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MITIGATING LSPI OVER THE OIL DRAIN INTERVAL

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Lubrizol

LUBRIZOL DEVELOPS A THREE-PART PROPENSITY AND DURABILITY TEST EVALUATING FRESH AND USED OIL PERFORMANCE TO PREVENT THE HARMFUL EFFECTS OF LOW-SPEED PRE-IGNITION.

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Low-speed pre-ignition

A three-part propensity and durability test evaluates fresh and used oil performance to prevent the harmful effects of low-speed pre-ignition

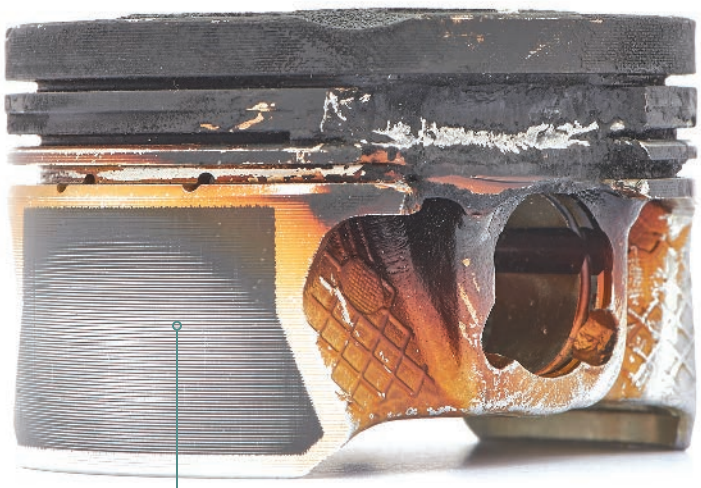
The automotive industry's acknowledgment of the harmful effects of low-speed pre-ignition (LSPI) and the recent licensing of new API SN Plus specification is now reducing this harmful, sometimes catastrophic event in turbocharged gasoline direct-injected (TGDI) engines.

However, it is important to note that the new specification only evaluates the performance of fresh-oil LSPI. Recent studies have found that LSPI propensity can change over an oil drain interval. Although the API SN Plus tests effectively quantify LSPI propensity of fresh oil, they do not quantify the LSPI propensity of aged oil. This is an important distinction as engine oil and chemical additives change and degrade over time.

Researchers are now starting to introduce the concept of LSPI durability, defined as the ability of an engine oil to resist LSPI over a relevant oil drain interval (ODI). To quantify LSPI durability, an engine test methodology that evaluates LSPI on fresh oil, then ages the oil using a relevant duty cycle, then finally re-evaluates the aged oil for LSPI propensity, was developed. Using this three-part testing protocol, researchers are finding that not all formulation strategies that mitigate LSPI as fresh oil also provide LSPI reduction once the oil is aged.

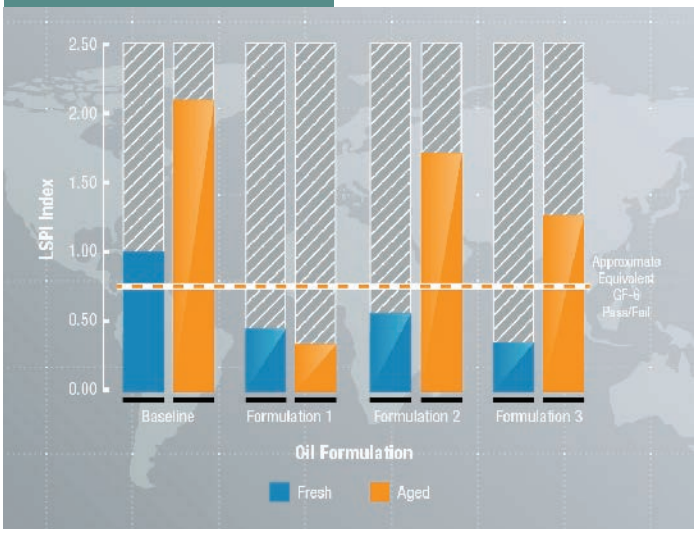
"We thought it was important to go beyond standard tests to fully understand LSPI propensity and durability in both fresh and used oils. This helps us formulate a solution that we are confident can truly mitigate harmful LSPI in TGDI engines throughout the oil drain interval," says Alex Michlberger, lead technologist for passenger car engine oil testing at Lubrizol.

To that end, a specialized engine dynamometer test cycle was developed to age the oil between fresh and aged LSPI tests. To ensure real world relevance, this cycle was based on the World Harmonized Light Vehicle Transient Cycle (WLTC). The testing protocol included LSPI evaluation followed by 100 hours of aging, followed by a second LSPI test on each oil. In this manner, both the fresh and aged LSPI propensity of each engine oil was evaluated.



Low-speed pre-ignition can cause significant damage to the pistons of an TGDI engine

Four oil formulas – both fresh and aged – were tested for low-speed pre-ignition mitigation. The findings showed that LSPI propensity often increased significantly in aged oils



A total of four oils were tested: a baseline oil – all calcium detergent system (poor LSPI performance); Formulating solution 1 – calcium is reduced and magnesium is added; Formulating solution 2 – molybdenum dialkyldithiocarbamate (MoDTC) is added; and finally Formulating solution 3 – the addition of titanium.

The results of the tests found that all three formulation strategies were successful at mitigating LSPI in fresh oil; however, following the aging process, the propensity of LSPI was observed to be very different. Both formulation 2 and 3 showed very poor LSPI durability, while formulation 1 was the only oil to continue to mitigate LSPI when aged.

"This is an important finding – that not all oils which pass a fresh oil certification test may mitigate LSPI over the full oil drain interval," concludes Michlberger.

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