Experiment Number 08

How important is material tribological compatibility in lubricated reciprocating sliding line contacts?

Background

It is common knowledge that a sliding bearing should not be made from like-like materials because of the mutual solubility of the contacting materials [1]. In a lubricated reciprocating sliding contact, the surfaces may not come into contact apart from at the end of the stroke. This experiment examines the effect of like and different materials on the sliding contact.

Method

Steel against annealed steel and steel against cast iron were selected as the tribo-couples. They were lubricated with PAO 4cSt base oil. The contacts were subjected to a load induced (P_{max}=390MPa) scuffing test, after being run-in according to the ASTM G181 run-in procedure.

Wear Scar Images

Figure 1: Cast Iron

Comments

Grinding marks are clearly visible across the whole wear scar. Very little wear occurred with almost no material piled up at the ends of the scar. Of most interest are the white polished sections at the stroke reversal positions. These are very shiny; with higher magnification there appears to be no definite interface and certainly no cracking or delamination of this surface. The roughness of the wear scar, at 8.5µm, is only slightly lower than the un-worn surface, at 8.8µm.

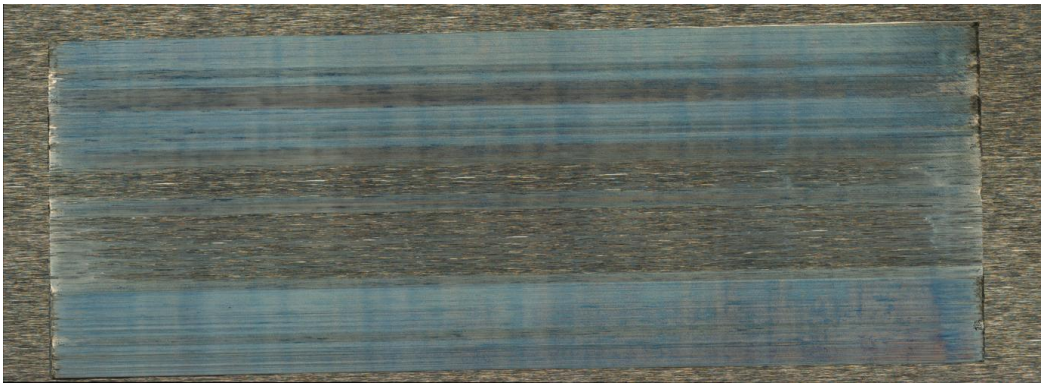


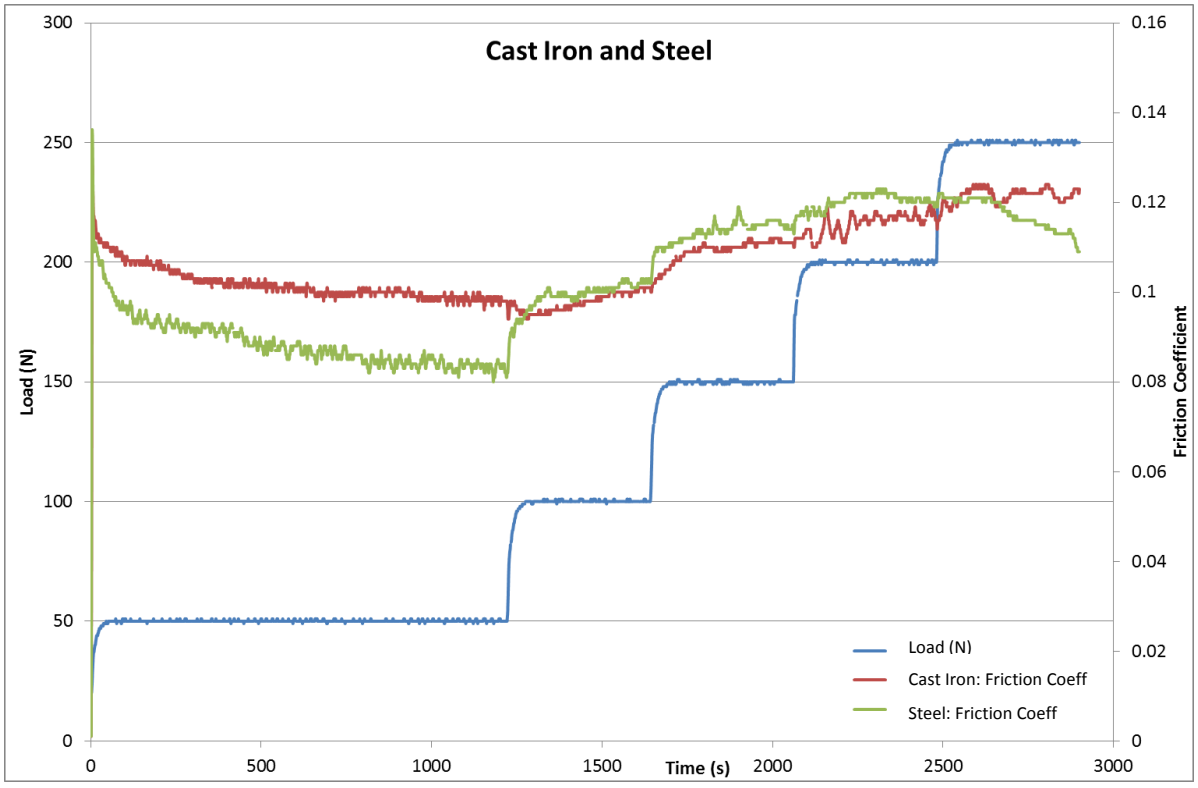
Figure 2: Annealed tool steel

Comments

Grinding marks are only visible in the centre third of the wear scar. The outer sections are polished; a significant volume of material is piled up at the ends of the stroke. Polished region had a roughness of 3.7µm. The wear scar had a roughness of 6.3µm compared with the substrate roughness of 11.7µm.

The cylinder reciprocating specimen suffers a pressure distribution characterised by maximums occurring at each end. It is suspected that in the initial strokes, wear debris from the soft annealed plate form at the edges of the stroke due to the pressure distribution. The cylinder is lifted on the wear debris, raising it out of contact with the middle of the plate, resulting in the observed wear scar.

Results



Conclusion

Although both samples were run-in according to ASTM G181, they still exhibit running-in behaviour at the beginning of the actual test. After loading to 100 N, both tests exhibit similar friction coefficients. In the case of the cast iron, very little wear occurs at the reversal positions, compared with significant polishing across the whole of the wear scar in the case of the annealed plate. This difference is promoted by the increased adhesive wear caused by the mutual solubility of the like-on-like contact.

Bibliography

[1] E. Rabinowicz, Friction and Wear of Materials, Wiley, 2013.