Effect of Casting Moulds on Tribological Properties of Al-Sn Alloy

Prasanna S Y[1], Moinodin Sha[2], Kalyan Kumar[3], Shreedhar B[4], Veerendra Kumar[5], Satyanarayan[6]

[1,2,3,4,5]Student, [6]Associate Professor
Department of Mechanical Engineering,
Alva's Institute of Engineering and Technology, Moodbidri–574225, India

***Abstract*: In the present study, an effect of casting mould on tribological properties of Al–15%Sn was investigated. Liquid Al–Sn (740ºC) alloy was poured into moulds of aluminium and wood. Al–Sn alloy solidified in aluminium mould exhibited higher cooling rate compared to wood mould. Size of Sn grains/particles became finer and distributed uniformly in the matrix of alloy solidified in Al mould than in wood mould. An effect of surface wear on Al–Sn alloy cooled in different moulds was also assessed. Alloy cooled in Al mould exhibited less worn surface (692.3µm) than alloy cooled in wood (2045.6µm).**

***Keywords*: Al–Sn, Moulds, Microstructure, Mechanical properties.**

Introduction

Al–Sn is an immiscible alloy and it is called as soft tribological alloy. Al–Sn based alloys are broadly utilized as sliding bearing materials in car and shipbuilding industry due to their great compatibility, wear resistance and sliding properties [1]. Al-Sn alloys have good mechanical and tribological behaviours [2]. Excellent tribological properties can be achieved in Al-Sn alloys when the soft Sn-rich phase is dispersed homogeneously into the Al matrix. However due to the low density of the aluminium alloys, in engineering applications especially where it has to perform in friction environment it is necessary to improve its mechanical and tribological properties to support different loads and provide expected performance to the alloys [3,4]. Hence, in the present study an attempt has been made to improve the tribological properties of Al–Sn alloys by solidifying in aluminium and wood moulds.

Experimental

Al–15Sn alloy ingot was purchased in the dimensions of 350mm in length, 10mm width and 40mm of height as shown in Figure 1. Aluminium, and wood moulds were prepared in cylindrical dimension of 120 mm length, 30 mm inner diameter and 87 mm outer diameter as shown in Figure 2.

Figure 1: Al-15Sn Ingots

Figure 2: Moulds of Aluminium and Wood

Al–Sn ingot was melted in an electric resistance furnace (Heatron) and liquid alloy was solidified in Al and wood moulds. Figure 3 shows cylindrical specimen of Al–15Sn alloy after solidified in Al and Wood moulds and Figure 4 shows machined cylindrical specimen of Al–15Sn alloy. After allowed to solidifying the liquid alloy in both the moulds, the specimens were sectioned (after machining) using diamond saw precision cutter (Magnum make) and mirror polished using disc polishing machine. Microstructures of grain structures were observed under the metallurgical microscope by etching. Further specimens were cut into as per the standard specimen of wear testing using the electron discharge machine (EDM) by adopting wire radian cutting method at Bengaluru. The standard dimension is 10mm in diameter and length of 50mm as shown in Figure 5.

Figure 3: Al-15Sn alloys after solidified in Al and Wood moulds (un-machined)

Figure 4: Al-15Sn specimens after machining

Figure 5: Wear Standard Specimen

The standard specimens were tested on the Pin on disc wear testing machine (Ducom make). The experiment was conducted to investigate the wear properties for all specimens. The test was conducted by applying a load of 40N at disc speed of 750 RPM having a track diameter of 50mm for a time period of 30 Minutes and readings were noted down at an interval of 1 minute. Graphs obtained were in the digital wear testing machine plotted for both the specimens. Wear results were compared to each other.

Result and Discussion

The microstructure of the alloy solidified in Aluminium and wood mould are shown in Figure 6. Microstructure of alloy cooled in Aluminium mould showed fine distribution of soft tin phase which formed a regular–shaped continuous network and surrounded the Al grain boundaries (Fig 6a). However tin phase were not distributed uniformly and found to be coarser (Fig 6b) and micro pores observed in the samples.

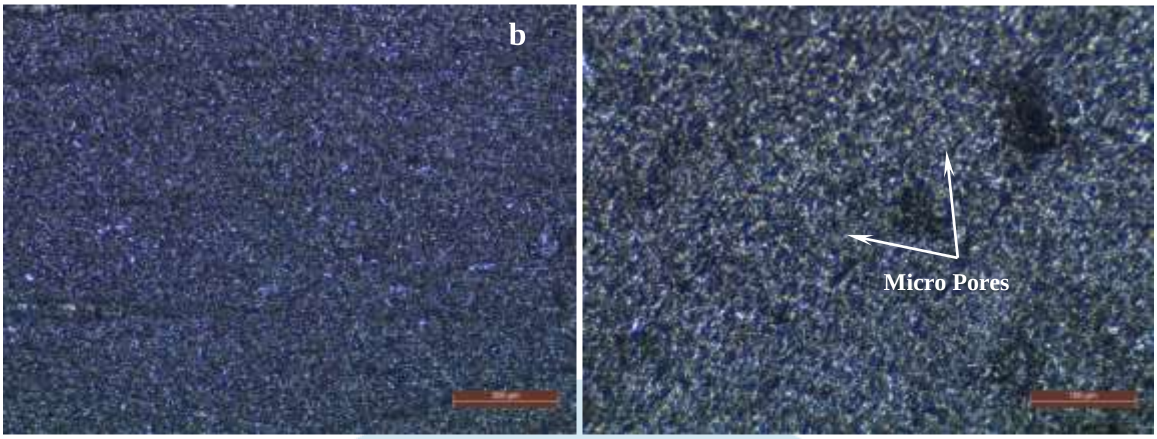
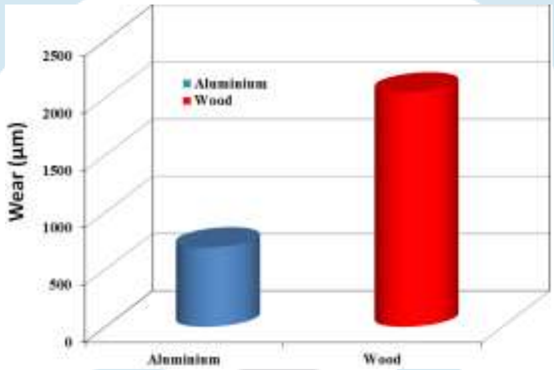


Fig 6 : Microstructure of Al–Sn solidified in (a) aluminium mould (b) wood mould



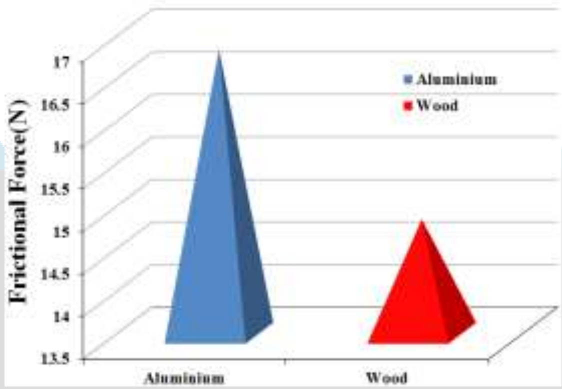


Fig 7: Effect of wear for the alloy solidified in (a) Al mould (b) wood mould

Fig 8: Effect of frictional force for the alloy solidified in (a) Al mould (b) wood mould

Effect of wear and frictional force for the alloy solidified in Al mould and wood mould are shown in Figure 7 and 8. Results indicated that an alloy cooled in wood mould exhibited higher wear rate (2045.63µm) compared to an alloy cooled in Al (692.35µm). Frictional force required to wear for the alloy cooled in wood mould showed less (14.84N) as compared to an alloy cooled in Al (16.84N). This is due to plastic deformation and increase of temperature at the interface between specimen and wear disc. The sample prepared from alloy cooled in Al exhibited less worn surface because of higher ductility than samples from alloy cooled in wood. Moreover Sn grains in Al cooled specimen found to be finer. Hence alloy solidified in Al mould found to be better than alloy solidified in Al mould in terms of tribological properties. The poor tribological properties for alloy solidified in wood mould are due to presence of micro pores occurred during solidification.

Conclusions

Based on the results and discussion the following conclusions are drawn.

- Al–15Sn alloy cooled in wood mould exhibited higher wear rate (2045.63µm) compared to an alloy cooled in Al (692.35µm).
- Frictional force required to wear for the alloy cooled in wood mould showed less (14.84N) as compared to an alloy cooled in Al (16.84N).
- Alloy solidified in Al mould found to be better than alloy solidified in Al mould in terms of tribological properties.

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