar diameter for MM-2487-15 was 0.45 mm which is 38% less than that for Aeroshell 41. This is significant because it shows that the anti-wear additives in MM-2487-15 do a better job at preventing wear than those in Aeroshell 41.

B. Figure 1 showed that the viscosity profile for MM-2487-15 was slightly higher than that of Aeroshell 41, but that this is due to MM-2487-15 being closer to the actual specification of an ISO 15. Figure 1 also showed that MM-2487-15 has a viscosity of 1,420 cSt at -50°C. At this viscosity, the lubricant will still be fluid and perform optimally.

C. The RPVOT presented in Figure 2 showed that MM-2487-15 had better oxidative stability than Aeroshell 41. MM-2487-15 lasted 9.5 times longer based on the vessel life.

D. Dielectric strength has been tested many times by end-user equipment and third-party laboratories where MM-2487-15 consistently achieved results well over 40kV while the Aeroshell 41 product typically tested at 35kV or lower.

E. Aeroshell 41 had an ISO particle code of 16/15/12 and MM-2487-15 had an ISO code of 18/16/12. This shows that Aeroshell 41 is considered a super-clean fluid, and that MM-2487-15 is a clean fluid. A super-clean fluid is beyond the practical needs of most hydraulic equipment and requires special handling and storage

Conclusion

MM-2487-15 outperformed Aeroshell 41 in wear tests and in oxidative stability. MM-2487-15 also had comparable low-temperature fluidity down to -50°C. Aeroshell 41 was slightly cleaner in terms of particle count, but MM-2487-15 is still a clean fluid by ISO standards.