ABSTRACT

In the present era the major challenges the automobile industries face are to improve fuel economy, to reduce vehicle emissions, to increase styling and enhance vehicle performance. In order to address some of these issues Metal Matrix Composite (MMC) replaces number of conventional materials due to better mechanical, thermal and wear properties. MMC is a material made up with non-ferrous alloys as major constituent and ceramic or organic compound as reinforcements. The interfacial bonding between alloy and reinforcements enhances the mechanical and wear properties thus it replaces conventional aluminium alloy. It is proved to be an important class of materials which are being used in automotive, aerospace and marine applications. By improving its functional properties it can be further employed in many more applications. Due to their isotropic properties and feasibility of mass production it is used to manufacture automotive parts which are subjected to cyclic loading such as pistons, connecting rods and brake callipers. Automotive pistons are generally manufactured with LM13 eutectic (Si=12%) aluminium alloy because of its high strength, low thermal co-efficient, light weight, and good wear resistant properties. Pistons are always subjected to high mechanical, thermal and wear loads which induce thermal stresses results in failure of piston material. To overcome these problems the material must be strong enough and high wear resistant. In order to enhance the mechanical and wear properties of the piston
it is reinforced with silicon carbide and graphite ceramics to form metal matrix composites. The main aim of this research work is to produce and investigate mechanical and wear behaviour of LM13-SiC composite and LM13-SiC-Gr hybrid composite which may help in developing a new material for piston with enhanced mechanical and tribological properties. Although various reinforcements are used with aluminium alloys, Silicon Carbide (SiC) is a widely used reinforcement with aluminium alloys. SiC particulates enhance higher specific stiffness, strength, and hardness, while Gr particles impart improved self-lubrication property. This research may help in replacing LM13 piston with hybrid aluminium metal matrix composites (HAMMCs) piston to withstand high mechanical, thermal and wear loads.

For the present investigations the composites are manufactured by compocasting technique using stir casting method. The microstructure, surface fracture and surface contamination and elemental analysis on alloy and composites are performed using Field Emission Scanning Electron Microscope (FE-SEM). The mechanical behaviour of alloy and composites were investigated by conducting various tests as per standard. The dry sliding wear experiments were conducted using pin-on-disc apparatus to investigate the wear behaviour of alloy and composites. The wear experiments were conducted based on design matrix and wear rate of alloy and composites was recorded. The experiments were designed with full factorial Central Composite Design (CCD) by Response Surface Methodology (RSM) using Design Expert v10 software. The non-linear regression model was developed to predict the wear rate with a reasonable accuracy in terms of
actual factors. RSM was used to determine the optimum dry sliding wear parameters for a minimum wear rate of composites. Validation of the developed regression model was verified by conducting confirmatory test. The characterization study reveals the SiC particulates are uniformly distributed and graphite particles are agglomerated at some locations within the matrix. It is found that the mechanical properties have been improved in terms of hardness and strength when compared with unreinforced aluminium alloy. The statistical analysis reveals normal load is the most influencing parameter on wear rate of composites followed by reinforcement wt. %, sliding distance and sliding speed is the least influencing parameter. However from the studies it has been found that hybrid composite is more suitable for wear resistant applications.

**Keywords:** Hybrid Aluminium Matrix Composites, Silicon Carbide, Graphite, Compocasting, Dry Sliding Wear, Response Surface Methodology and Optimization.