Experiment Number 11

What is the effect of specimen hardness and a friction modifier on friction noise in a steel on steel reciprocating point contact?

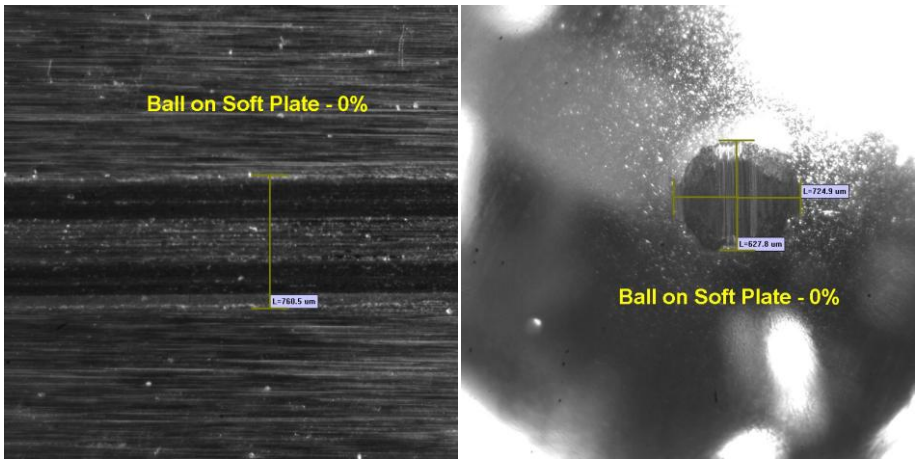
Background

One might assume that disorderly friction and friction noise were exclusively associated with localised events such as scuffing and that the addition of an additive such as a friction modifier may lead to reduced friction noise. This is not necessarily the case. This experiment uses the analogue friction noise measurement system described in Experiment 07.

Test Conditions

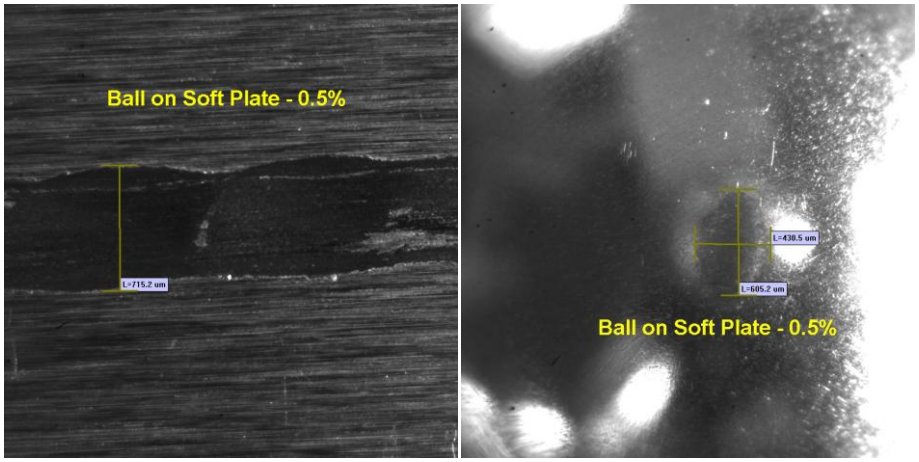
Moving Specimen:	6 mm diameter 52100 steal ball
Fixed Specimen:	NSOH BO1 steel gauge plate
Fixed Specimen Hardness:	Annealed (soft) and through-hardened (hard)
Load:	28 N
Lubricants:	PAO
	PAO + 0.5% OFM
Stroke:	25 mm
Frequency:	5 Hz
Temperature:	50 C

Comparison of Wear Scar – Soft Plate



761 725 x 628

Figure 1: Ball on Soft Plate - PAO



715 431 x 605

Figure 2: Ball on Soft Plate – PAO + 0.5% OFM

Without the added friction modifier, the wear scar is similar to that produced with the low lubricity reference fluid in the ISO diesel fuel lubricity test. The addition of a friction modifier reduces the size of the ball wear scar, resulting in an elliptical scar similar to that produced by the high lubricity reference fluid. Curiously, the corresponding plate wear scar, although smaller, appears to have wavy edges.

Comparison of Friction and Friction Noise – Soft Plate

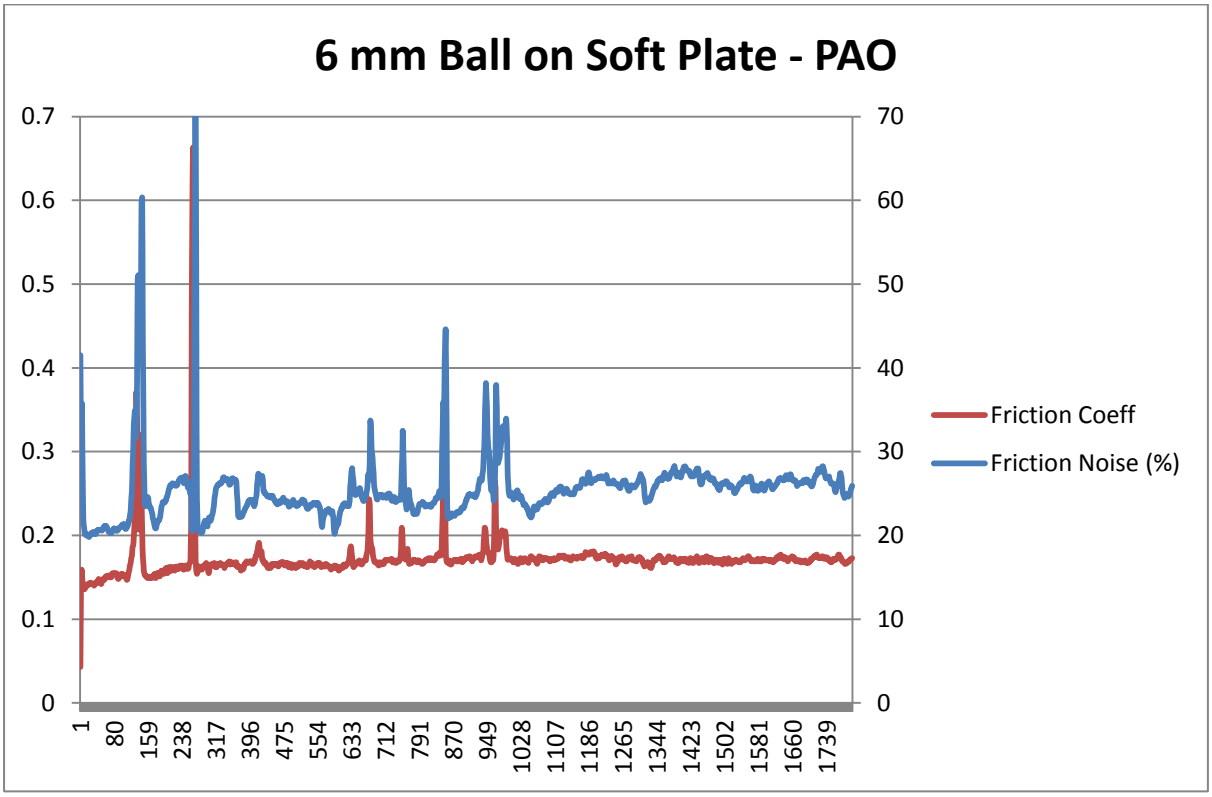


Figure 3: Soft Plate - PAO

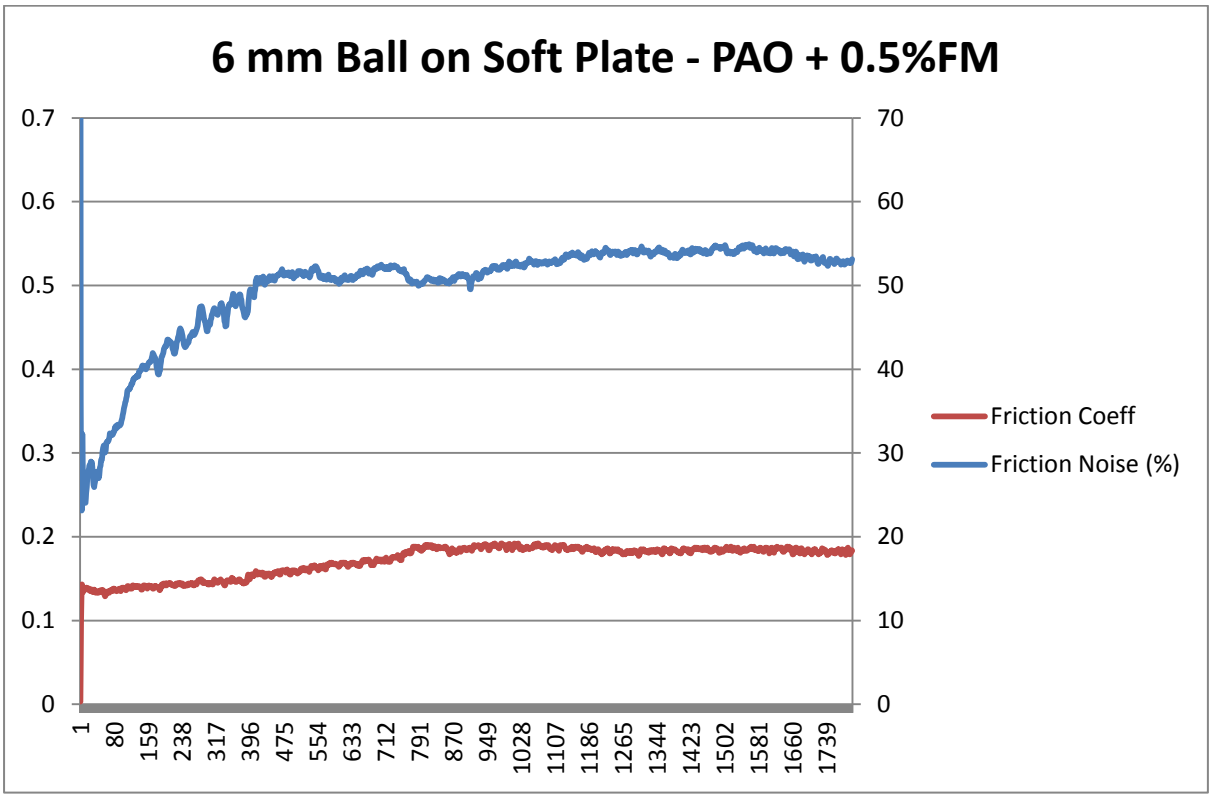


Figure 4: Soft Plate – PAO + 0.5% OFM

Comparison of Instantaneous Friction – Soft Plate

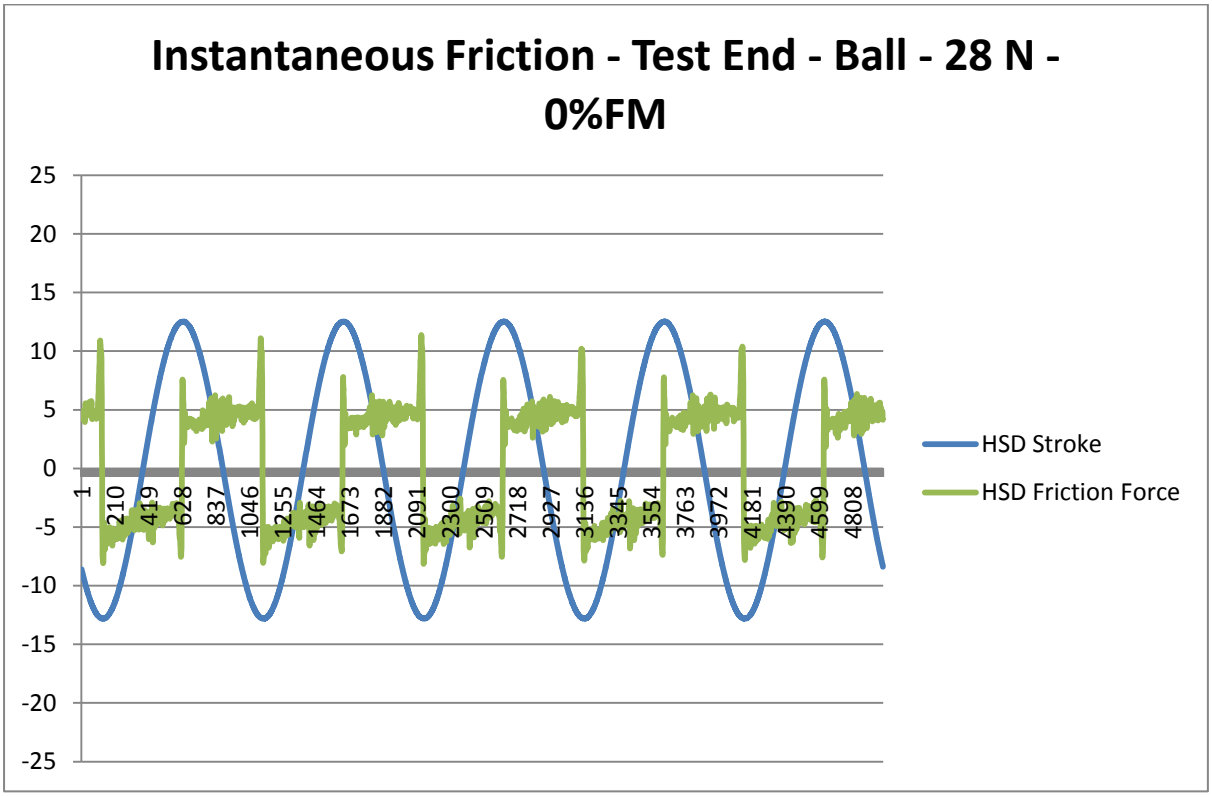


Figure 5: Soft Plate - PAO

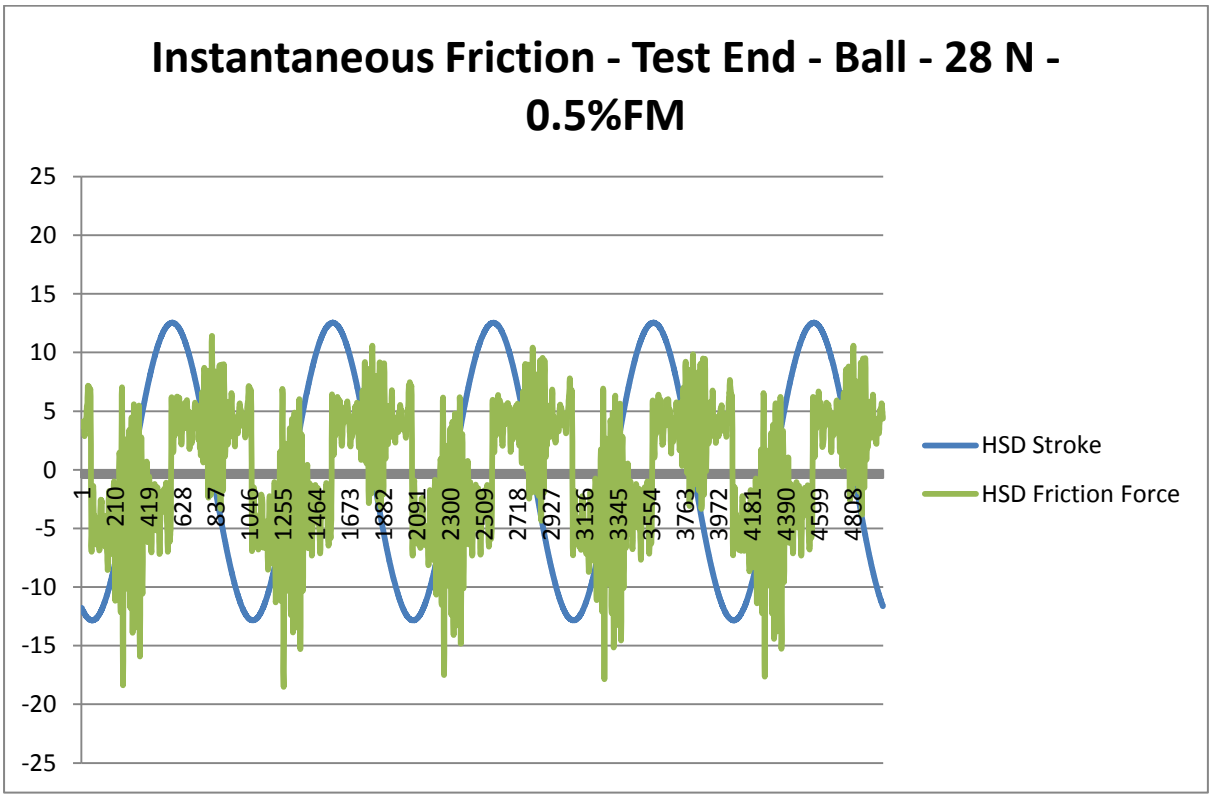


Figure 6: Soft Plate – PAO + 0.5% OFM

Comments on Soft Plate Tests

The test with the PAO base fluid produced a number of spikes in both the r.m.s. friction and the friction noise traces, indicating scuffing type events. These were not observed with the test with 0.5% OFM added, however, in this case, the friction noise level was much higher, indicating a more disorderly friction signal, caused by something other than scuffing.

Examination of the instantaneous friction traces shows that with the OFM test there is a major disturbance to the instantaneous friction trace about the mid-stroke position and this accounts for the high level of friction noise signal recorded.

Further examination of the plate specimens provides an explanation for this behaviour. Both with and without OFM, the plate wear scars have been subjected to a degree of plastic flow (ratchetting), but this is more severe and more pronounced in the test with the OFM added.

Figure 7: Soft Plate - PAO

Figure 8: Soft Plate – PAO + 0.5% OFM

The addition of OFM appears to reduce adhesion allowing more severe plastic deformation. It is worth noting that a similar result can be generated with the same fluids and plates, with a line contact configuration:

Figure 9: **Soft Plate – PAO - Wear**

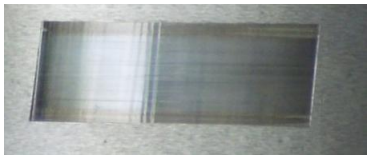
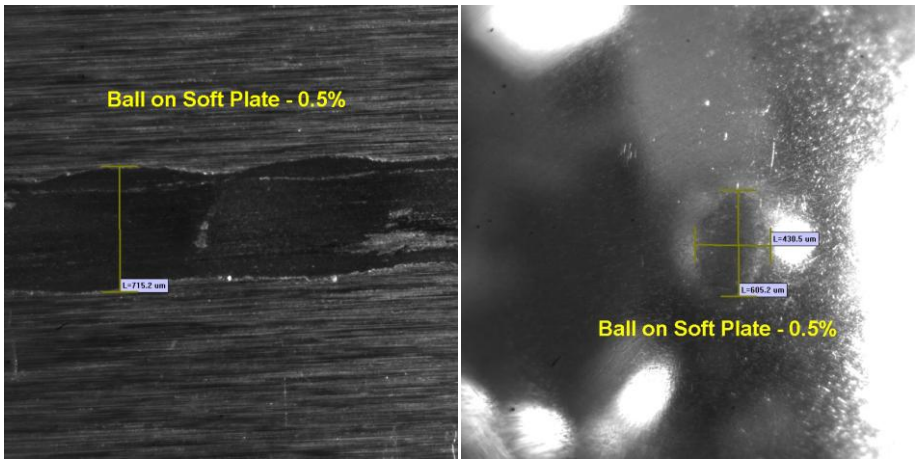


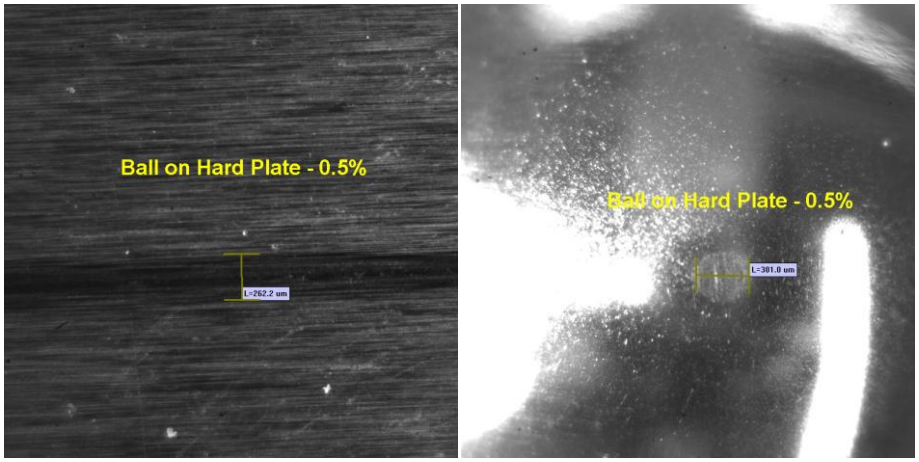
Figure 10: Soft Plate – PAO + 0.5% OFM – Plastic Flow

Comparison – Soft and Hard Plates – PAO + 0.5% OFM



715 431 x 605

Figure 11: Ball on Soft Plate – PAO + 0.5% OFM



262 301 x 301

Figure 12: Ball on Hard Plate – PAO + 0.5% OFM

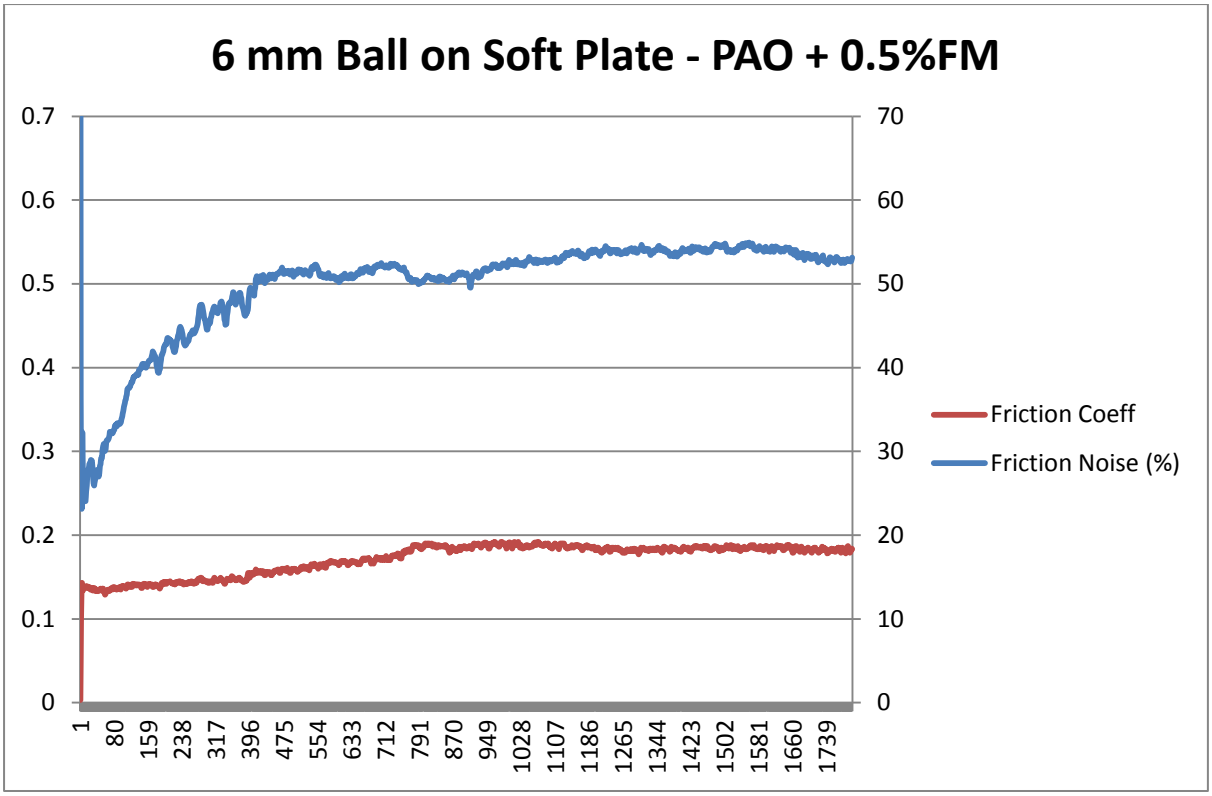


Figure 13: Ball on Soft Plate – PAO + 0.5% OFM

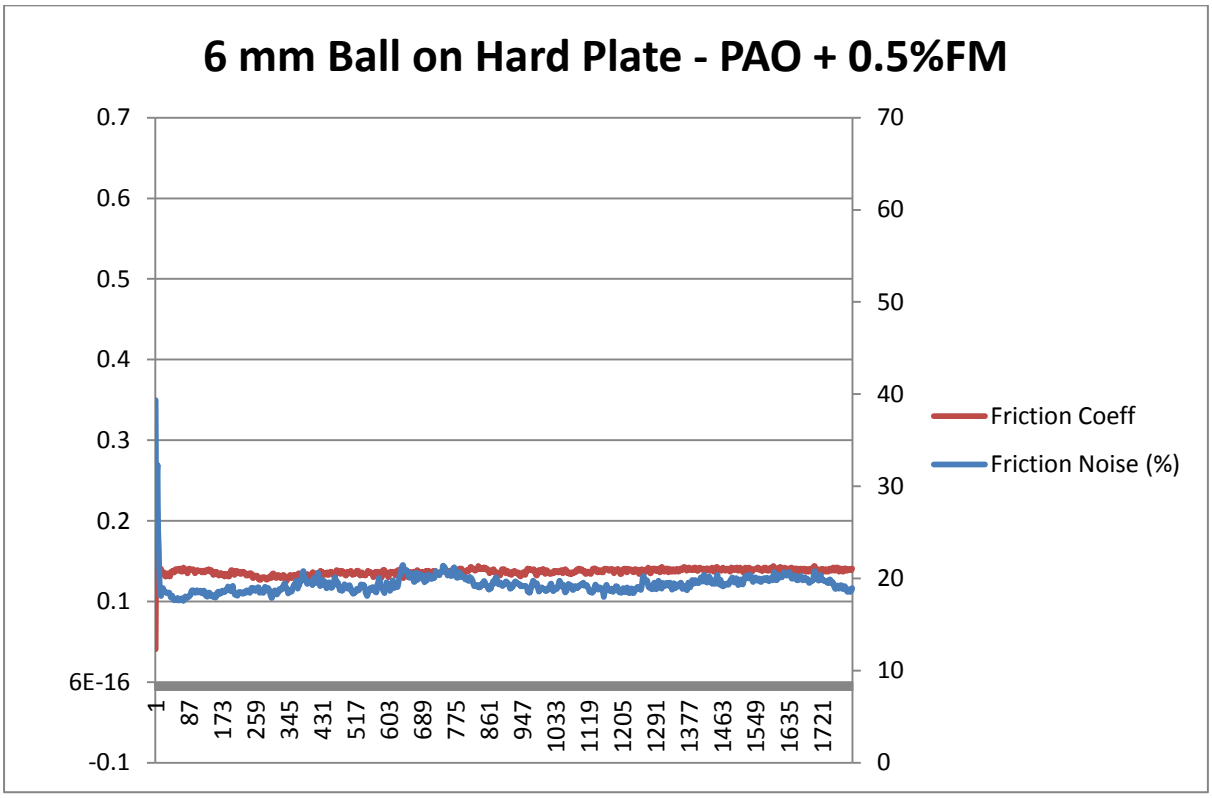


Figure 14: Ball on Soft Plate – PAO + 0.5% OFM

Comments on Soft versus Hard Plate Tests

Running on a hard plate eliminates the plastic flow associated with running on a soft plate, with a resulting reduction in both friction coefficient and friction noise.