ABSTRACT

Brake pads are one of the essential safety components in a braking system of an automobile. A brake pad is, typically, a combination of any friction material bonded with a steel back plate. Automobile brake friction materials are a constitution of multiple ingredients, in order to meet the desirable performance properties. Asbestos is known to be a 'harmful' content and banned for being used as an ingredient to produce brake pads because it can cause lung cancer and other health problems. There is always a need for the development of 'non-asbestos' Brake Friction Materials (BFM) that do not contain any toxic and noxious components. Development of bio-based (Eco-friendly) materials with desired properties is a trending subject of research across the globe.

Because the market is flooded with various options for brake pad materials, it is imperative that the vehicle manufacturers choose the right pad material with great care not only to ensure the optimal functioning of the braking system but also passenger safety. Mechanical and tribological properties of brake pads contribute greatly to their effectiveness. There is a requirement to choose the proper material for a certain application that has a consistent friction coefficient and reduced wear.

Copper is used as functional filler in various forms in the friction material formulation. Because of its hazardous impact to the aquatic life, a suitable replacement of Cu is the focus of this research.

The formulation of (BFM) requires the skills to select suitable ingredients and its optimized content to meet the multiple performance criteria. This includes achieving an adequate and stable friction coefficient (μ), lesser wear on the friction material, counter friendliness to the disc surface and minimizing its sensitivity to fade and recovery characteristics.

Among the various properties, resistance to fade is the most important aspect and difficult to achieve, also. In a Non-Asbestos Organic (NAO) brake friction material, binder resin, fillers, solid lubricants and some organic fibers degrade at elevated temperatures during the fade and, thereby, deteriorating the friction level. Hence, the influence of these ingredients on the tribological properties of a NAO brake friction material has to be studied.

In this research work, a detailed comparison was performed on the developed pads with the three commercially available brake pads viz. metallic, semi-metallic and Non-asbestos brake pads.

Initially, three commercially available brake pads for four-wheeler automotive applications were acquired. Samples were cut from the brake pads to study their physical and mechanical properties. The effects of friction and wear were analyzed using a pin-on-disk tribotester. Surface morphology on the worn-out surface of the brake pads was studied.

It was observed that the frictional properties remained stable and less fluctuating in the semi-metallic and NAO pads, whereas the coefficient of friction of all the pads ranged between 0.35 and 0.55. The wear rate of the metallic pads was less than that of NAO and semi-metallic pads. The surface morphology studies revealed that the metallic pads contained more primary plateaus and smaller amounts of secondary plateaus compared to semi-metallic and NAO pads, resulting in better wear resistance characteristics.

Three novel friction composite materials using Ground Granulated Blast Furnace Slag (GGBFS) as a suitable alternative for Cu were developed by increasing its Wt.% from 5% ,10% and 15% . The influence of GGBFS as a replacement of barytes in brake pads formulation to enhance the tribological performance was investigated.

The physical, mechanical and chemical properties of the developed friction composites were tested as per the industrial standards. The tribological properties were analyzed as per SAE J661 standard using the chase test rig. Initial studies revealed that the friction composite having 5% GGBFS exhibited better physical, mechanical and chemical properties with excellent frictional performance having minimal fluctuations even at higher temperatures.

However, the results showed that the friction composite containing 15 Wt. % GGBFS possessed a better wear resistance property compared with the other two composites due to the formation of tribo lubricating layer at the frictional interface. Scanning electron microscope (SEM) analysis was performed to understand the wear mechanism and tribo layer formations through topography studies.

Overall, the friction composite 5 % GGBFS exhibited less fade and better recovery, while those with 15 % exhibited the highest wear resistance. SEM images confirmed the presence of few primary plateaus, less back transfer of polymeric materials and fine debris, which avoid frictional undulations and made the pad to behave counter-friendly to the rotor surface.