



Vanderbilt Chemicals, LLC

A Wholly Owned Subsidiary of R.T. Vanderbilt Holding Company, Inc.

MOLYVAN™ FEI Plus

Lubricant Additive



Friction Reducer

Antiwear

Antioxidant

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Typical Properties

Physical State	Brown Liquid
Density at 25°C, mg/m ³	1.01
Viscosity at 100°C, mm ² /s.	10.5
Molybdenum Content, %	1.5
Phosphorus Content, %	0.6
Sulfur Content, %	3.9
TBN	9.5
Sulfated Ash, %	5.8
Recommended Treat Rate	4.75%

MOLYVAN FEI Plus is a partial additive package designed for enhanced fuel economy and maximum catalyst compatibility. This unique combination of additives contains a high level of molybdenum and organic friction modifiers for improved fuel economy, a low phosphorus antiwear system for improved catalyst compatibility and a strong antioxidant system to promote fuel economy retention while maintaining oil robustness.

MOLYVAN FEI Plus can be blended with a commercial dispersant, a overbased calcium sulfonate detergent, an appropriate VI improver and base oil to make a fully formulated engine oil with 250 ppm phosphorus and 700 ppm molybdenum. The finished oil exceeds the ILSAC GF-5 limits for fuel economy and catalyst compatibility while maintaining oil robustness.

Disclaimer:

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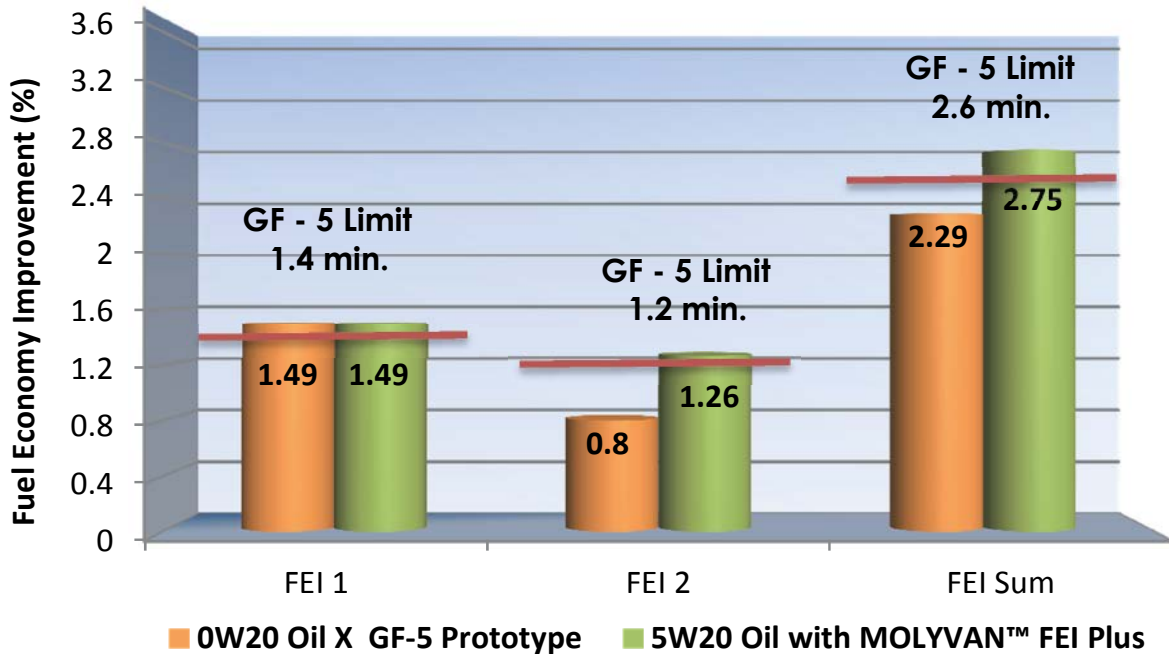
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30 WINFIELD STREET, P.O. BOX 5150, NORWALK, CONNECTICUT 06856-5150 • (203) 853-1400
Fax (203) 853-1452 • Internet Address: www.vanderbiltchemicals.com

Figure 1 Sequence VID Engine Test Data

An experimental 5W-20 engine oil containing **MOLYVAN™ FEI Plus** Lubricant Additive and a GF-4 dispersant/detergent system was submitted for a Sequence VID engine test. The Sequence VID engine test measures fuel economy for gasoline powered passenger cars. Even with a GF-4 dispersant/detergent system, the experimental oil passed the FEI 2 and FEI Sum requirements for next generation GF-5 engine oils.



*Oil X is an ASTM Sequence VID engine test precision matrix oil.

Table 1 Taxi Fuel Economy Test Data

An SAE 5W-20 engine oil formulated with **MOLYVAN FEI Plus** delivered a 6% mpg increase in fuel economy versus the commercial GF-5 comparator oil in the Las Vegas, Nevada desert field test after a combined 100,000 miles of testing.

Taxi	Idle (%)	Avg. Speed (MPH)	Miles	Fuels (Gal.)	MPG
Commercial GF – 5 Oil					
1	29.1	17.3	31,981	2392.0	13.37
2	25.5	17.1	35,438	2658.9	13.33
3	26.2	16.8	37,360	2696.9	13.85
Avg.	26.9	17.1	34,926	2,683	13.52
Oil with MOLYVAN™ FEI Plus Lubricant Additive					
4	28.6	19.3	32,675	2450.4	13.33
5	26.6	18.5	39,229	2761.5	14.20
6	24.1	18.7	36,140	2322.0	15.56
Avg.	26.4	18.8	36,015	2,511	14.34

Table 2
Sequence IIIG Test Data

An experimental 5W-30 engine oil containing **MOLYVAN™ FEI Plus** Lubricant Additive and a GF-4 dispersant/detergent system was submitted for a Sequence IIIG engine test at an independent test lab. The Sequence IIIG engine test measures wear, oil thickening and piston deposits under severe high temperature test conditions. The experimental oil passed all key test parameters including oil thickening, cam and lifter wear, and piston deposits required for GF-5 engine oils.

	Results	GF-5 Limit
PVis, %	54.8	150% max
WPD, merits	4.18	4.0 min
ACLW, μ	22.6	60 max

Las Vegas, Nevada Field Test Results

A field test was run in the Las Vegas, Nevada desert over a 2 year period to compare the performance of a 5W-20 fully formulated engine oil containing **MOLYVAN FEI Plus** to a commercial 5W-20 GF-5 engine oil for 100,000 miles of taxi service. Both engine oils were formulated with Group II base oils. The field test consisted of six 2007 Ford Taurus cabs with 3 cars per test oil. Two engines were disassembled and inspected at end of test. The end of test engine inspection showed equivalent or better wear, sludge and varnish performance for the engine oil with **MOLYVAN FEI Plus**. Piston deposits were substantially lower with the **MOLYVAN FEI Plus** engine oil. The catalytic converters were inspected by an outside test lab at the end of test. Cam lobe wear was visually lower with the **MOLYVAN FEI Plus** engine oil.

Table 3
Engine Tear Down Rating Summary After 100,000 miles of Service

Two engines were disassembled, inspected and rated. The ratings for various engine parts are shown below.

	GF-5 Commercial Oil	Oil with MOLYVAN FEI Plus	Improvement	No Harm
Avg. Eng. Sludge, merits	9.73	9.71		✓
Avg. Varnish, merits	9.31	9.32		✓
Oil Screen Clogging, %	0	0		✓
Piston Ring Sticking	0	0		✓
Piston Crown Land, merits	2.36	3.83	✓	
Avg. Piston Undercrown Varnish, merits	5.93	6.31	✓	
Avg. Intake Valve Deposits, merits	9.90	9.85		✓
Avg. Exhaust Valve Deposits, merits	8.93	8.87		✓

Figure 2 Elemental Analysis After 100,000 Miles of Service

Catalysts from a taxi running on commercial GF-5 engine oil and an engine oil containing **MOLYVAN™ FEI Plus** Lubricant Additive were submitted to an independent outside test lab for elemental analysis using Proton Induced X-ray Emission (PIXE). The phosphorus loading on the exhaust catalyst for the **MOLYVAN FEI Plus** oil was 4 times lower than for the commercial GF-5 oil. Lower phosphorus loading has been shown to result in less catalyst poisoning and improved exhaust catalyst compatibility.

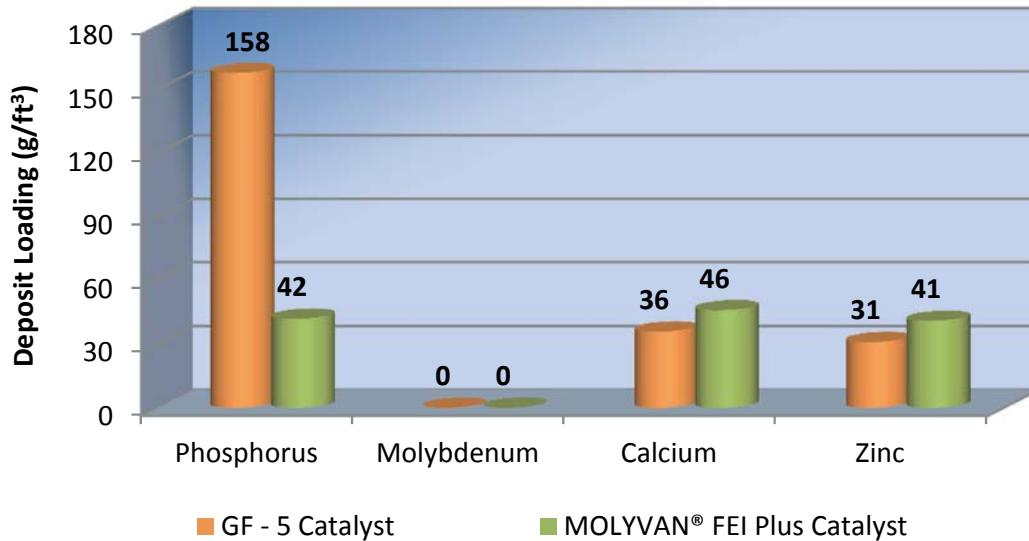


Figure 3 Piston Inspection After 100,000 Miles of Service

Pistons from the engine oil containing **MOLYVAN FEI Plus** show lower crown land deposits and lower piston skirt wear compared to the commercial GF-5 engine oil.

Commercial GF-5 Oil



MOLYVAN™ FEI Plus Oil Lubricant Additive



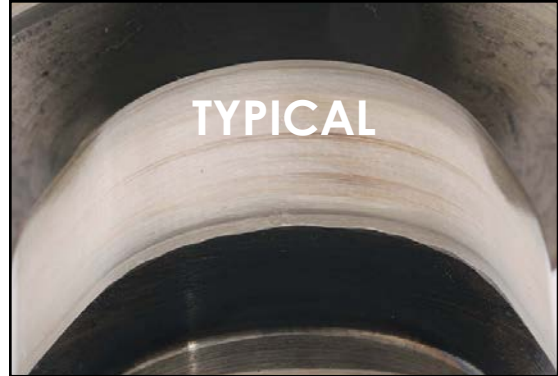
Figure 4 Cam Shaft Lobe Inspection After 100,000 Miles of Service

Visual inspection show the cam lobes from the **MOLYVAN™ FEI Plus** Lubricant Additive engine oil have less wear compared to the commercial GF-5 engine oil.

Commercial GF-5 Oil



MOLYVAN™ FEI Plus Oil
Lubricant Additive



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30 Winfield Street, P.O. Box 5150, Norwalk, CT 06856-5150

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