

Fuel Economy Durability - A Concept to be Considered for Motorcycle Oils

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ABSTRACT

Motorcycle manufacturers have recognized that highly friction modified passenger car oils can be deleterious to clutch performance, leading to clutch slippage. To address this issue, a JASO specification for four-stroke motorcycle oils was developed in 1999, categorizing oils into high friction oils termed JASO MA and low friction oils termed JASO MB. The high friction oils were preferred for most motorcycles where the engine oil also lubricates the clutch and gears. New motorcycle transmission technologies have increased the number of dry clutch applications which has led to an increased demand for JASO MB oils to improve fuel efficiency. While JASO MB oils contain friction modifiers to improve initial fuel economy, the motorcycle specifications have not addressed the fuel economy durability of motorcycle oils. This paper will investigate the fuel economy durability of JASO MB quality oil in various ways in order to determine if the fuel economy benefit is maintained throughout the time the oil spends in the engine.

INTRODUCTION

The fuel efficiency of vehicles has been an important issue over the last 25 to 30 years due to concerns over the conservation of natural resources and the protection of the environment (1). One way to improve the fuel efficiency of vehicles is to utilize energy conserving motor oils that reduce engine friction. The first industry standard for energy conserving motor oils was established in 1983 by the American Petroleum Institute (API). Various tests such as the Sequence VI and Sequence VIA were utilized from 1983 until 2000 to evaluate the fuel efficiency of engine oils. In 2000, the Sequence VIB test was introduced, which for the first time evaluated not only initial fuel economy, but also fuel economy durability. This test was utilized for the International Lubricant Standardization and Approval Committee (ILSAC) GF-3 and GF-4 specifications. It has recently been replaced by the Sequence VID test (2), which measures fuel economy durability for the ILSAC GF-5 specification in a General Motors 3.6L V6 engine. Fuel economy durability therefore has been a

key performance parameter engineered into passenger car oils for the past 10 years. During this timeframe, different types of friction modifiers have been developed and higher levels of friction modifiers have been added to engine oils in order to meet the more stringent fuel economy and fuel economy durability targets.

As highly friction modified passenger car oils became common in the market, motorcycle manufacturers found that they can be deleterious to clutch performance, leading to clutch slippage. To address this issue, a JASO T903 specification for four-stroke motorcycle oils was developed in 1999, categorizing oils based on clutch friction performance into high friction oils termed JASO MA and low friction oils termed JASO MB. The JASO MA category was divided into JASO MA1 and MA2 in 2006. The JASO T903:2006 classification of oils is shown in table 1 (3).

Table 1. Classification of JASO Oil Quality

	DYNAMIC FRICTION INDEX (DFI)	STATIC FRICTION INDEX (SFI)	STOP TIME INDEX (STI)
MA2	≥1.80 and <2.50	≥1.70 and <2.50	≥1.90 and <2.50
MA1	≥1.45 and <1.80	≥1.15 and <1.70	≥1.55 and <1.90
MB	≥0.50 and <1.45	≥0.50 and <1.15	≥0.50 and <1.55

The high friction oils are preferred for most motorcycles where the engine oil also lubricates the clutch and gears. New motorcycle transmission technologies have increased the number of dry clutch applications which has led to an increased demand for JASO MB oils to improve fuel efficiency. While JASO MB oils contain friction modifiers to lower friction and improve fuel economy, no industry standard tests exist to evaluate the fuel economy durability of motorcycle oils. The focus of this study is to evaluate fuel economy durability of JASO MB oils using various techniques.

OIL SELECTION

In order to investigate the fuel economy durability of JASO MB quality oil, a high quality JASO MB oil was purchased from the Japanese market. Analysis of this oil is shown in table 2.

Table 2. Viscometric and Elemental Analysis of Purchased JASO MB Oil

VISCOMETRIC ANALYSIS	
VISCOSITY @40 cSt	68.57
VISCOSITY @100 cSt	10.68
VISCOSITY INDEX	145
HTHS 150 cP	3.13
ELEMENTAL ANALYSIS	
BORON %	0.018
CALCIUM %	0.184
MOLYBDENUM %	0.049
NITROGEN %	0.111
PHOSPHORUS %	0.094
SULFUR %	0.654
ZINC %	0.112

The oil was found to have been formulated to conventional 10W-30 viscometrics and to contain a high level of molybdenum, indicative of a high treat level of a friction modifier.

FUEL ECONOMY MEASUREMENTS – EVALUATION 1

Since there is no motorcycle test available to measure the fuel economy durability of a JASO MB oil, a Sequence VID test was utilized (2). The Sequence VID test is a standardized ASTM test (D7589) used to measure a lubricant's ability to improve the fuel efficiency of a passenger car engine. The test incorporates a flush and run procedure using a General Motors (2008 Cadillac) 3.6L V6 engine. The test method involves measuring the fuel required to run the engine at various operating stages. The operating conditions shown in table 3, in combination with weighting factors were designed to correlate to the EPA's FTP cycle which is used to quantify fuel efficiency.

Table 3. Sequence VID Test Conditions

FE Stage	Speed (rpm)	Load (Nm)	Oil Temp (°C)
1	2000	105	115
2	2000	105	65
3	1500	105	115
4	695	20	115
5	695	20	35
6	695	40	115
Aging	2250	110	120

The test begins with a six-stage evaluation of a baseline or reference oil. The candidate oil is then flushed into the engine and after 16 hours of aging, which represents approximately 1500 miles of driving, the candidate oil is evaluated using the same six-stage procedure. This provides a measure of the initial fuel efficiency of the oil. The oil is then aged an additional 84 hours for a total of 100 hours which represents 6500 miles of driving. The six-stage evaluation is then repeated. This second evaluation provides a measure of the fuel economy durability of the lubricant. After flushing the engine with a high detergent oil, a fresh charge of reference oil is again introduced into the engine and evaluated, thus bracketing the candidate oil at beginning and end with a baseline or reference oil test.

Test results are reported as a Fuel Economy Improvement (FEI) and are calculated as a percent improvement over baseline for the initial evaluation after 16 hrs of aging (FEI 1) and after 100 hours aging (FEI 2).

The commercial JASO MB oil was evaluated in the Sequence VID test. The fuel consumption of the baseline oil as well as the commercial JASO MB test oil are shown in figure 1. Clearly when the engine is run on the test oil after aging, much more fuel is consumed than when the test was run on the new oil. This indicates a drop in fuel efficiency as the oil ages.

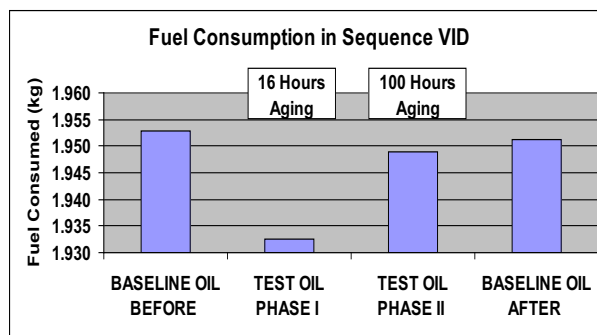


Figure 1. Commercial JASO MB OIL