Chapter 5
Tribology and Aluminium Matrix Composites

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ABSTRACT

Knowledge of tribology is very old but much attention has been paid only in the 20th century. It is science and technology of interacting surfaces in sliding, rolling, or any other kind of motion. Tribology includes knowledge of wear, friction, and lubrication, which is of much importance in designing of machine components. This chapter deals with an overview of friction, sliding friction, and contributing factors such as adhesion, ploughing, deformation, third body, time dependence, and mechanisms of friction in metallic materials. It also provides an overview of adhesive and abrasive wear and wear mechanism in mild and severe wear regime for metallic materials. Important material properties, environmental effects, and operating parameters have also been highlighted. In the last section, the importance of Particle Aluminium Matrix Composites (PAMCs) with soft and hard dispersion is explained with the help of operative wear mechanisms.

The present situation of wear has been stated as a complex jigsaw puzzle. Pieces fit together here and there but the overall pattern is far from clear. Rigney et al (1984)

1. INTRODUCTION

Documents are available for bearing applications providing low friction even in early days of human existence (Dowson, 1979; Stachowiak, 2005) and available evidences suggest that the knowledge of friction was available since the late 16th century. Tribology comes from a Greek word 'Tribos'

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which means ‘rubbing’ of surfaces. Rubbing of a surface may take place when it is in relative motion with another solid object or liquid or gas with solid particles. Under such situations friction and wear are observed and to minimize them some kind of lubrication (solid, fluid, gaseous) is required. Hence, tribology is the science and technology of wear, friction and lubrication because in any mechanical system all three are important. However, depending on situations and applications wear and friction both may be desirable or undesirable or one of these may be desirable and other one undesirable which becomes evident from the Table 1 (Stachawiak, 2005).

Though the evidences of knowledge of tribology are available for long but it has been very limited. Extensive knowledge has been gained only after Second World War. It becomes a need of the hour for tribologists to put extra effort in minimizing wear and friction. It is estimated that the losses as waste of energy due to friction and in the form of wear as production losses due to mechanical failure of machine components, are of the tune of millions of millions £ every year.

These losses cannot be minimized just by providing proper lubrication, it requires proper designing of materials keeping in mind the properties requirement for a particular applications. It has become very difficult for metallurgists to provide a metal or monolithic alloy with combination of such a wide range of properties to fulfill the today’s demand, but composites and nano-composites have the capability to fill the gap to a large extent. It is simply because composites are materials made up of two or more constituent materials with significantly different physical or chemical properties. When they are combined together, they provide a material which is characteristically different from the individual components and superior in properties. The individual components remain separate and distinct within the finished product. Composites are preferred for their high strength to weight ratio, low specific gravity, low cost etc. over traditional materials.

This chapter presents an overview of friction and wear with emphasis on adhesive and abrasive wear. Though the large numbers of materials have been used in tribological applications but this chapter emphasizes only on tribology of particle aluminium matrix composites (PAMCs).

2. FRICTION

Friction is the loss of energy in the form of dissipation while bodies are in contact during sliding or rolling motion. Da Vinci was the first known who introduced friction but nearly two hundred years later Amonton provided a clearer picture of friction. He initiated work in this area and provided few laws. Amonton proved the basic laws experimentally in 1699 and Coulomb added one more law later in 1785. According to Coulomb when machine parts are in motion, sliding velocity doesn’t affect coefficient of friction (Bhushan, 1999). Much later in twentieth century Dowson (1979), Bowden & Tabor (1998) and Ludema (1964) contributed immensely in this area. The main laws of friction are (Stachowiak, 2005):

- When a static body is subjected to increasing tangential load, proportionality exist between maximum tangential force before sliding and the normal force,

Table 1. Wear and friction applications

Application	Required level of	
	Friction	Wear
Braking systems and clutches	High	Low
Pencils	Low	High
Tyres	High	Low
Erasers	High	High
Bearings, Pistons	Low	Low

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