ABSTRACT

The functions of a piston ring are to seal off the combustion pressure, to distribute and control the oil, to transfer heat and to stabilize the piston. Most piston rings and metallic sealing rings for modern application require some form of coating, where running conditions are severe to minimise abrasion and corrosion. The piston ring coating improves the life of engine as well as fuel efficiency. In this study, three type of piston coating processes were investigated: Plasma Arc Spray, Hard Chrome Plating & Gas Nitriding. Plates with similar composition as the piston ring material were prepared by the casting process using induction arc furnace and sand mould. The plasma arc coating having composition with weight percentage 20 %(63) Mo, 10% (43) NiCr 10% (70) Cr3C2 60 % (350) Fe was used. Thermal spray process of the type plasma arc spray was used for the study along with hard chrome plating and gas nitriding, which are the preferred processes in the automobile industries. The cast iron substrate of same composition as of piston rings was used to get the similar result as in the engine cylinder piston combination. After preparation of the coating, the plate (90x90x2 mm) was prepared with the help of a surface grinder and a fixture was designed to hold the plate on the pin on disc machine. There are different wear tests such as scratch test, slurry abrasion test, erosion test and pin on the disc test. The selection of the wear test depends on the material of the coating and its applications. For marine applications of the coating, slurry erosion and corrosion test are preferred. But in case of dry applications of the coating the pin on disc and scratch test are commonly performed. In the present study two variables were selected for wear test: load (30, 40 and 50 N) and wear track (50, 60 and 70 rpm) keeping the sliding distance 1200 m and speed 500rpm constant. Wear test of the coating was conducted on pin on disc machine under dry conditions. The wear rate was calculated using mass loss methods on an electronic balance having least count of 0.0001g. The coefficient of friction was found with LVDT which elucidated the frictional force during wear test. The morphology of worn surfaces of the coating was analysed with scanning electron microscope. The XRD was done to determine the change in intermolecular spacing of the worn surfaces of the coating. The wear rate of the coating was found to be increased with increase in load as well as sliding speed for the plasma spray coating and gas nitriding but reverse trends were observed for the hard chrome plating. However, the co-efficient of friction of the coating was found to decrease with increased load and sliding speed for all processes. The d-spacing of the coating molecules on the wear track was found to decrease with increased load. The microstructure of the worn surfaces of the coating was also examined with optical telescope and no change in microstructure of the coating due to frictional heat was found. The micro hardness at the cross section of the coating at wear track was found to decrease when moving away from the wear track. The main wear mechanisms observed by scanning electron microscope were adhesion, deformation and microcutting. The wear rate depends on the load applied. With the increase of applied load the wear rate found to be increased except in the case of hard chrome plate with the tungsten carbide counter body. The Coefficient of friction was found to be decreased with the increase of load except in the hard chrome plating with the tungsten carbide pin.

Key words: Air Plasma spray, pin on disc, microstructure, wear rate, Hard chrome plating.