

Demonstration of the Ability of a Novel Engine Oil to Remove Hydrocarbon Deposits in Two-Stroke Engines

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ABSTRACT

In a two-stroke engine, carbon is a natural by-product of incomplete combustion. Fuel and oil quality vary leading to various degrees of carbon deposit build up on critical engine parts over time. If the carbon deposits are left on engine components and allowed to accumulate, it can lead to reduced horsepower, reduced fuel economy, increased emissions, and in the worst case the deposits can cause engine damage. A novel two-stroke engine oil was developed specifically to remove these deposits, restore the operating efficiency, and potentially lengthen the useful life of the two-stroke engine.

In order to prove the restorative ability of this novel technology, dynamometer tests and field trials were conducted. In the dynamometer portion, the oil was tested in two of the standard TC-W3® certification tests for marine engine oils. The first was the OMC 40HP and the second was the OMC 70HP test. Both test engines had heavy deposits from previous testing which were significantly reduced by using this novel engine oil. Final proof of performance data was obtained by evaluating the new engine oil in field trials. In the field trials two types of engines were used. One trial used an early 1970s Mercury 40HP carbureted engine. The other trial used 2007 model direct fuel injected Mercury 225HP OptiMax engine. As many boaters keep and maintain their engines for a long time, this represents the range of engines in the market today. These engines were previously used and had deposit buildup. Similar to the dynamometer testing, deposits were removed from these engines by using this novel engine oil.

In summary, for two-stroke engines to operate well, carbon build-up and deposits must be minimized. The new oil developed is significant and important because it successfully reduces deposits, hence restoring the engines operating efficiency. This may lead to reduced emissions, enhanced fuel efficiency, and longer operating lifetimes.

INTRODUCTION

The simplicity of the two-stroke engine design, in addition to its excellent power-to-weight ratio, has made this engine extremely suitable for a variety of different applications. Today, applications of the two-stroke engine extend to many recreational areas including marine engines. It is well documented that for two-stroke engines to operate well, carbon build-up and deposits must be minimized.

- Combustion chamber deposits can lead to physical and thermal restrictions and can promote hot spots, auto-ignition, and induce detonation (1).
- Deposits that build up on the cylinder wall and piston skirts affect the surface finish and sealing properties in the cylinder. These deposits can also come loose and get between the cylinder wall and piston skirt causing scratches and scuffing and scoring (2).
- The deposits in piston ring grooves behind the piston rings will affect the free movement of the rings and heat transfer from the piston to the cylinder liner. Ring failure usually occurs when these deposits harden and cause the rings to stick in their grooves. When the rings are completely stuck, they often break. Deposits on the top ring groove can cause

Table 1. Effect of Deposits

Engine Components	Effect of the Deposits
Piston Skirt	Loss of Oil Film Control
Piston Crownland	Interferes with Combustion Efficiency
Piston Top Ring	Compression Loss, Blow-by, Ring Jacking, Stuck Ring
Piston Second Ring	Blow-by, Ring Jacking, Stuck Ring
Piston Third Ring	Blow-by, Ring Jacking, Stuck Ring
Piston Second Land	Change in Compression
Piston Undercrown	Loss of Heat Transfer, Flakey Deposits
Cylinder Wall	Reduced Compression, Loss of oil Film Control
Cylinder Head	Interferes with Combustion Efficiency

sticking, scuffing, and scoring because they block oil passage and trap metal wear particles (3).

- Finally, the lubricant provides cooling for the piston. If deposits form on the piston undercrown, the heat transfer from the piston crown will be reduced and the piston crown temperatures will rise (4).

A summary of the impact of these deposits on various engine components is shown in [Table 1](#).

While conventional two-stroke engine oils are designed to minimize deposit formation, all engines will gradually accumulate deposits over time. The new oil is significant because it successfully reduced deposits in older engines, hence restoring the engines operating efficiency. This may lead to reduced emissions, enhanced fuel efficiency, and ensures improved and consistent engine performance over many additional hours of operation. Both laboratory testing and field testing were done to demonstrate the deposit removing capability of this of the novel engine oil.

LABORATORY EVALUATION

The oil performance was evaluated in two standard laboratory engine tests. The two engine tests were the National Marine Manufacturers Association (NMMA) OMC 40 HP and OMC 70 HP tests which are used for certifying TC-W3 oils. Both of

these tests are recognized as benchmarks for performance in two-cycle marine engines.

To start the evaluation of the new technology in the OMC 40 HP engine test engine with heavy deposits from previous testing was selected. Before the test was started, all critical, wear-related engine hardware, such as the piston, cylinders and cylinder heads, was measured and rated in order to provide a baseline for comparison at the completion of the test.

The test cycle (five minutes at idle and fifty-five minutes at wide open throttle) was run for seven hours. Then the engine was shut down for at least one hour and the sequence was repeated fourteen times for a total running time of 98 hours. At the end of the 98 hours a comprehensive engine wear and deposit formation assessment was conducted. All ratings were performed by certified CRC® (Coordinating Research Council, Inc.) raters. Comparing the ratings before the test and then after the test, a percent improvement was calculated at various critical locations and these improvements are seen in [Table 2](#) and an example calculation from the actual ratings in [Table 3](#).

While the improvements can be quantified using the CRC Ratings, photographs may provide even stronger evidence of the ability of this new oil to remove old deposits from the engine.

Table 2. OMC 40 HP test results

40 HP OMC Engine	Percent Improvement
Piston Skirt	19%
Piston Crownland	49%
Piston First Land	103%
Piston Second Land	Not applicable to 40 HP engine
Piston Top Ring Groove Light Carbon	65%
Piston Second Ring Groove Light Carbon	460%
Piston Third Ring Groove Light Carbon	Not applicable to 40 HP engine
Piston Undercrown	32%
Cylinder Wall Varnish	Not rated in NMMA procedure
Cylinder Head	6%

Table 3. Example calculation of percent improvement from CRC piston ratings

	Start		100 hours				
	Cylinder No. 1	Cylinder No. 2	Cylinder No. 1	Cylinder No. 2	Cylinder No. 1 % Improvement	Cylinder No. 2 % Improvement	Percent Improvement
Piston Skirt	8.6	7.9	9.9	9.7	16	22	19

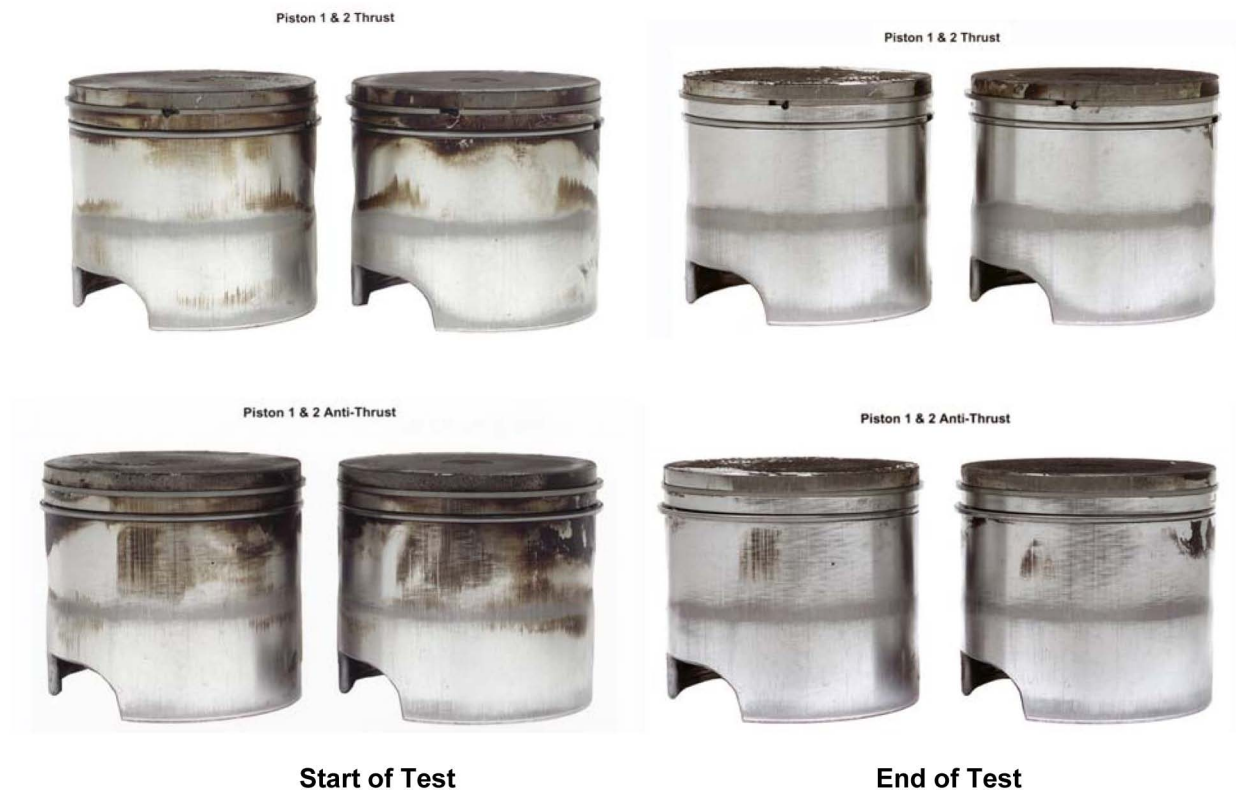


Figure 1. Comparison of Pistons from OMC 40 HP Test