MATERION

REDUCE EMISSIONS, NOT PERFORMANCE:

ADVANCED MATERIALS ENABLE EFFICIENCY GAINS WITHOUT SACRIFICING ENGINE PERFORMANCE

Government-mandated reductions in fuel consumption and emissions are forcing designers to consider new technologies to increase engine efficiency. To demonstrate the advantages of applying to passenger car engines, a suite of materials currently used in performance and racing engines, Materion Inc. has partnered with Cosworth Ltd. UK to redesign components and perform comparative testing on a commercially available, turbocharged passenger car engine. An overview of the results to date is contained here.

Baseline Engine: Ford 2.3l EcoBoost, as used in the Focus RS in Europe and the Mustang in North America.

ADVANCED MATERIALS APPLIED BY COMPONENT (MATERION BOTTOM-END)

- Pistons and connecting rods: SupremEX® Al-SiC composite
  50% stronger than Al with comparable density
- Piston top rings: PerforMet® alloy
  Thermal conductivity of aluminum, strength of steel
- Small-end bearings: ToughMet® alloy
  Low friction of Pb-containing alloys, strength of steel

DESIGN CHANGES ENABLED

- Crevice volume reduced by 0.36 cc (58.2% smaller)
- Rod + piston + pin mass reduced by 340 g (31.6% lighter)
- Rod length increased by 5.0 mm (3.3% longer)
- Skirt length (oil ring relief to bottom) reduced by 4.3 mm (13% shorter)
- Piston-guided rod

TESTING COMPLETED TO DATE

- Dynomometer testing of 18-point engine map: Materion bottom-end versus baseline
- Motored friction testing of Materion bottom-end versus baseline
- Motored friction testing of Materion bottom-end before and after removal of balance shaft

GAINS DERIVED

Dyno testing of Materion bottom-end compared to baseline

- Brake-specific fuel consumption (BSFC) reduced by up to 3.1% (see figure 1)
- Hydrocarbons appear to be significantly reduced; more testing required to quantify

Motored friction testing of Materion bottom-end compared to baseline (see figure 2)

- 3.9% to 5.9% friction reduction (-0.9 Nm at 2000 rpm; -3.6 Nm at 6000 rpm)

Motored friction testing of Materion bottom-end with balance shaft removed versus installed (see figure 2)

- Additional 2.9% to 5.1% friction reduction (-0.9 Nm at 2000 rpm; -2.1 Nm at 6000 rpm)

FIGURE 1. BSFC REDUCTION: MATERION BOTTOM-END VERSUS BASELINE

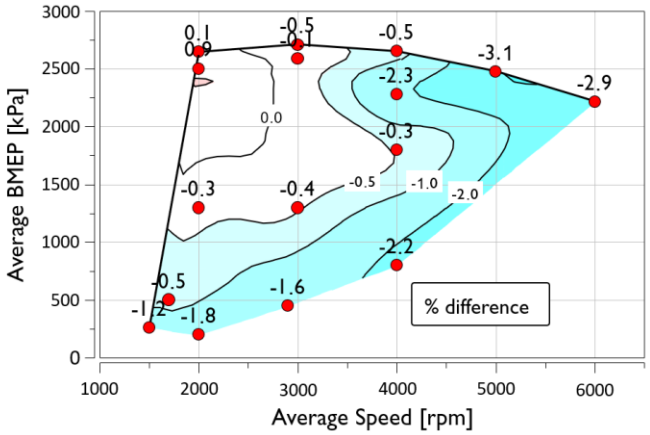
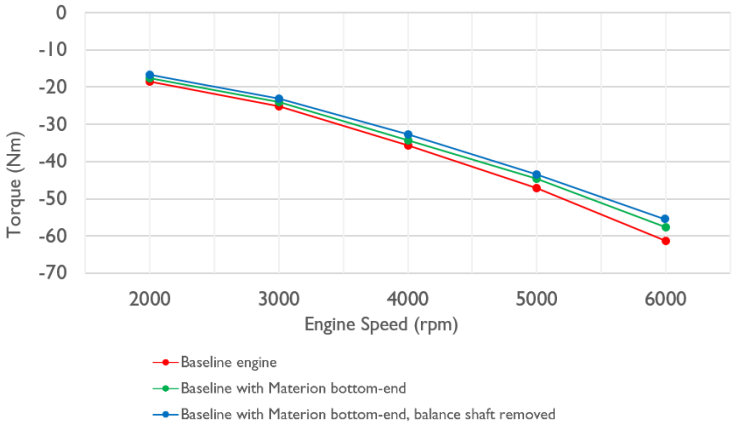


FIGURE 2. MOTORED FRICTION TESTING



FUTURE TEST PLANS

- Materion engine test: PerforMet valve seats and valve guides installed and tested with Materion bottom-end
- Further studies of potential thermal gains
- Isolation testing to determine the contributions of individual components
- Endurance testing of the Materion engine

UPCOMING PRESENTATIONS IN 2020

- **SAE World Congress & Exhibition** | Detroit | April 21-23
- **Sustainable IC Engine Symposium** | Stuttgart | June 16-18
- **Aachen Colloquium** | Aachen | October 5-7

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