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LOW FRICTION RING PACK FOR GASOLINE ENGINES

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ABSTRACT

Lower emissions, reduced friction and low lubricant oil consumption are the main drivers for new gasoline engines. In terms of piston ring pack, the trend is to reduce ring tangential load and width. On the other hand, the main concern is to have proper ring conformability and lube oil control. This work presents the comparison of a baseline ring pack with a low friction pack in terms of friction, blow-by control and lube oil consumption. Besides ring width and tangential load reductions, evaluations of ring materials are also carried out.

Narrow compression rings, 1.0 and 0.8 mm, were engine tested. PVD top ring was also tested and showed about 10% friction reduction compared to the usual Gas Nitrided one. 3-piece 1.5 mm oil rings were compared with the usual 2.0 mm ones. Being more flexible, the narrower oil rings can have same conformability with reduced tangential load.

Friction was measured in the mono-cylinder SI Floating Liner engine at 5 operational conditions. Effect of cylinder roughness on friction is discussed by reciprocating bench tests.

Compared with a typical 1.2/1.2/2.0 mm SI ring pack, the proposed 1.0/1.0/1.5 mm pack brought about 28% reduction in ring friction in the tested conditions, which would mean in about 1% of fuel savings in urban use.

NOMENCLATURE

BMEP: Brake Mean Effective Pressure [kPa]
FMEP: Friction Mean Effective Pressure [kPa]
Ft: Ring Tangential Load [N]
h: Ring width [mm]
hs: segment width [mm]
IS: distance between segments [mm]
OCR: Oil Control Ring
P_0: Ring Unitary Pressure [MPa]
PVD: Physical Vapor Deposition
w: Expander Wire Width [mm]

INTRODUCTION

Mechanical losses in an internal combustion engine account for approximately 10% of the total energy of the consumed fuel. This amount represents around 25% of the effective power at full load, more at part loads. At idle or no-load, 100% of the indicated power is consumed by friction. The piston and the piston rings are the largest contributors to the mechanical losses, but the relative share varies with engine type and load condition. Fig.1 shows the energy distribution for a 2.0L SI engine at full load/5000 rpm.

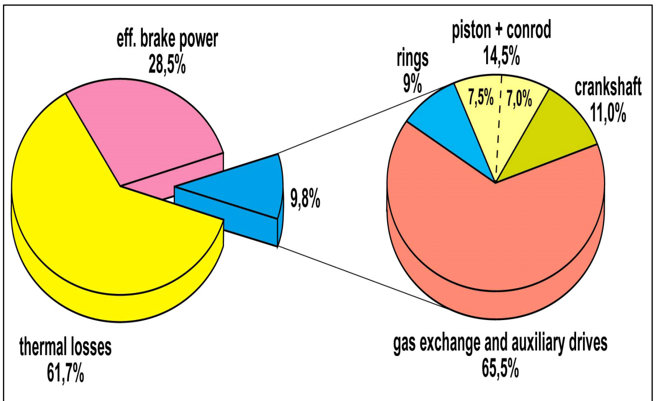

Fig.1- Breakdown of total energy distribution and engine mechanical losses [1].

The search for reducing friction is continuous, but the interest for low friction components has increased recently, especially sparked by the fuel price increase and more rigorous emissions legislation. A common question during engine design is “how much friction reduction / fuel economy can be expected from a given design change”. Fig.2 shows a rough estimation based on total friction, but it remains difficult to estimate the benefits of a given design change, e.g. lower ring Ft or reduced piston skirt area. Simulations can be done to address single design changes, that later can be engine tested in a complete design pack. An

