Assessment of asperity coefficient of friction for various coating materials used in piston ring/liner conjunction using AFM

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The piston ring/cylinder liner conjunction can experience various regimes of lubrication during piston strokes inside the engine cylinder. In the current engines, the nature of lubrication usually remains hydrodynamic at mid-stroke whilst a mixed regime of lubrication may be experienced at and near reversals. The direct contact between the tips of some of the asperities of opposing surfaces leads to mixed (partial) regime of lubrication.

A model proposed by Greenwood and Tripp can be used to predict asperity level contribution to the total piston friction. At the same time Reynolds or average flow model equation can be employed to predict the portion of load carried by the lubricant trapped between the asperities. Friction between the asperity tips is usually proportional to the load that they support; stated in terms of a proportionality factor; i.e. coefficient of friction.

The surfaces are usually furnished with hard wear resistant coatings and in parts by solid lubricants. Both the piston rings and cylinder liner surfaces are usually coated. These coatings change the friction characteristics of the counterfaces because of their surface topography as well as material mechanical properties.

AFM is used to obtain surface topographical parameters in contact tapping mode. The corresponding surface topographical parameters are obtained from representative regional areas of the contacting solid surfaces, using a Talysurf. The combination of topography and coating characteristics are used to develop the necessary parameters for a boundary friction model.

A numerical model of the top compression ring to cylinder liner is developed based on mixed-hydrodynamic regime of lubrication. The results for friction and the effect of coating on the power loss and wear of the conjunction are discussed in the paper.

**Keywords:** Boundary friction; asperity interaction; piston-ring/cylinder liner contact