E15 Outboard Marine High Ethanol Fuel Endurance

A study of the effects of running gasoline with 15% ethanol concentration in current production outboard four-stroke marine engines and conventional two-stroke outboard marine engines.

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GENUINE INGENUITY

Overview

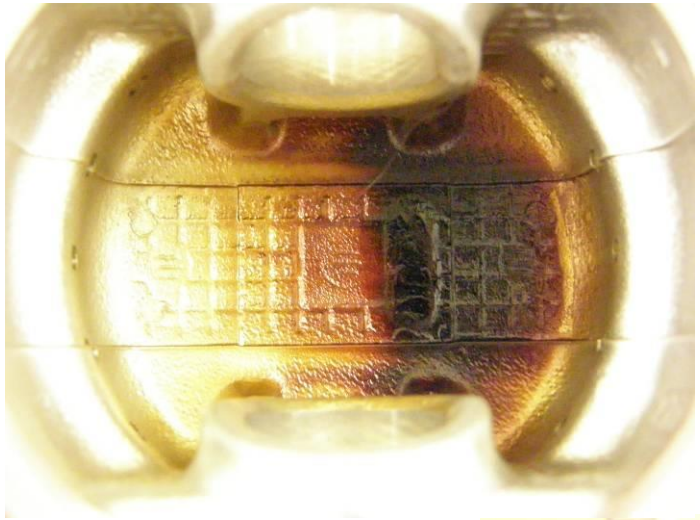
- **Test Objective: Run 300 hours of wide-open throttle (WOT) endurance on 3 engine families.**

  - Two engines from each family: One on E15 (15% ethanol blend fuel) and the other on pure gasoline.
    - 9.9HP 4-stroke carbureted,
    - 300HP Supercharged 4-stroke “Verado”,
    - 200HP 2.5L 2-stroke EFI (represents “legacy” product)
    - Engine selection was reviewed and approved by NREL Technical Monitor

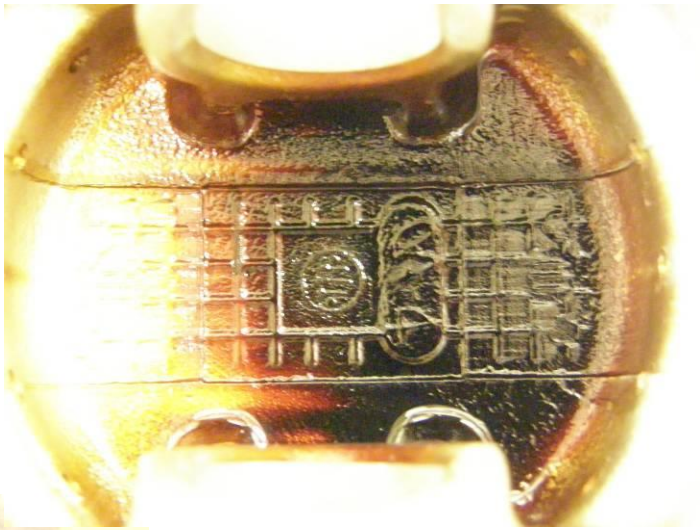
  - Test standards used were common qualification tests.
    - Test regimen was reviewed and approved by NREL Technical Monitor

9.9HP Carbureted 4-Stroke

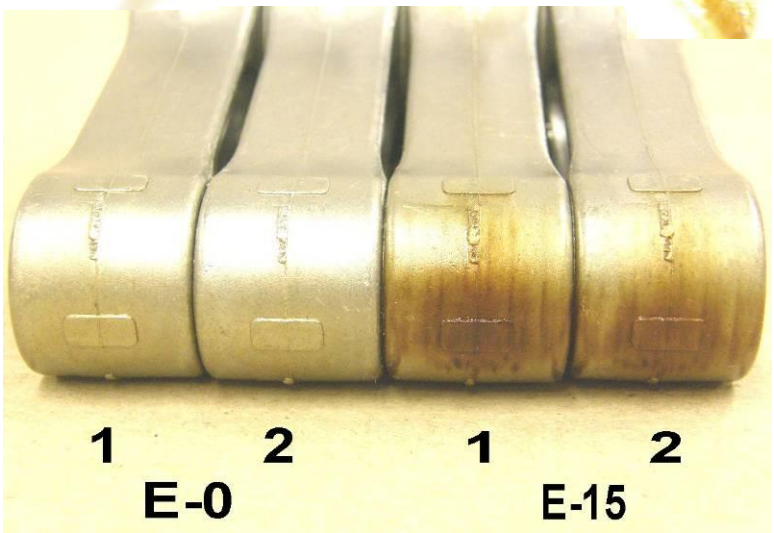
- **More carbon deposits on piston underside and rods of E15 engine.**



E0

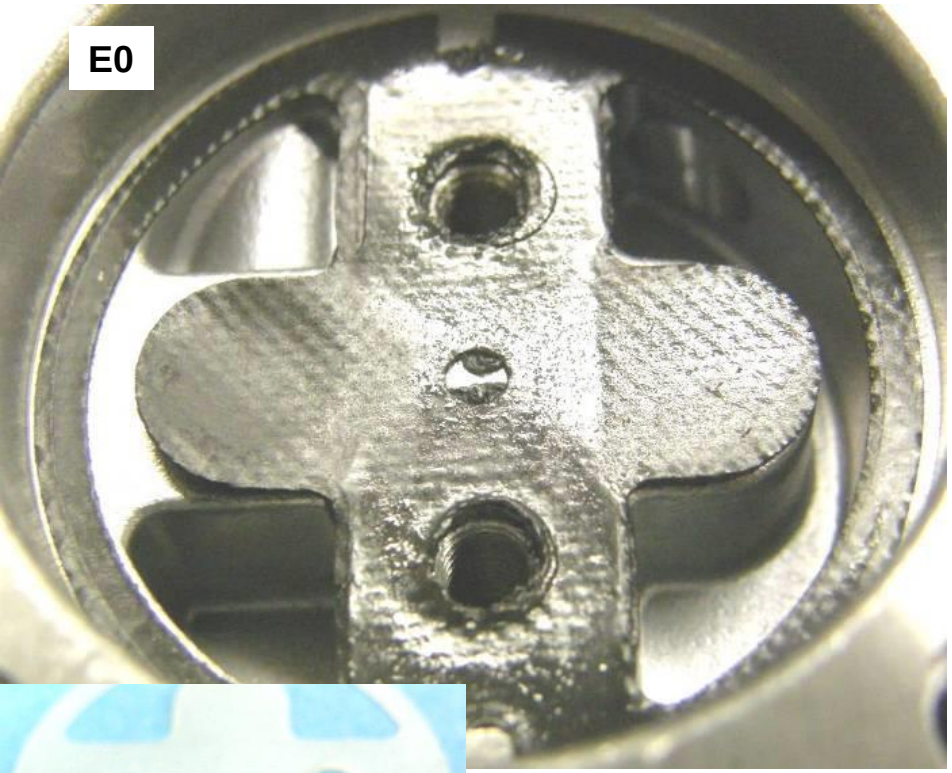


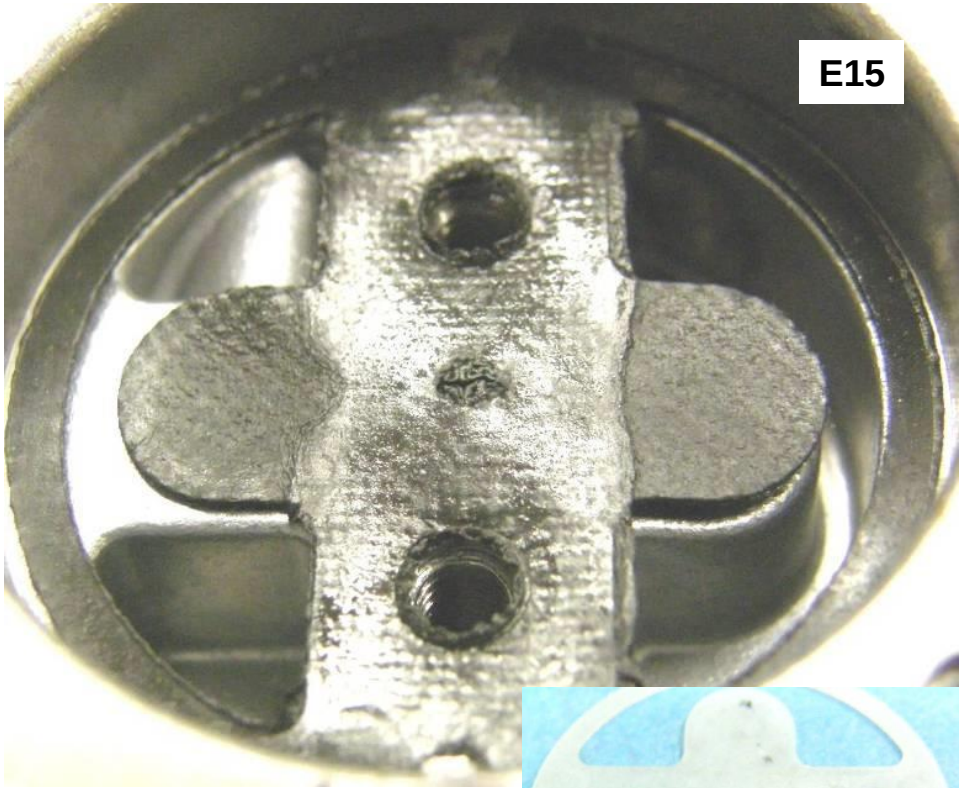
E15

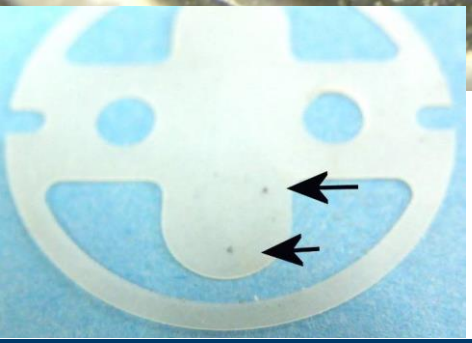


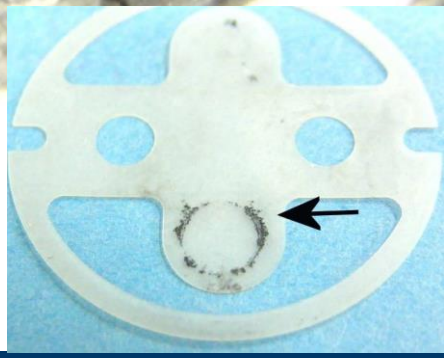
9.9HP Carbureted 4-Stroke

- **The fuel pump gasket showed signs of deterioration on the E15 engine compared with the E0 (pure gasoline) engine.**





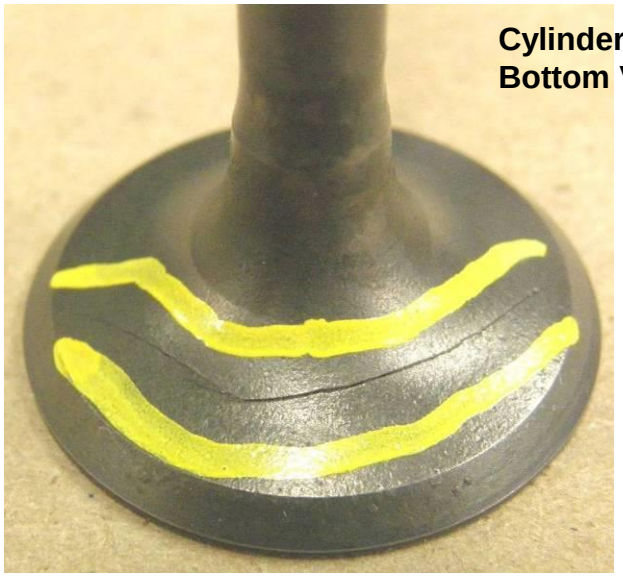




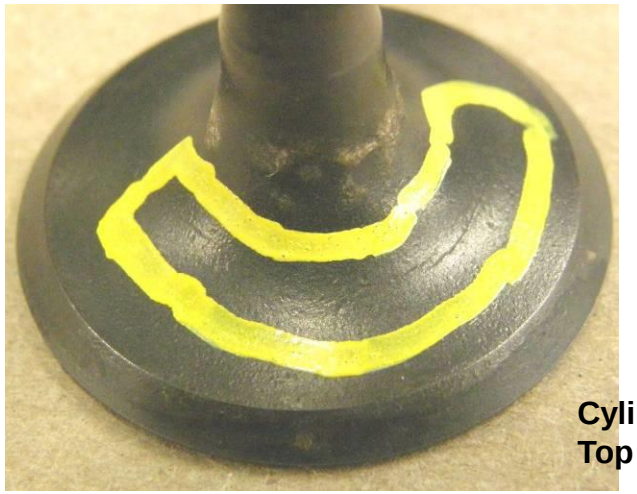
- **Material transfer from gasket to check valve in fuel pump.**

300HP Supercharged 4-Stroke “Verado”

Cylinder 3
Top Valve



Cylinder 3
Bottom Valve



Cylinder 6
Top Valve

300HP Supercharged 4-Stroke “Verado”

- **Carbon deposits may indicate that the E15 engine’s pistons and connecting rods were hotter during operation than those in the E0 engine.**

E0

E15

200HP EFI 2.5L 2-Stroke

Recovered Pieces from Failed Rod Bearing

Undamaged Bearing

Undamaged Rod **Damaged Rod**

Conclusions and Recommendations Summary

- **Despite the limited scope of the project several significant issues were discovered.**

- **More testing is necessary to understand effects on:**
  - Lubrication system in 2-stroke engines
  - "Driveability"- Examples: cold and hot start, acceleration, deceleration, etc.
    - Similar testing by Volvo Penta indicated difficulty starting the E15 engine.[1]
  - Storage (phase separation, corrosion, etc.)

Source 1: M. Cahoon, R. Kolb, and G. Zoubul, *Volvo Penta 4.3 LG E15 Emissions and Durability Test*, NREL SR-5400-52577, October 2011