

FIELD STUDY



Marine E-TEC™ Field Study

AMSOIL HP Marine Synthetic 2-Stroke Oil provides excellent protection in Evinrude® E-TEC marine engines programmed to the lean-mix setting.



Overview

Evinrude® E-TEC™ marine engines are unique in that they offer an alternative, lean-mix setting that allows the engine to use less oil. Whether programmed to operate at the standard mix ratio or reprogrammed to the lean-mix setting, E-TEC engines use sophisticated electronic equipment to monitor conditions, including rpm and throttle position, to determine the appropriate gas-to-oil mixture. To use the lean-mix setting, however, customers must have their engines reprogrammed by an Evinrude dealer and agree to use Evinrude XD100™ oil exclusively, often at a higher cost compared to other oils. Bombardier Recreational Products (BRP®), the manufacturer of Evinrude E-TEC engines, has not established a performance specification against which to qualify other oils.

Objective

Determine through real-world field validation if AMSOIL HP Marine™ Synthetic 2-Stroke Oil meets the increased performance needs of reprogrammed Evinrude E-TEC engines operating on the lean-mix setting. Further determine if consumers can safely use HP Marine Synthetic 2-Stroke Oil in E-TEC applications in place of Evinrude XD100 2-Cycle Oil.

Methodology

In conducting this field study, AMSOIL partnered with SEA-TOW®, a marine rescue organization specializing in non-emergency calls for assistance. Based in Naples, Fla., SEA-TOW typically tows large marine vessels, including yachts and sport cruisers. The engines that power their towing vessels routinely encounter heavy-duty, high-stress operation and provide the ideal environment for testing motor oils.

Both Evinrude 250 hp E-TEC engines used in the study were initially operated on the standard oil injection setting for 28 hours. An Evinrude dealer then reprogrammed both engines to operate on the lean-mix setting for the duration of the study. The starboard engine's oil reservoir was filled with AMSOIL HP Marine Synthetic 2-Stroke Oil, the portside engine's oil reservoir with Evinrude XD100 2-Cycle Oil.

The validation period lasted a total of 534 hours; approximately 240 hours were spent under severe-service conditions when the SEA-TOW boat towed marine vessels. The engines were closely monitored for the duration, and upon completion, both were disassembled and rated by a calibrated ASTM rater who evaluated each engine based on NMMA TC-W3 criteria for two-cycle marine engines. Merit ratings for each set of components (e.g. piston skirts, piston rings, etc.) were determined using the appropriate techniques and rating scales as defined in the Coordinating Research Council, Inc. *Deposit Rating Manual No. 20*. The evaluation included an examination of the condition of all engine parts. Some components received a merit rating based on a 1-10 scale, with 10 representing a component free of defects and 0 representing catastrophic distress. Others received merit ratings indicating the percentage of an area with defects (e.g. the percentage piston skirt area containing scuffing). The average merit rating of each group of components is shown in this study.

Piston Skirts

Portside of engine using AMSOIL HP Marine



Portside of engine using Evinrude XD100



Starboard side of engine using AMSOIL HP Marine



Starboard side of engine using Evinrude XD100



AMSOIL HP Marine Synthetic 2-Stroke Oil

Piston Varnish	8.52
Piston Skirt Condition (scratching)	1.42%
Piston Scuffing	0.00%

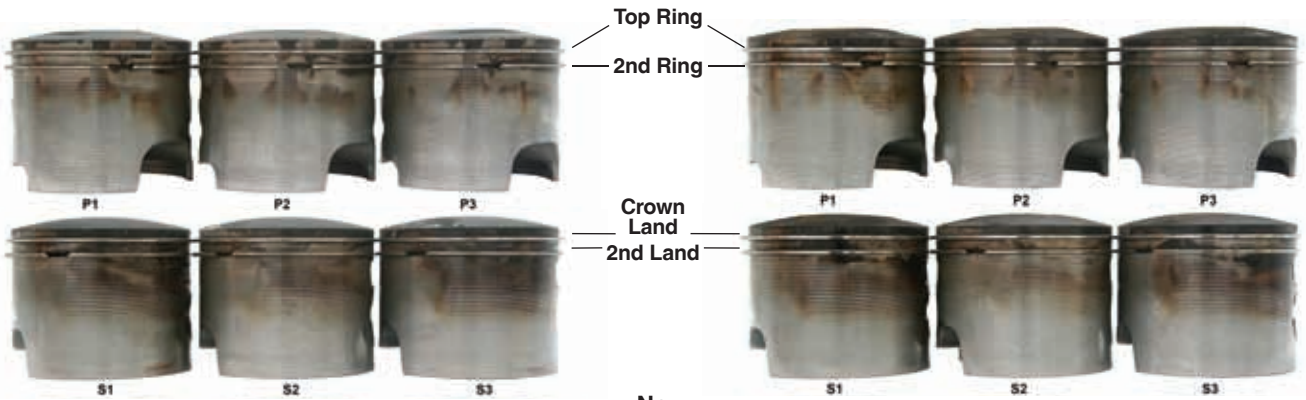
Evinrude XD100 2-Cycle Oil

Piston Varnish	8.57
Piston Skirt Condition (scratching)	1.25%
Piston Scuffing	0.00%

The pistons in both engines received nearly identical high merit ratings for varnish, indicating both oils excelled at inhibiting varnish formation.

Scratching refers to the alteration of the skirt surface in the form of sharp linear depressions from lapping of mating surfaces by fine particles suspended in the lubricant, fuel, air or imbedded in a surface, while scuffing appears as a matte finish. The presence of scuffing is commonly lubricant-related. In both engines, scratching was present at trace to very light levels, represented by the low percentage ratings. Both oils completely prevented piston skirt scuffing, earning perfect ratings of 0.00 percent scuffing.

Piston Rings & Lands



AMSOIL HP Marine Synthetic 2-Stroke Oil

Top Ring Sticking & Deposits	10.00
Second Ring Sticking & Deposits	10.00
Crown Land Deposits	3.98
Second Land Deposits	5.91

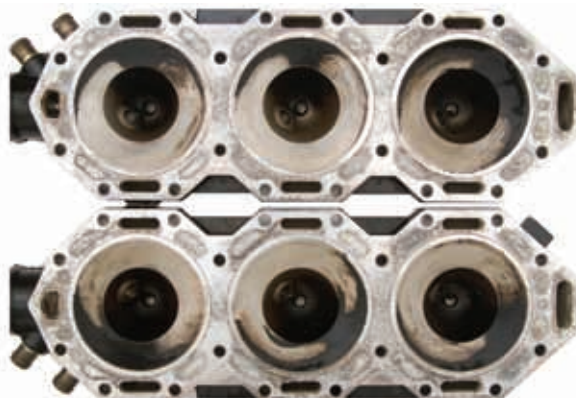
No differentiation is made between thrust side and anti-thrust side for ring and land deposits.

Evinrude XD100 2-Cycle Oil

Top Ring Sticking & Deposits	10.00
Second Ring Sticking & Deposits	10.00
Crown Land Deposits	2.99
Second Land Deposits	6.82

Deposits on the piston rings can cause ring sticking and consequent power loss. The top rings and second rings in both engines earned perfect merit ratings of 10.00, demonstrating no piston ring deposits. Merit ratings for crown land and second land deposits were similar for both engines.

Cylinder Heads



AMSOIL HP Marine Synthetic 2-Stroke Oil

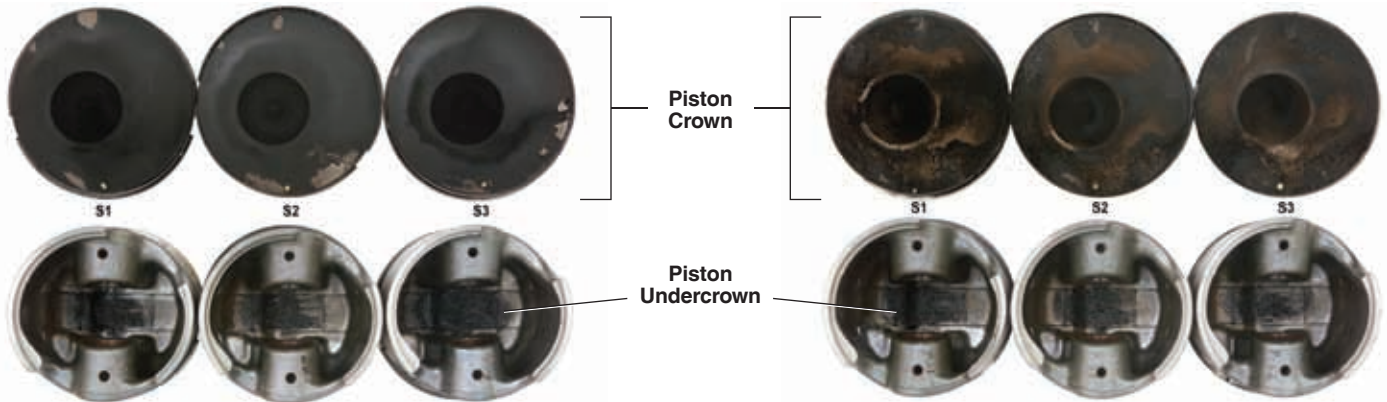
Cylinder Head Deposits	8.76
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Evinrude XD100 2-Cycle Oil

Cylinder Head Deposits	8.14
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Excessive cylinder head deposits are undesirable and can negatively affect engine performance. Both oils earned high ratings for deposit control, indicating good cleanliness properties.

Piston Crowns & Undercrowns



**AMSOIL HP Marine
Synthetic 2-Stroke Oil**

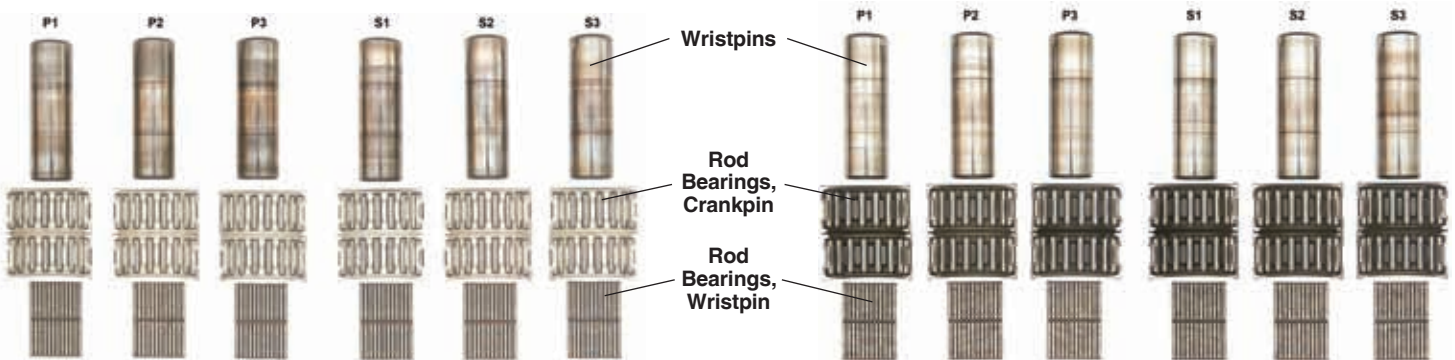
Piston Crown Deposits	7.02
Piston Undercrown Deposits	2.18

Evinrude XD100 2-Cycle Oil

Piston Crown Deposits	6.31
Piston Undercrown Deposits	2.66

While undercrown deposits do not impede performance, heavy piston crown deposits can cause preignition and consequent poor performance. Two-cycle oils must resist heavy deposit formation on the piston crown caused by the high temperatures inside the combustion chamber. HP Marine demonstrated strong performance in the area of piston crown deposits.

Connecting Rod Assemblies



**AMSOIL HP Marine
Synthetic 2-Stroke Oil**

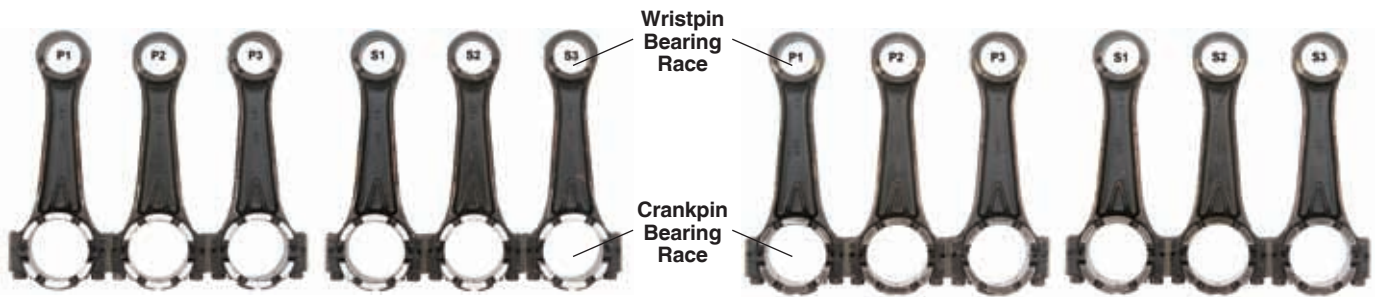
Wristpin: Condition/Deposits	6.82
Rod Bearing, Crankpins: Condition/Deposits	9.90
Rod Bearing, Wristpins: Condition/Deposits	8.38

Evinrude XD100 2-Cycle Oil

Wristpin: Condition/Deposits	8.38
Rod Bearing, Crankpins: Condition/Deposits	9.88
Rod Bearing, Wristpins: Condition/Deposits	7.62

Connecting rod assembly components are exposed to elevated temperatures and pressures that can rupture the oil film, leading to metal-to-metal contact and wear. The wristpins, crankpin rod bearings and wristpin rod bearings in both engines demonstrated trace to light levels of wear and were found to be in "good" condition according to the calibrated ASTM rater. Deposits on all components were limited to levels not adversely affecting performance.

Connecting Rods



AMSOIL HP Marine Synthetic 2-Stroke Oil

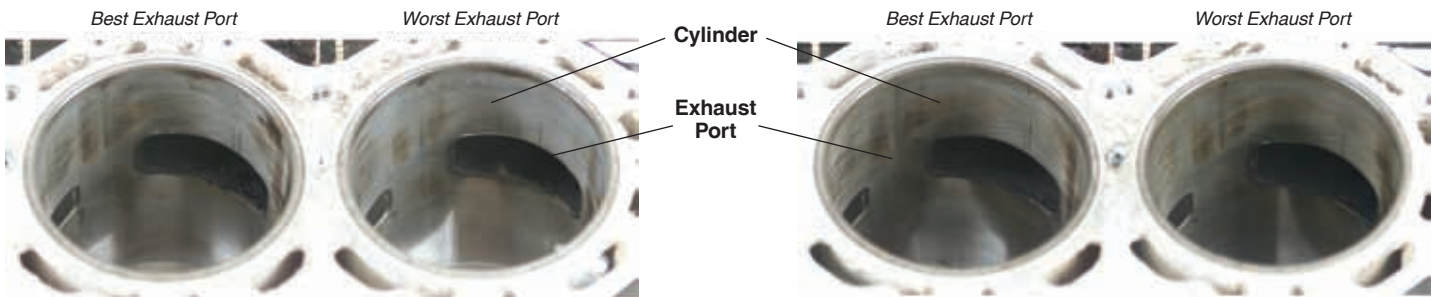
Wristpin Bearing Race: Condition/Deposits	7.90
Crankpin Bearing Race: Condition/Deposits	9.67

Evinrude XD100 2-Cycle Oil

Wristpin Bearing Race: Condition/Deposits	7.98
Crankpin Bearing Race: Condition/Deposits	9.73

The wristpin and crankpin bearing races undergo constant rotational stress, inviting wear. Bearing races in both engines demonstrated trace to light levels of wear and were found to be in "good" condition according to the calibrated ASTM rater. Deposits were limited to low levels in both engines.

Cylinders



AMSOIL HP Marine Synthetic 2-Stroke Oil

Exhaust Port Blocking	1.08%
Exhaust Port Deposits	9.89
Cylinder Bore Scuffing	0.00%

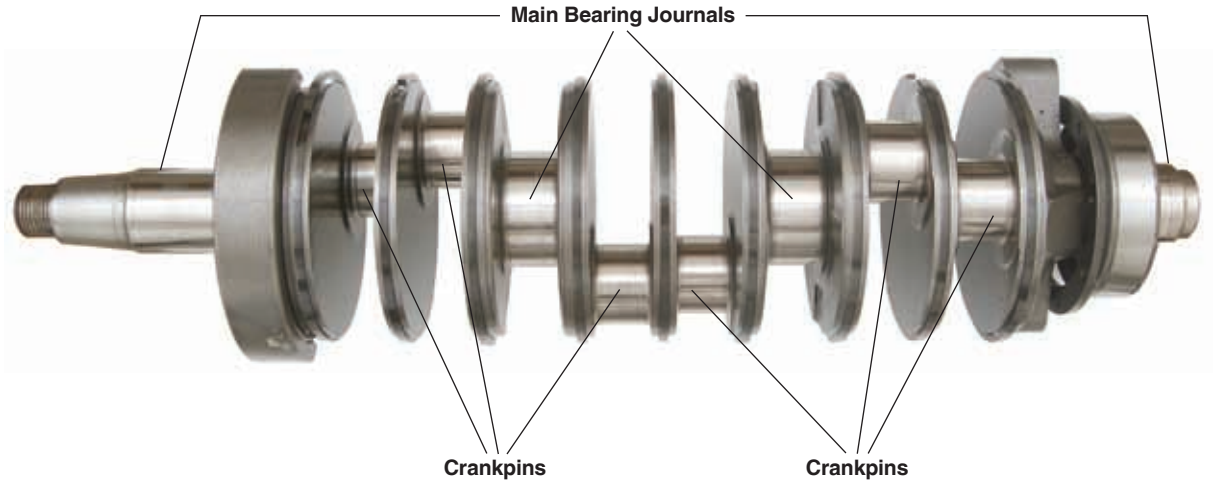
Evinrude XD100 2-Cycle Oil

Exhaust Port Blocking	1.17%
Exhaust Port Deposits	9.88
Cylinder Bore Scuffing	0.00%

Carbon deposit buildup in the exhaust ports restricts air flow and can cause reduced power and poor overall performance. Both engines displayed virtually no exhaust port blocking, represented by the low percentages. Deposits were likewise minimal, with ratings near perfect 10s.

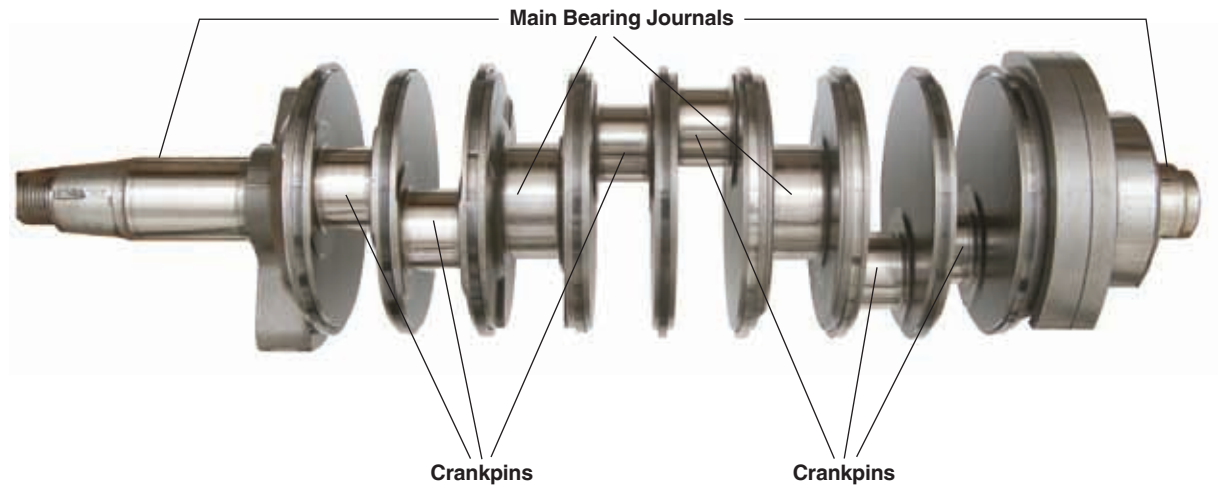
In the area of cylinder bore scuffing, both oils limited metal-to-metal contact and achieved perfect scores of 0.00 percent. The cross-hatch pattern remains visible on the cylinder walls of both engines.

Crankshafts



AMSOIL HP Marine Synthetic 2-Stroke Oil

Crankshaft Crankpin: Condition/Deposits	9.85
Crankshaft Main Journal: Condition/Deposits	9.78



Evinrude XD100 2-Cycle Oil

Crankshaft Crankpin: Condition/Deposits	9.85
Crankshaft Main Journal: Condition/Deposits	9.78

The crankpins and main bearing journals experience elevated pressures during operation and represent common suffering points. In both engines, the crankpins and main bearing journals demonstrated trace to light wear and were found to be in "good" condition according to the calibrated ASTM rater. Ratings for deposits were nearly perfect for both engines.

Main Bearings



AMSOIL HP Marine Synthetic 2-Stroke Oil

Crankshaft Main Bearings: Condition/Deposits	9.95
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Evinrude XD100 2-Cycle Oil

Crankshaft Main Bearings: Condition/Deposits	9.89
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The main bearings experience intense pressure and represent a common area where metal-to-metal contact can occur. Both oils limited wear to trace to light levels and the bearings were found to be in “good” condition according to the calibrated ASTM rater. Both oils nearly eliminated deposits as well.

Conclusion

As demonstrated in real-world, severe-service testing, AMSOIL HP Marine™ Synthetic 2-Stroke Oil meets the stringent performance needs of Evinrude® E-TEC™ marine engines programmed for reduced oil consumption. Operated simultaneously with an engine lubricated with Evinrude XD100, an identical engine lubricated with HP Marine demonstrated strong performance and excelled in critical-component lubrication. The cylinder bores, for example, demonstrated 0.00 percent scuffing, while the main bearings demonstrated only trace to light wear. The engine also displayed no ring deposits, earning perfect merit ratings. Finally, HP Marine effectively limited deposits throughout the engine and met the increased performance demands required by the lean-mix setting. Results prove the effectiveness of AMSOIL HP Marine Synthetic 2-Stroke Oil in Evinrude E-TEC applications.

AMSOIL fully supports the use of HP Marine as a replacement for Evinrude XD100 in Evinrude E-TEC engines, and warrants its use according to the AMSOIL Limited Liability Warranty (G1363).



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