

TRIBOLOGIC

Evaluation of Fluid Properties using the 4-Ball Machine

1. Standard Tests

A number of standard tests may be undertaken using the 4-ball machine and specific details of these may be found in the IP 239 or ASTM D2783 test standards. Of the various test procedures documented in these standards the most commonly used are probably those for

- a) *evaluation of wear* – measured by the removal of material from the test pieces
- b) *seizure* – indicated by the localised fusion of metal between the rubbing surfaces of the test pieces.
- c) *welding* – indicated by fusion of the material at the rubbing surfaces such that the four test pieces remain attached at the end of the test.



Plate 1: The 4-Ball Test Machine

2. The Test Machine (see Plate 1)

The test machine has a spindle driven by an electric motor at 1450-1500 rpm (UK, tests in the USA are run at a nominal 1800rpm due to the difference in mains frequency). At the end of the spindle is a chuck which carries one of the four ball bearings (specifically manufactured for test purposes) used for each test. The other three ball bearings are held against each other in a “cup” by means of a clamping ring and lock nut. The fluid sample for evaluation is placed in this cup such that these three lower balls are completely covered. The cup is located on a mounting disc which in-turn rests on a thrust bearing (to permit horizontal displacement) in the base of the machine.

Load is applied to the mounting disc via a load arm pivoted in the base of the machine. By placing a weight pan on the load arm at one of the notched positions the test load can be built up by adding further weights to this from a set specifically made for the 4-ball machine.

No provision is made for temperature control on the test machine but TRIBOLOGIC have a modified mounting disc containing an electric heater to permit tests to be undertaken at elevated temperatures and can also provide components to permit fluid recirculation if required.

3. Preparation

Prior to the start of a test programme the machine should be run, unloaded, for a minimum of 15 minutes. Ball bearings for the test programme must be cleaned in an appropriate solvent (for example white spirit to BS 245).

4. Summary of the Test Procedure

- 4.1 Select four ball bearings from those available for test. Fit one of these into the ball chuck and securely locate in the end of the spindle. Place the remaining three in the cup followed by the clamping ring and lock nut. (Plate 2 shows this assembly without lock nut) Secure the balls in the cup by tightening the lock nut.
- 4.2 Add sufficient fluid to the test cup to cover the balls by approximately 2 to 3 mm.
- 4.3 Locating the three balls in the cup against the one in the spindle place the mounting disc between cup and thrust bearing.
- 4.4 Select the weight pan position and weights to give the required test load. Loosen the load arm pin to permit the load arm to move freely, so setting up the test conditions between the ball in the chuck and the three balls in the cup.
- 4.5 Start the machine with reference to a suitable timer and run for the required duration. If undertaking weld load tests stop the machine as soon as signs of welding (normally smoke) are detected to prevent possible damage to the drive system.
- 4.6 Record / measure those values required for type of test being undertaken. For wear tests this would be the size of the wear scar in the direction of rubbing, and perpendicular to it, whilst for weld load tests it would be the weight on the weight pan.
- 4.7 Disassemble by working through the first four steps in reverse order.
- 4.8 Clean chuck and cup components with suitable solvent to prepare them for the next test.



Plate 2: The 4 Balls – Three in the Cup with Clamping Ring and the Third in the Chuck awaiting location within the Spindle.