CHAPTER 6

COMPARATIVE STUDY OF TRIBOLOGICAL BEHAVIOUR IN DRY AND LUBRICATING SLIDING CONDITION

6.1 INTRODUCTION

This chapter deals with the comparative study of tribological properties of ZA alloy and composites in dry and lubricating sliding conditions. Purpose of this chapter is to look into the widening of possible applications of present composite. Hence, variation in wear and COF has been compared in dry and lubricating conditions.

6.2 COMPARISON OF WEAR AND COF BEHAVIOUR

Figure 6.1 shows the comparative behaviour of wear and wear rate of C9.0 composite with sliding distance in dry and lubricating condition at same applied load of 50 N and sliding velocity of 2.5 m/s. The data has been represented in semi log to clearly distinguish the variations. This is evident that with increasing sliding distance the cumulative wear increases in both dry and lubricating sliding conditions. This can also be observed from the wear rate (Fig. 6.1(b)) that in the case of lubricating sliding condition the wear rate stabilizes much earlier i.e. at about 2000 m sliding distance, while in dry sliding condition stability is achieved after 3000 m sliding distance. Further, percentage decrease in variation of COF with sliding distance for C9.0 composite (Fig.6.2) under same conditions as mentioned above that COF increases with sliding distance in both the conditions, however, in the presence of lubricants, COF stabilizes just after 2000 m sliding distance but for dry conditions it stabilizes after 3000 m sliding distance. Further, percentage decrease in COF from dry to lubricating condition are in the range of ~ 95 - 96%.

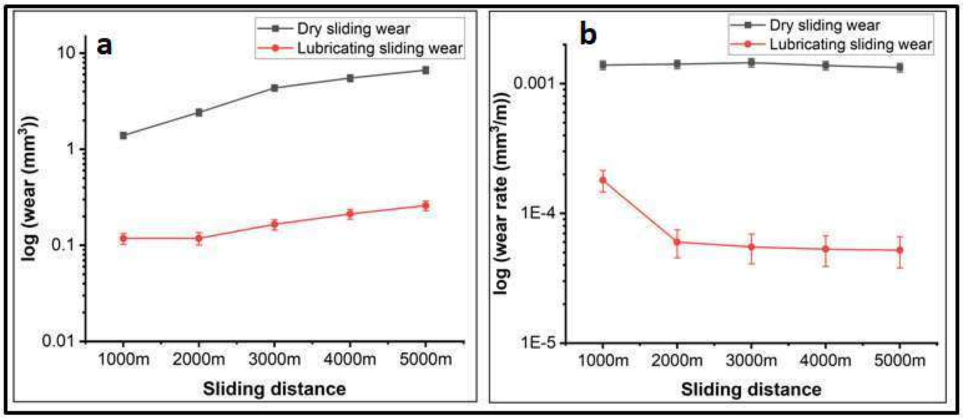

Fig. 6.1 Comparative behaviour of C9.0 composite at constant load of 50 N with varying sliding distance for (a) Wear (mm^3) (b) Wear rate (mm^3/m)

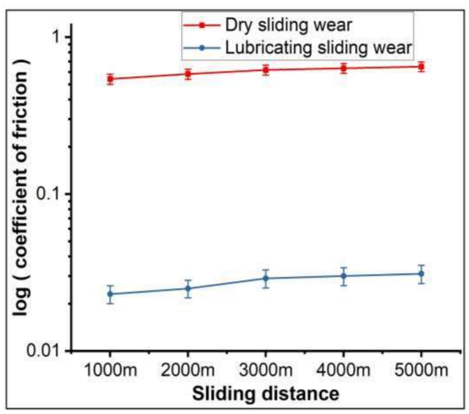

Fig. 6.2 Comparative COF behaviour of C9.0 composite at constant load of 50 N with varying sliding distance

Figure 6.3 shows comparison of wear rate and COF for C9.0 composite with applied load in dry and lubricating sliding condition for 5000 m sliding distance and 2.5 m/s sliding velocity. Under dry conditions there is a dip in increase of wear rate at 20 N then it remains almost stable, whereas, in lubricating conditions also wear rate increases but it remains stable from beginning itself. Further, percentage decrease in wear rate from dry to lubricating conditions with applied loads are in the range of ~ 94 – 97%.

Figure 6.3(b) shows comparison of COF in dry and lubricating condition for same parameters as for wear rate. It shows an increase in COF with increase in applied load in both dry and lubricating conditions. However, the percentage increase in COF with applied loads (10 – 50 N) is approximately same for both dry and lubricating condition and of the order of ~ 23%.

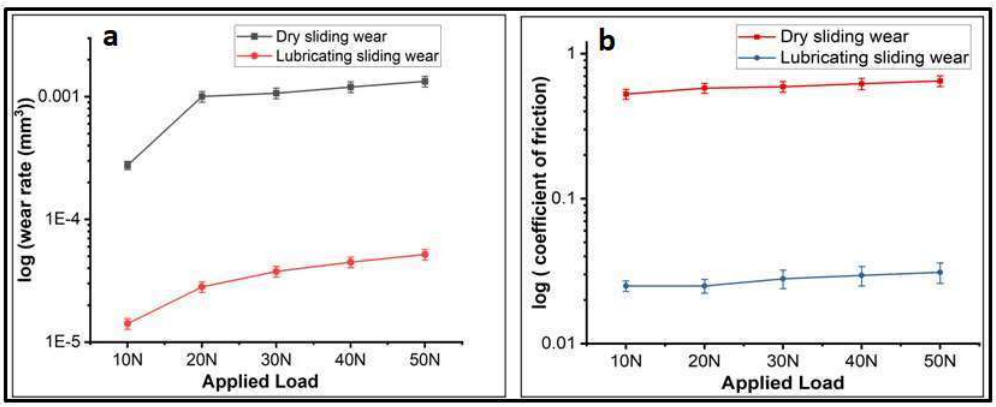

Fig. 6.3 Comparative behaviour of C9.0 composite for 5000 m sliding distance with varying applied load for (a) Wear (mm^3) (b) coefficient of friction

Figure 6.4 shows the wear and COF of ZA alloy and composites both in dry and lubricating sliding conditions for 5000 m sliding distance, 50 N applied load, and 2.5 m/s sliding velocity. In both the cases i.e. dry and lubricating sliding conditions cumulative wear significantly reduces with the addition of ZrB_2 particles and composites with 9 vol.% of ZrB_2 shows minimum cumulative wear i.e. highest wear resistance [Vineet et al., 2022(b)]. Further, percentage decrease in cumulative wear from dry to lubricating conditions with 9 vol.% ZrB_2 is ~ 96%.

Figure 6.4(b) shows the variation of COF in dry and lubricating sliding conditions with vol.% ZrB_2 for same parameters as in case of wear. It is interesting to note in dry sliding condition the COF value increases with increase in vol.% of ZrB_2 but with lubrication this nature get reversed. Further, percentage decrease in COF from dry to lubricating conditions with 9 vol.% ZrB_2 is ~ 95%.

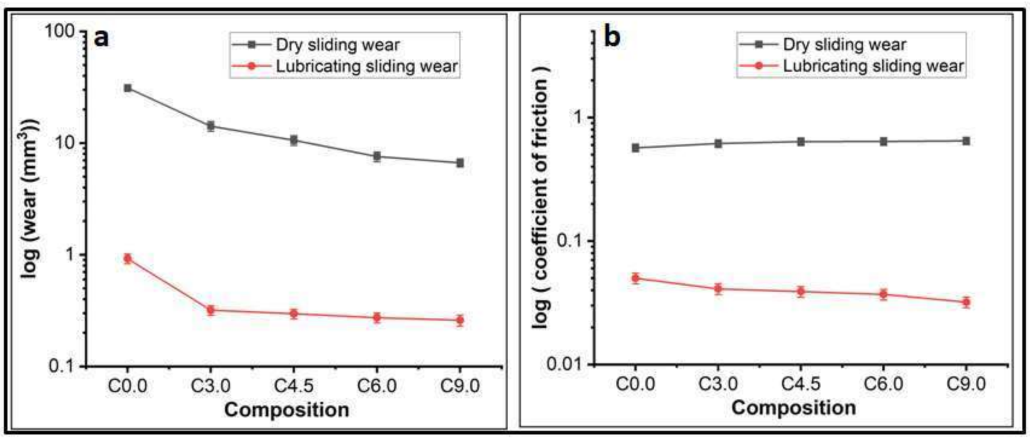

Fig. 6.4 Behaviour of ZA alloy and composites in dry and lubricating sliding condition at constant load and sliding distance of 50 N and 5000 m (a) Wear (mm^3) (b) COF

6.3 COMPARISON OF QUANTITATIVE DATA

Further, to substantiate the above results the comparison of wear depth, and average surface roughness study for the dry and lubricating sliding condition is given in Figs. 6.5, and 6.6.

The wear depth was also calculated using equation (2.9). The reported values is the average value. Linear decrease in wear depth and average surface roughness value with addition of reinforced particles is observed. Figures 6.5 and 6.8 indicate that as vol.% of ZrB_2 increases from 0 to 9, the wear depth value decreases from 0.99 ± 0.04 mm to 0.22 ±

0.01 mm and average surface roughness value decreases from 4.20 ± 0.03 μm to 3.25 ± 0.01 μm in dry sliding condition while in lubricating condition wear depth decreases from 0.030 ± 0.002 mm to 0.007 ± 0.0001 mm and average surface roughness value decreases from 1.65 ± 0.03 μm to 1.30 ± 0.02 μm. This can be observed that with addition of lubricant the wear depth and average surface values decrease significantly and confirm the above observations.

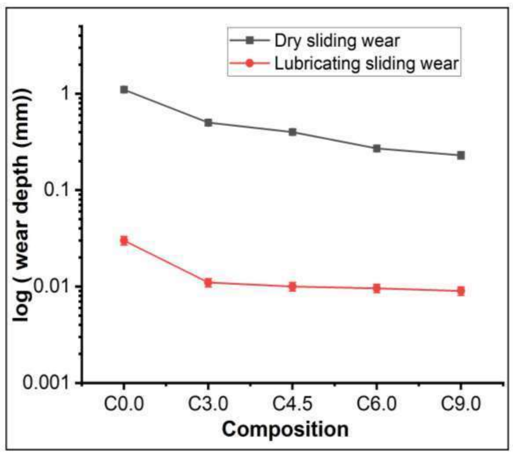

Fig. 6.5 Wear depth for ZA alloy and composites in dry and lubricating sliding conditions

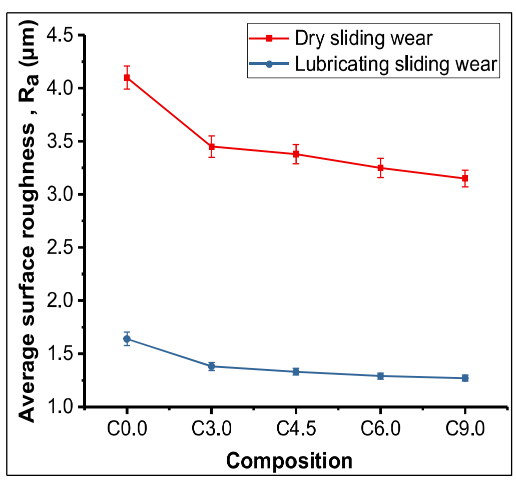

Fig. 6.6 Average surface roughness (Ra) for ZA alloy and composites in dry and lubricating sliding conditions

6.4 CONCLUSIONS

On comparing tribological properties of ZA alloy and composites in dry and lubricating sliding conditions, following can be concluded:

- ❖ Severity of wear increases by 3.79 times when sliding distance increases from 1000 to 5000 m in dry wear but with lubrication for same distance enhancement in wear is only 1.59 times. Data indicates that with lubrication, working limit of composites can be extended.
- ❖ Wear rate increases by 3.83 times when load increase from 10 to 50 N in dry wear but with lubrication for same applied load enhancement in wear is only 2.66 times. Which indicates that with lubrication working load limit of composites can be extended.
- ❖ Wear deceases by 80% when ZrB_2 increases from 0 to 9 vol.% in dry wear but with lubrication for same composition range decrease in wear is 97%. Which indicates that with lubrication working limit of composites can be extended.
- ❖ COF increases by 1.2 to 1.3 times when either sliding distance increases from 1000 to 5000 m or applied load increases from 10 to 50 N in dry as well as lubricating conditions.
- ❖ COF increases by 1.2 times when ZrB_2 increases from 0 to 9 vol.% in dry wear but with lubrication for same composition range COF decrease by 1.56 times. Which indicates that with lubrication composites can have suitability in wider range of applications.