Experiment Number 02

What is the effect of increasing the fixed specimen hardness in a steel on steel reciprocating line contact?

Background

This experiment seeks simply to demonstrate the effects of increasing the hardness of a steel stationary sample, lubricated with PAO 4sCt base oil containing an organic friction modifier, on the friction and wear mechanism.

Test Conditions

Moving Specimen:	6 mm diameter x 10 mm long 52100 cylinder
Plate Specimen:	NSOH BO1 tool steel (annealed and hardened)
Frequency:	10 Hz
Stroke:	25 mm
Test Fluid:	PAO (4cSt) plus 0.5% OFM

Method

Both specimens were run-in according to ASTM G 181. The specimens were then tested to failure by increasing the load (P_{max}=390 MPa) through the contact.

Wear Scar Images

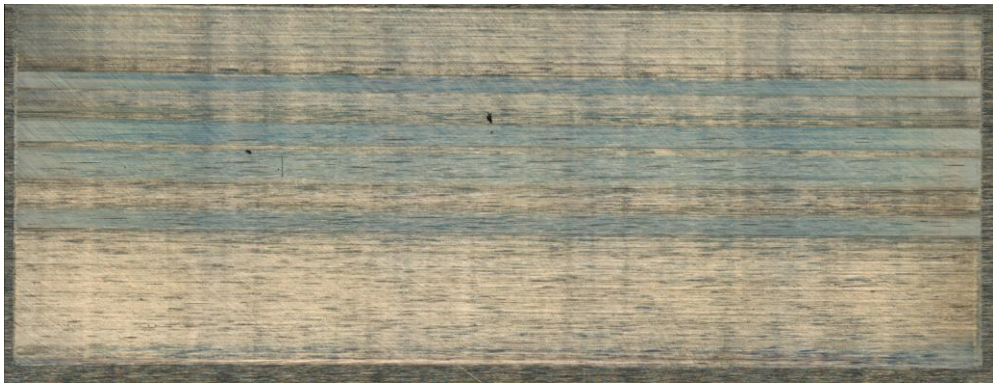


Figure 1: Annealed plate

Comments

Grinding marks are visible across the entire wear scar with narrow strips of light polishing in the direction of reciprocation. There was a significant amount of wear debris from the annealed plate observed in the lubricant and wiped from the surface of the cylinder. The unpolished region exhibits

an abraded surface which may be due to the friction modifier preventing adhesion of the wear debris. The surface roughness in the wear scar is 5.6µm compared with a substrate roughness of 7.1µm. The unpolished (abraded) sections have roughness of 2.6µm compared with a polished section Ra of 2.2µm.

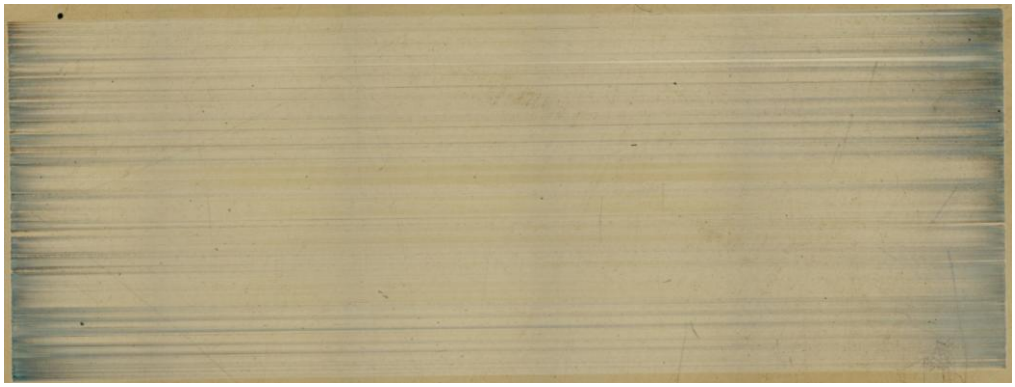
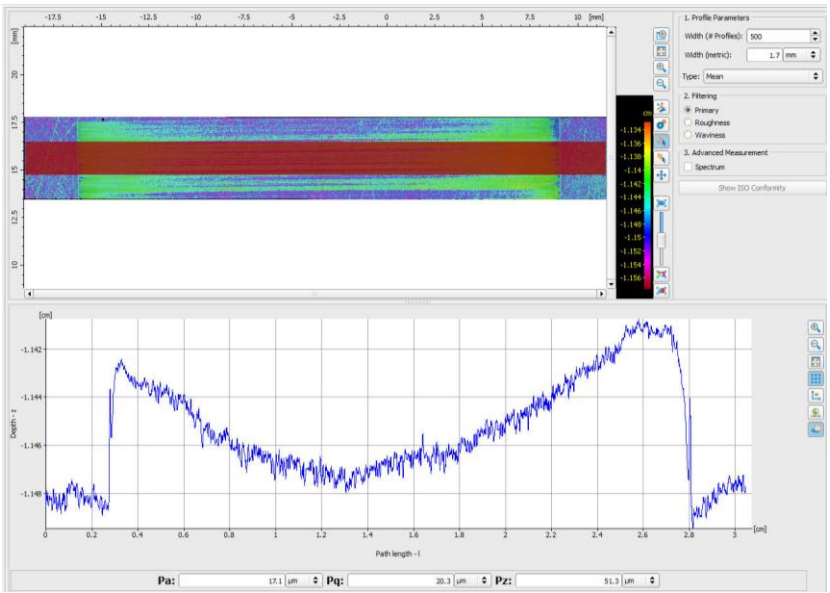


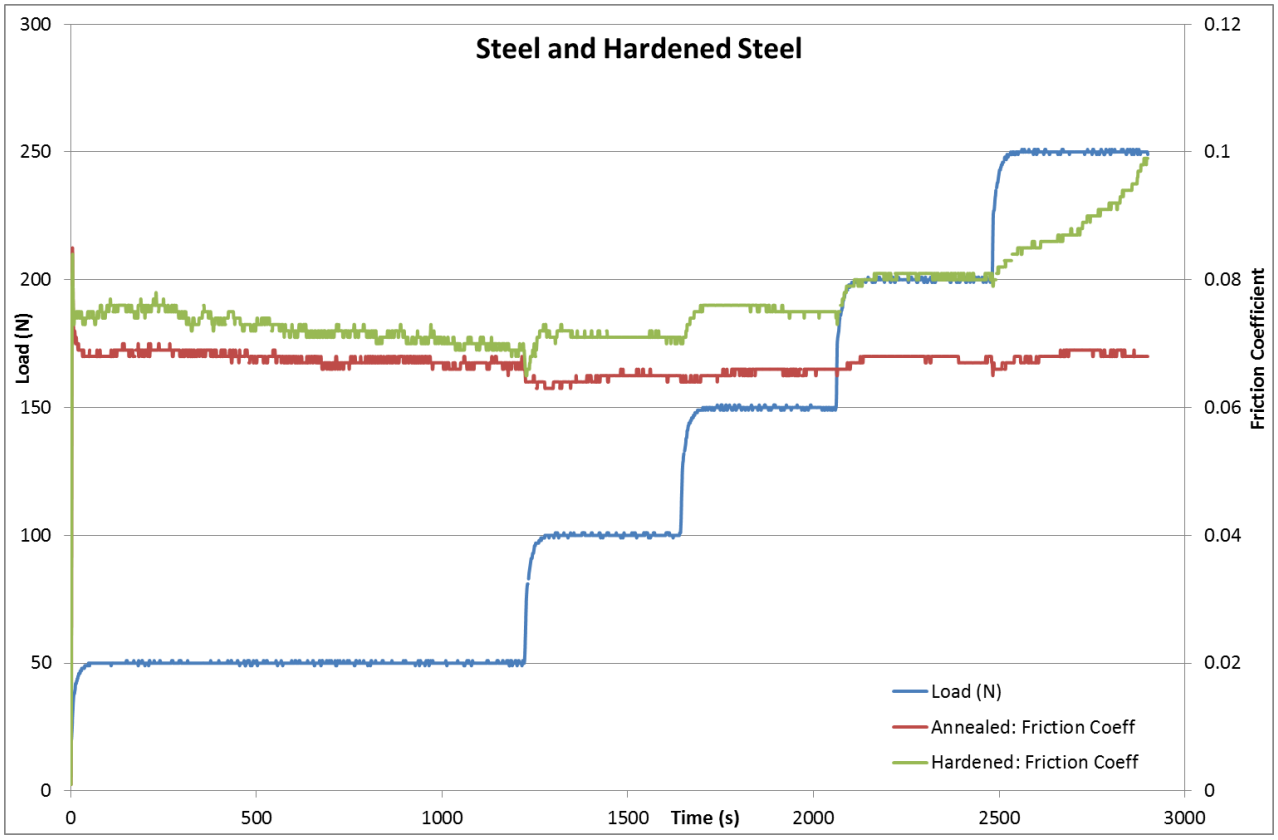
Figure 2: Hardened Plate

Comments

Material transfer is observed across the wear scar. The magnitude of the transfer exhibits a velocity dependence. The surface roughness of the wear scar varies from 6.5µm at the reversal positions to 16.6µm at the mid stroke compared to a substrate roughness of 8.8µm. The increase in roughness is indicative of the sporadic material transfer at the mid stroke. This can be seen more clearly by examining the profile of the wear scar below.



Friction Data



Conclusion

It can be seen that neither of the samples exhibit running in behaviour and this is expected, as the samples were previously run-in according to ASTM G 181. The friction coefficient of the annealed plate exhibits very little response to increasing load, compared with the hardened plate. This is because of a difference in the wear mechanism; in the case of the annealed steel, the cylinder polished the plate. However, the harder plate caused the cylinder to wear, producing a transfer film on the plate. This resulted in a like-like contact and consequently an increase in friction coefficient.