

CYLINDER BORE HONING PATTERN OPTIMIZATION FOR IMPROVED ENGINE FRICTION AND WEAR

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ABSTRACT

Friction between power cylinder components such as piston rings and cylinder bores is responsible for a significant part of total power loss in internal combustion engines. Fuel economy and emissions can be improved by reducing frictional losses. Piston rings experience a wide range of lubrication regimes in operation. In the mid-stroke, hydrodynamic regime is observed due to high speed and relatively lower pressure, whereas mixed lubrication occurs near top dead center as a result of peak firing pressure and lower speed. Squeeze film lubrication reduces the probability of metal-to-metal contact and wear in this case. In a typical piston ring and cylinder bore contact, smooth surfaces enhance hydrodynamic lubrication and reduce friction, wear and oil consumption. However, smooth cylinder bore surfaces are prone to scuffing due to starvation. Oil retaining and heat dissipating plateau honing patterns are necessary to maintain proper lubrication. Optimization of cross-hatched or textured cylinder bore patterns for improved friction, wear and oil consumption constitute a trust area for engine developers.

Patir and Cheng's average flow model with surface flow factors [1] has been used by many researchers to model rough surfaces, including piston and cylinder bore contacts with roughness orientation [2]. Surface flow factors compare flow in a rough bearing to that of a smooth bearing and obtained for roughness with Gaussian distribution and do not represent plateau honed cylinder surfaces. Several attempts have been made to model lubrication characteristics of honed cylinder bores [3].

In this study, three-dimensional surface patterns representing cross-hatched plateau honed cylinders (Fig. 1) were developed and used to calculate surface flow and shear factors for pressure driven and shear driven flows. Flow factors obtained by numerical simulations were used to calculate piston ring lubricant film thickness and friction for a heavy duty diesel engine using the existing piston ring and cylinder bore friction model [2]. The effects of various cross-hatch honing angles and

surface patterns on lubricant film thickness, load carrying capability and friction were investigated.

The results showed that low honing angles generate resistance to fluid flow and enhance hydrodynamic lubrication reducing asperity friction. However, oil film transported to combustion chamber also increases in low honing angles that will result in increased oil consumption due to evaporation.

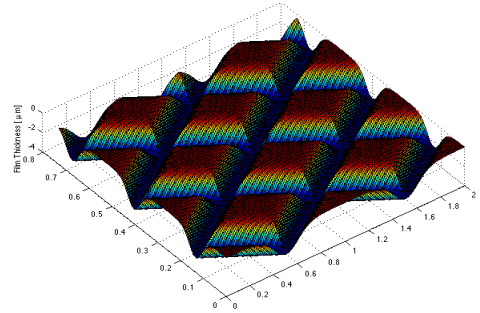


Fig.1 Generated plateau hones surface pattern.

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REFERENCES

- [1] Patir, N. and Cheng, H. S., "Application of Average Flow Model to Lubrication Between Rough Sliding Surfaces", ASME J. Lubrication Tech., 101, 1979, 220-230.
- [2] Akalin, O. and Newaz, G.M., "Piston Ring - Cylinder Bore Friction Modeling in Mixed Lubrication Regime: I. Analytical Results," ASME, J. Tribol., 123, 2001, 211-218.
- [3] Jocsak, J., Li, Y., Tian, T., and Wong., V.W., "Modeling and Optimizing Honing Texture for Reduced Friction in Internal Combustion Engines," SAE Paper, 2006-01-0647, 2006.