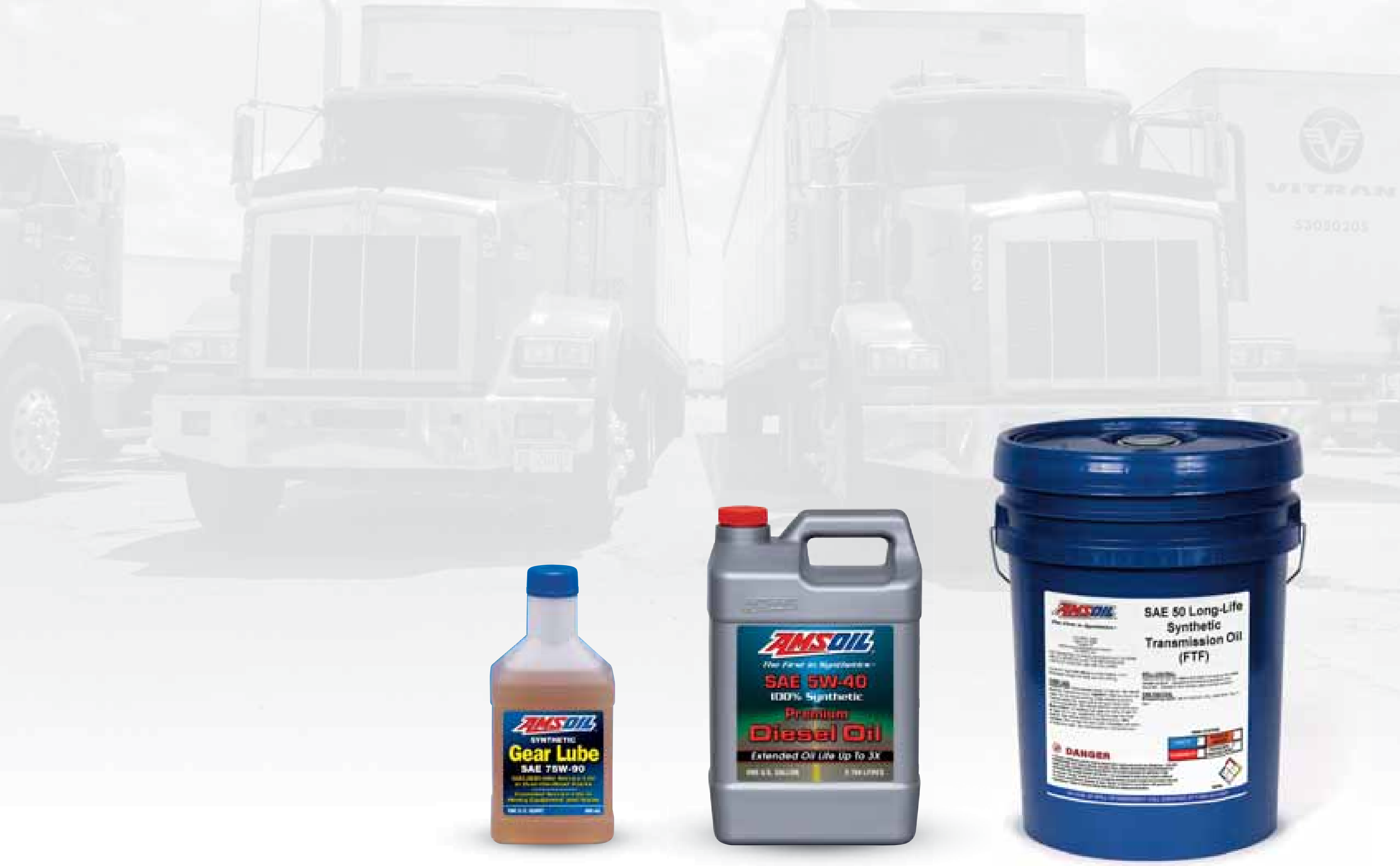
FIELD STUDY

Diesel Fleet Fuel Economy Study

AMSOIL synthetic drivetrain lubricants increased fuel economy in short- to medium-haul trucking applications by 6.54 percent.



Overview

The rising cost of fuel continues to challenge the profitability of delivery services, beverage companies, energy providers and similar fleet operations. Administrators often must raise prices or apply surcharges to remain competitive, resulting in strained customer relations at best, lost business at worst.

Fleet managers have responded with interest in products capable of increasing fuel economy. Even slight increases result in significant cost reductions for fleets accumulating tens of thousands of miles annually. Synthetic lubricants continue gaining popularity due to their all-around increased performance compared to conventional lubricants. They are recognized as a cost-effective and legitimate contributor to increased fuel economy.

Objective

Determine, using the SAE J1321 (TMC RP-1102) In-Service Fuel Consumption Test Procedure, whether or not AMSOIL synthetic lubricants provide increased fuel economy compared to conventional lubricants in short- to medium-haul diesel trucks.

Method

AMSOIL INC. simultaneously compared fuel consumption in two short- to medium-haul diesel trucks owned by Ford Motor Company and operated out of Ford's Rawsonville, Mich. fleet maintenance facility. Testing was conducted in accordance with the SAE J1321 (TMC RP-1102) In-Service Fuel Consumption Test Procedure. The procedure's primary goal is to eliminate all operating and environmental variables that may influence fuel economy. One truck, designated the control vehicle, operated on conventional lubricants throughout the procedure. The remaining truck, designated the test vehicle, was tested using AMSOIL synthetic lubricants.

The SAE J1321 test consists of a baseline segment and a test segment. The baseline segment was conducted on a predetermined route representative of real-world driving conditions. Following each run, the total fuel consumed in the test vehicle was divided by the total fuel consumed in the control vehicle to produce a Test/Control (T/C) ratio. The average of three T/C ratios within a 2 percent range was used in calculating the final fuel economy results. The baseline segment's main purpose was to determine the baseline rate of fuel consumption in both the test and control vehicles while operating with conventional lubricants.

The test segment was conducted according to the same procedures, with the lone difference being installation of AMSOIL synthetic lubricants in the test vehicle's engine, transmission and front and rear differentials. Test runs were again executed until achieving three T/C ratios within a 2 percent range, with the average of the three T/C ratios used in determining the final results of the study. The average baseline and test segment T/C ratios were computed to determine the percentage of fuel economy improvement.

Note: *The participation of the Ford fleet does not reflect an endorsement of AMSOIL INC. or of AMSOIL products.*

Study Vehicles

In a study of this kind, it is critical the control and test vehicles exhibit specifications as close to identical as possible. AMSOIL selected two vehicles from Ford's Rawsonville fleet with the following specifications:

	Control & Test Vehicles
Year	2001
Make	Kenworth
Model	T800B
Engine Make/Model	Cummins N14
Rated Power, hp	370
Rated Speed, rpm	1,800
Peak Torque, lb. ft.	1,450
Peak Torque Speed, rpm	1,200
Transmission Make/Model	Eaton Fuller 10-Speed/Concept 2000
Differential Make/Model	Meritor/RT-40-145
Differential Ratio	3.73
Tire Make/Model	Goodyear/G316 LHT
Tire Size	285/75R/24.5
Tire Pressure, psi	100

The control vehicle's gross vehicle weight (truck and trailer) was 47,360 lbs., while the test vehicle weighed 47,200 lbs. Both had approximately 750,000 miles on their odometers. Thorough maintenance further equalized tire condition, brake condition and the overall mechanical integrity of each truck. To further limit variables that might affect fuel economy, each vehicle received new air and fuel filters, equalized accessory settings and grease throughout their chassis and driveshafts.

The trailers pulled by each vehicle demonstrated equally similar specifications:

	Control & Test Trailers
Year	2002
Make	Wabash
Model	DX253
Type	Van
Height	13' 6"
Length	53'
Width	102"
No. Axles	2
Tire Size	295/75R/22.5
Tire Pressure, psi	100
Empty Weight, lbs.	16,200

Baseline Segment Lubricant Selection

Prior to initiating the baseline segment, both the control and test vehicles underwent a thorough lubricant flushing procedure to remove the old engine oil, transmission fluid and front and rear differential fluid. The vehicles were first brought to normal operating temperature via on-road operation. After draining the fluids, the following conventional lubricants were installed due to their prevalence in the industry and their use in Ford's fleet:

Engine: Chevron's Texaco® URSA® Super Plus 15W-40

Transmission: Chevron's Texaco Multigear EP 80W-90

Front and Rear Differentials: Chevron's Texaco Multigear EP 80W-90

After installing the new lubricants, both vehicles were brought to normal operating temperature and immediately drained of their lubricants to ensure a complete flush. The same Texaco lubricants were again installed. Finally, the transmission alone was drained and refilled a third time following the same procedure to ensure a complete fluid exchange. With both vehicles suitably prepared, the baseline segment was initiated.

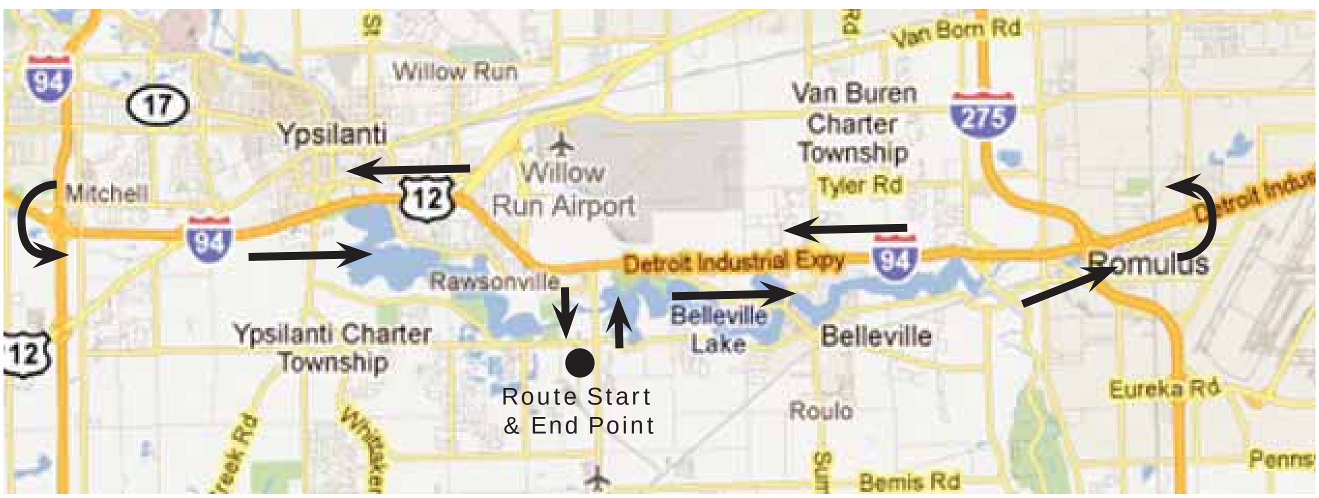
Driving Conditions

To ensure consistency, the control and test vehicles followed identical procedures throughout the test. Each driver became familiar with the route and demonstrated methodical driving habits. During the procedure, both drivers achieved similar rpm prior to shifting and similar throttle positioning during acceleration. Each travelled within two miles per hour of the posted speed limit at all times, engaged the cruise control at the same position along the test route, braked appropriately and maintained an appropriate following distance to eliminate aerodynamic interaction.

Test Route

A route representative of real-world, short- to medium-haul operations beginning and ending at Ford's Rawsonville, Mich. fleet maintenance facility was selected. The 40-mile route included approximately 3.4 miles of city driving and 36.6 miles of highway driving, with vehicle test speeds of 30 mph in the city and 60 mph on the highway. The route was designed to limit the instances of interrupted test speeds due to local traffic.

The first baseline test run began with an appropriate warmup period, after which both trucks were refueled from the same pump to ensure fuel consistency. The trucks immediately proceeded to the test's starting point and, once cued, began navigating the route. Upon completion, each truck was refueled to the bottom of its filler neck flange. Temperature, humidity, barometric pressure and other weather conditions were recorded, as well as fuel temperature, odometer mileage and data from each truck's engine control module (ECM). Fuel consumption measured by the ECM was recorded and used to calculate the T/C ratio for run number one. The trucks were then positioned at the starting point in preparation for run number two, and repeated the process until three T/C ratios within the acceptable 2 percent range were collected.



Test Segment Lubricant Selection

Upon completion of the baseline segment, both the test vehicle and the control vehicle executed a complete test run to reach normal operating temperature. The engine, transmission and front and rear differentials in the test vehicle were immediately flushed following the same guidelines followed prior to the baseline segment. The lone difference, however, was installation of the following AMSOIL synthetic lubricants:

Engine: Premium API CJ-4 5W-40 Synthetic Diesel Oil

Transmission: SAE 50 Long-Life Synthetic Transmission Oil

Front and Rear Differentials: 75W-90 Long-Life Synthetic Gear Lube

The test segment then began following the same route and procedures used during the baseline segment. Consecutive runs were completed until three T/C ratios within the acceptable 2 percent range were collected.

Results

Baseline Segment

Fully grasping how fuel economy results are calculated using the SAE J1321 (TMC RP-1102) In-Service Fuel Consumption Test Procedure requires an understanding of how T/C ratios are calculated. Using Run 5 from Table 1 below as an example, dividing 5.90 (gallons of fuel consumed in the test vehicle) by 5.50 (gallons of fuel consumed in the control vehicle) produces the T/C ratio (1.07).

SAE J1321 requires conducting runs until three T/C ratios within a 2 percent range are achieved. This requirement helps eliminate statistical anomalies that skew final results. The baseline segment required five test runs to produce three T/C ratios within a 2 percent range. Those T/C ratios were averaged using rules for significant digits to produce the Average Baseline T/C Ratio (1.07). The ratio indicates for every 1.00 gallon of fuel consumed by the control vehicle (using conventional lubricants), the test vehicle (also using conventional lubricants) consumed 1.07 gallons of fuel. It is immediately evident the test vehicle displayed worse fuel economy during the baseline segment compared to the control vehicle despite both operating with the identical conventional lubricants under the same operating procedures. This portion of the test procedure identifies the natural differences in fuel consumption between identically equipped vehicles.

Table 1 Baseline Segment Results

	Run 1	Run 2	Run 3	Run 4	Run 5
Control Vehicle (gal. consumed)	5.90	5.60	5.50	5.70	5.50
Test Vehicle (gal. consumed)	6.00	6.00	5.80	6.30	5.90
T/C Ratio	1.02	1.07	1.05	1.11	1.07

Avg. Baseline T/C Ratio 1.07*

Acceptable 2 percent range

** Calculated using rules for significant digits*

Test Segment

Immediately following the Baseline Segment, the test vehicle underwent the previously described flushing procedure prior to installation of AMSOIL synthetic lubricants. The control vehicle continued to operate with its original Texaco conventional lubricants installed. Test segment results are calculated in identical fashion. Because the first test run was completed only to allow each vehicle to reach normal operating temperature, the results were eliminated from consideration. Six subsequent test runs were conducted to achieve the three required T/C ratios. Run 6 was eliminated from consideration due to heavy traffic and stop-and-go conditions. Table 2 displays the results.

Averaging the three T/C ratios that fall within the acceptable 2 percent range produces an Average Test T/C Ratio of 1.00. This ratio indicates that for every 1.00 gallon of fuel consumed by the control vehicle (with conventional lubricants), the test vehicle (with AMSOIL synthetic lubricants) also consumed 1.00 gallon of fuel. Applying the natural differences identified in the baseline segment between the control vehicle and the test vehicle (which demonstrated worse fuel economy despite both having operated with conventional lubricants), the switch to AMSOIL synthetic lubricants resulted in increased fuel economy. Determining the exact percentage of improvement requires completing the equation shown below.

Table 2 Test Segment Results

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7
Control Vehicle (gal. consumed)	5.70	5.70	5.50	5.50	5.70	5.50	5.80
Test Vehicle (gal. consumed)	6.00	5.70	5.80	5.70	5.70	5.70	5.80
T/C Ratio	1.05	1.00	1.05	1.04	1.00	1.04	1.00

Avg. Test T/C Ratio 1.00*

Acceptable 2 percent range

****1.07 – 1.00 / 1.07 x 100% = 6.54% Improved Fuel Economy using AMSOIL Synthetic Lubricants**

** Calculated using rules for significant digits*
*** (Avg. Baseline T/C Ratio) – (Avg. Test T/C Ratio) / (Avg. Baseline T/C Ratio) x 100%*

Reduced Emissions

A reduction in fuel consumption directly correlates to a reduction in exhaust emissions. The Environmental Protection Agency (EPA) establishes limits for diesel exhaust emissions, and the calculations below are derived from the 2010 limits that apply to model-year (MY) 2010 and newer vehicles. Many state and local governments have adopted these standards for older MY engines as well, which to meet require aftermarket exhaust-treatment devices, such as diesel particulate filters. Table 3 compares emissions levels from a single truck operating with conventional lubricants and the same truck realizing a 6.54 percent reduction in emissions operating with AMSOIL synthetic lubricants.

Table 3 Emissions Reductions

	2010 EPA Limits	Annual Emissions Operating with Conventional Oil*		Annual Emissions Reductions Operating with AMSOIL (6.54% Fuel Economy Improvement)	
Nitrogen Oxides (NO_X)	0.2 g/bhp-hr	228.8 kg/yr**	503.4 lb/yr	14.9 kg/yr†	32.7 lb/yr
Particulate Matter (PM)	0.01 g/bhp-hr	11.4 kg/yr	25.1 lb/yr	0.7 kg/yr	1.6lb/yr
Carbon Dioxide (CO_2)	10.1 kg/gal	202,000.0 kg/yr	444,400.0 lb/yr	13,130.0 kg/yr	28,886.0 lb/yr
Carbon Monoxide (CO)	15.5 g/bhp-hr	17,732.0 kg/yr	39,010.4 lb/yr	1,152.6 kg/yr	2,535.7 lb/yr

* *Based on 400 hp truck averaging 120,000 annual miles; achieving 6 mpg; and operating 11 hours/day, 5 days/week, 52 weeks/year*

** *Sample Calculation: NOx = 0.2g/bhp-hr x 400hp = 80g/hr x 11hr x 5days x 52 weeks = 228.8kg/yr*

† *AMSOIL Reduction: NOx = 228.8kg/yr x 0.065 = 14.9kg/yr (reduction)*

Conclusion

Testing completed in compliance with the industry-standard SAE J1321 (TMC RP-1102) In-Service Fuel Consumption Test Procedure demonstrates use of AMSOIL synthetic lubricants can increase fuel economy in short- to medium-haul diesel applications and, in this case, did by 6.54 percent. The study was designed to eliminate environmental and operating variables as much as possible by using two nearly identical trucks and operating them in a consistent and methodical fashion throughout the same test route. Following the baseline segment, data indicate the test vehicle operating with conventional lubricants in its engine, transmission and front and rear differentials consumed more fuel than the control vehicle operating with the same lubricants. After a thorough lubricant flush and installation of AMSOIL synthetic lubricants, data collected during the test segment indicate the test vehicle consumed less fuel than it did during the baseline segment. Calculations derived from the data sets confirm a 6.54 percent fuel economy improvement provided by AMSOIL synthetic lubricants. The fuel economy improvement directly correlates to reduced fuel costs and reduced exhaust emissions as well.

Although this study was completed using full-sized semi trucks and 53’ closed-box trailers, these results can be extrapolated to conclude that the fuel economy benefits extend to all types of fleet applications and can reduce costs in a variety of scenarios, including small fleets accumulating relatively few daily miles per vehicle and larger fleets accumulating significantly more.

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