

Evaluation of Extreme Pressure and Anti-Wear Properties Using a Translatory Oscillation Tribometer to Screen Gear Oils for Scuffing Loading Testing

Overview

Machinery operating under heavy load, slow speed conditions often require anti scuff gear lubricants or extreme pressure (EP) lubricants to provide protection against adhesive and frictional wear. The Translatory Oscillation Tribometer (SRV®) is an invaluable instrument for evaluating friction and wear properties which can be applied to EP and anti-wear (AW) testing of gear oils. The instrument can function as a tool to screen gear oils and narrow down which gear oils should undergo expensive and time-consuming tests, such as the FZG standard scuffing loading test, which measures the scuffing load capacity of lubricants as per ISO 14635.

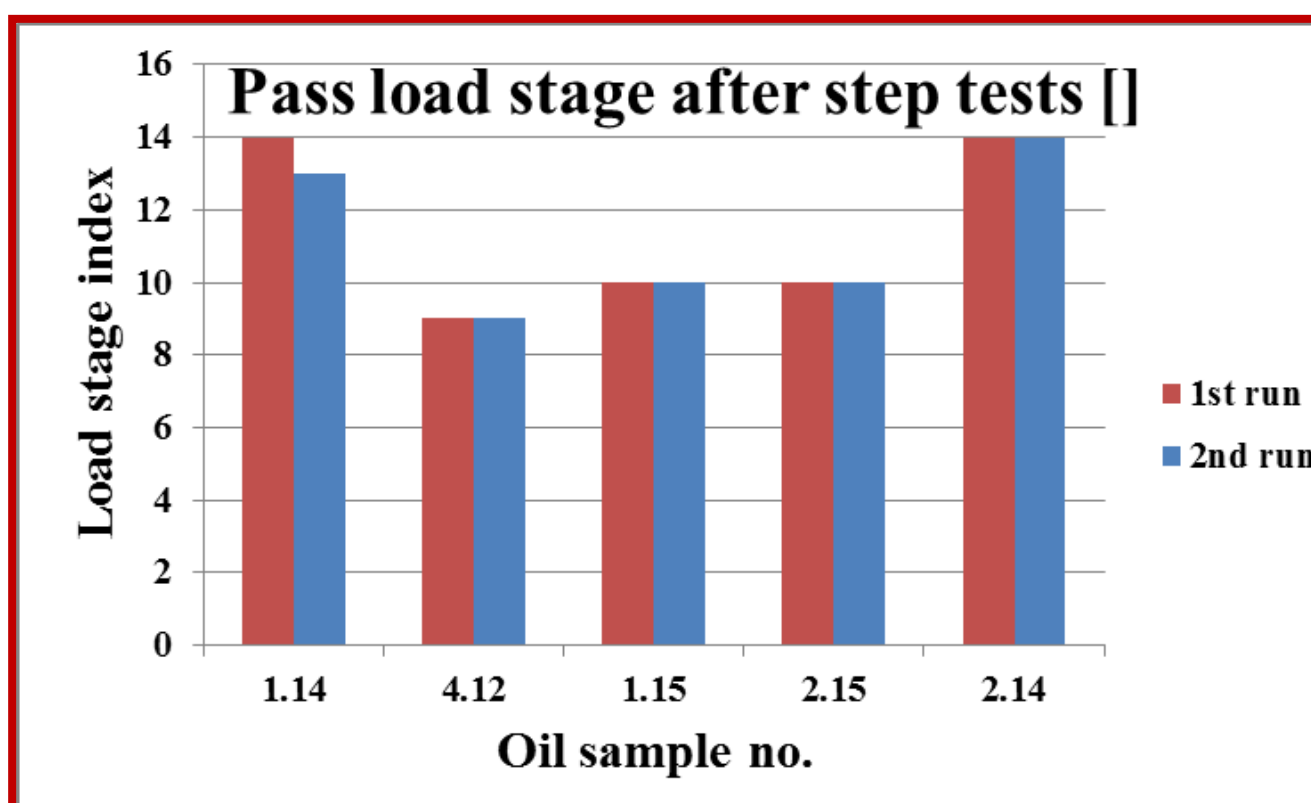
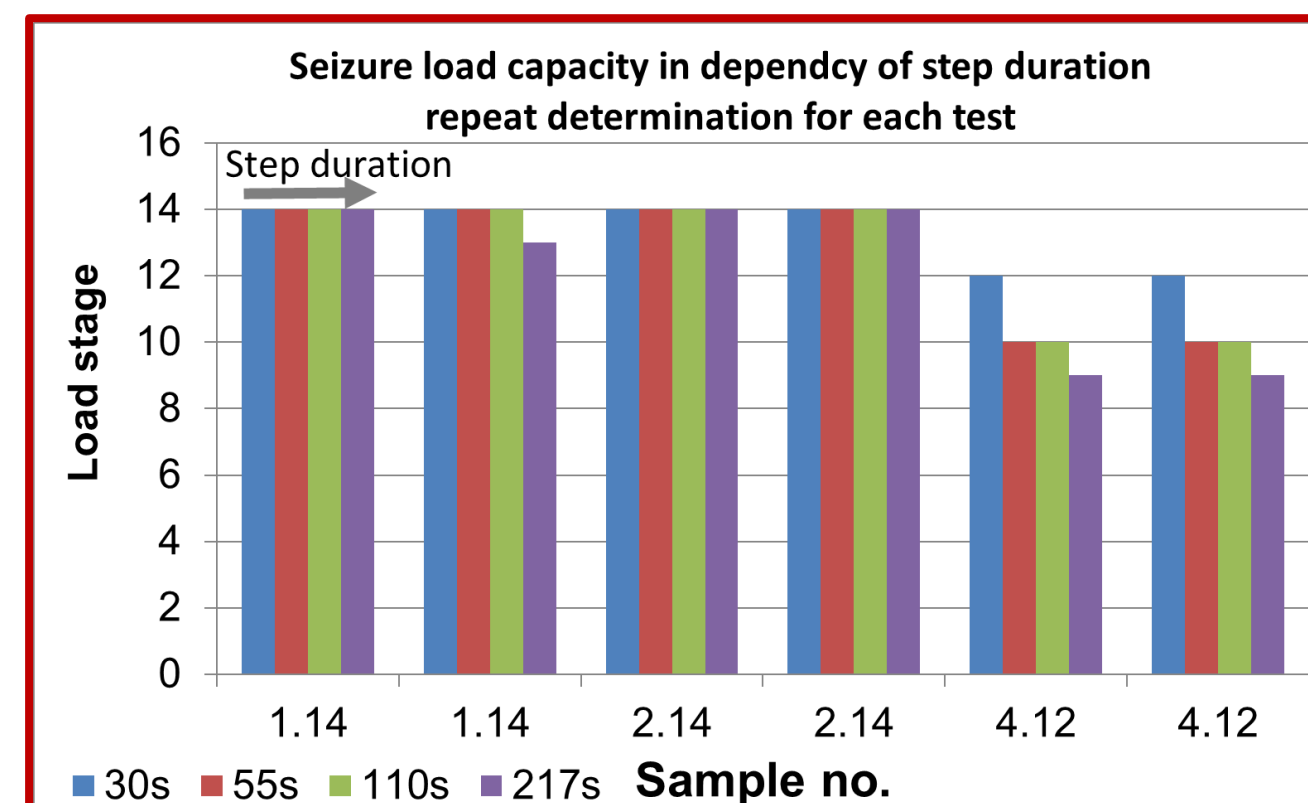
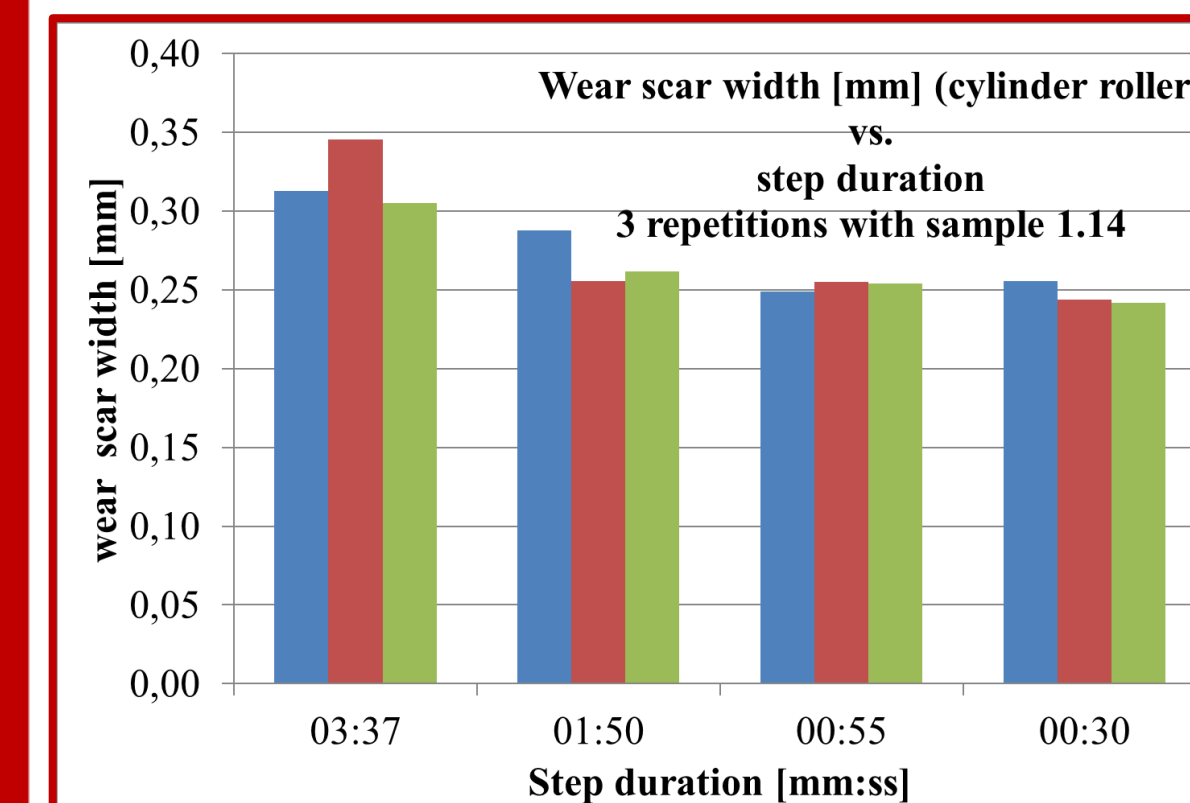
Step Test Parameters and Results

Step load tests are conducted on the gear oils below, implementing the ISO 14635-1 (FZG A/8, 3/90) test parameters to the SRV® Tribometer, with the following restrictions:

- Load step duration: the SRV frequency is 50 Hz, which is half of the number of rotations for FZG test parameters.
- Maximum sliding speed is set to 0.63 m/s
- Temperature is 98°C at the bottom of the lower specimen, bringing the surface temperature to around 90°C.

Gear Oils and Step Load Test Data

Sample ID	ISO VG	Kin. Visc. at 40°C, cSt	Kin. Visc. at 100°C, cSt	VI	Density, kg/m ³	Base Oil	FZG-Test, A/16.6/90, Failure Step	FZG Gear Scuffing Test A/8.3/90
4.12						Mineral Oil	7	
1.14	320	320	37.4	166	860	Synthetic	>13	
2.14	320	320	56	240	1060	PAG		>12
1.15	320	321	52.7	230	1069	PAG	>12	
2.15	320	320	54.4	237	1075	PAG	>14	>12

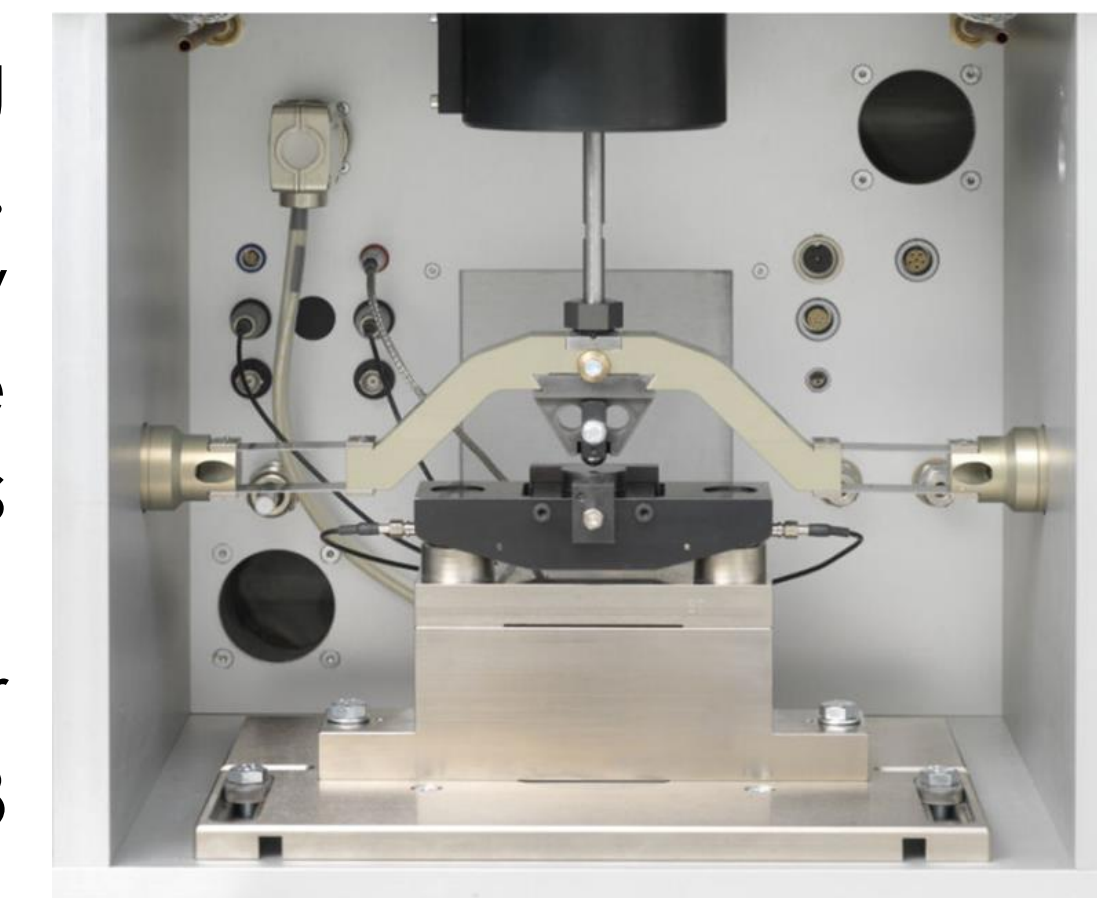


An increasing load duration results in increased wear.
 ✓ This indicates there may be less surface pressure than calculated.
 At shorter step durations, higher seizure loads are achieved.
 ✓ The load durations are too short to provoke a reaction.

Instrumentation

There are motivations to develop a quick and cost-effective method for an application-oriented screening of gear lubricants and associated additive packages. This new method would allow easy screening of new alloys and coatings. The new approach is to evaluate the seizure load-carrying capacity using step load tests on the SRV® instrument. The SRV® test system uses DIN 51834-4 for the evaluation of friction and wear for Hertzian contact pressures, between FZG load stages 3 and 14 and beyond.

SRV® Tribometer



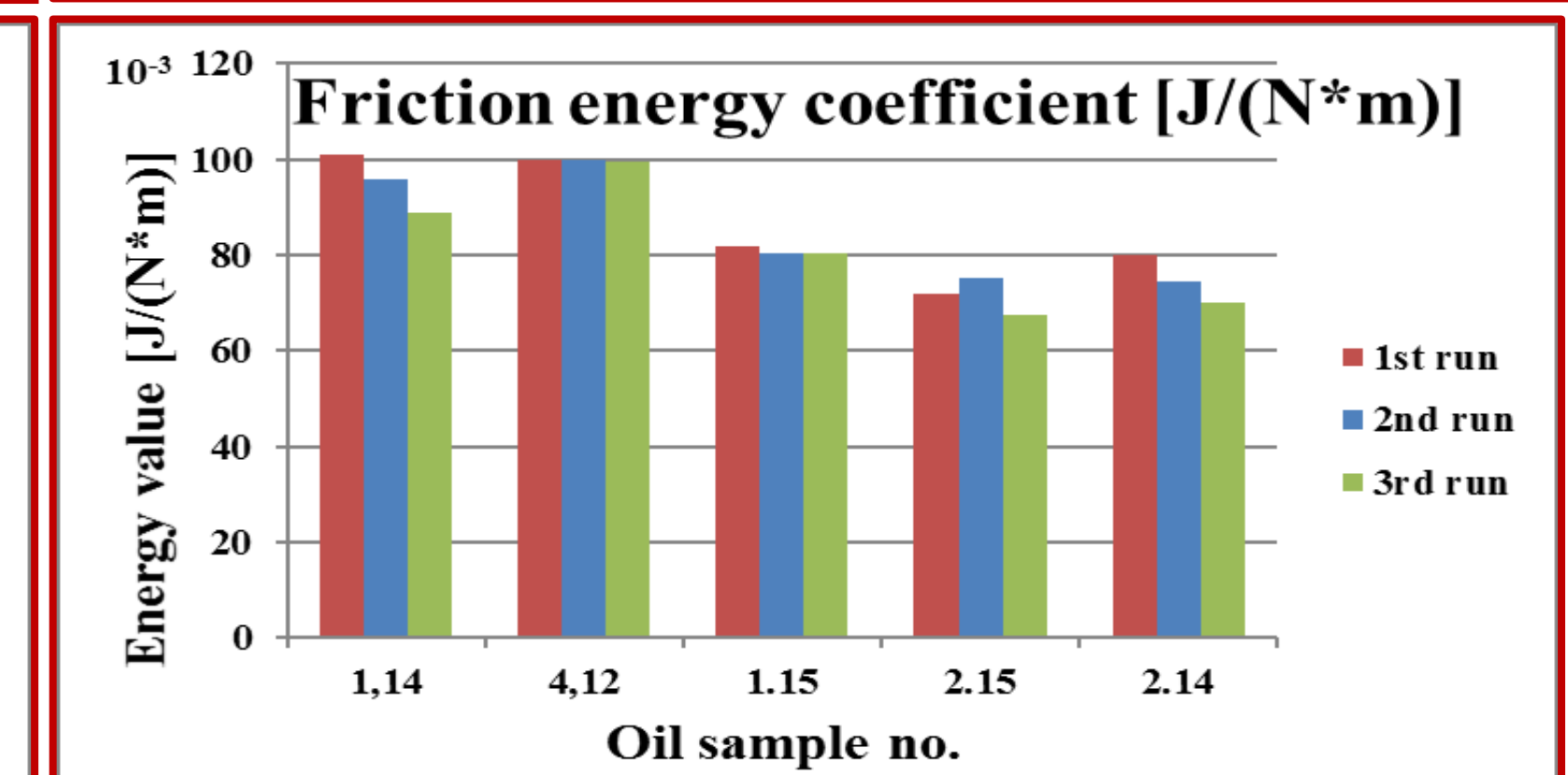
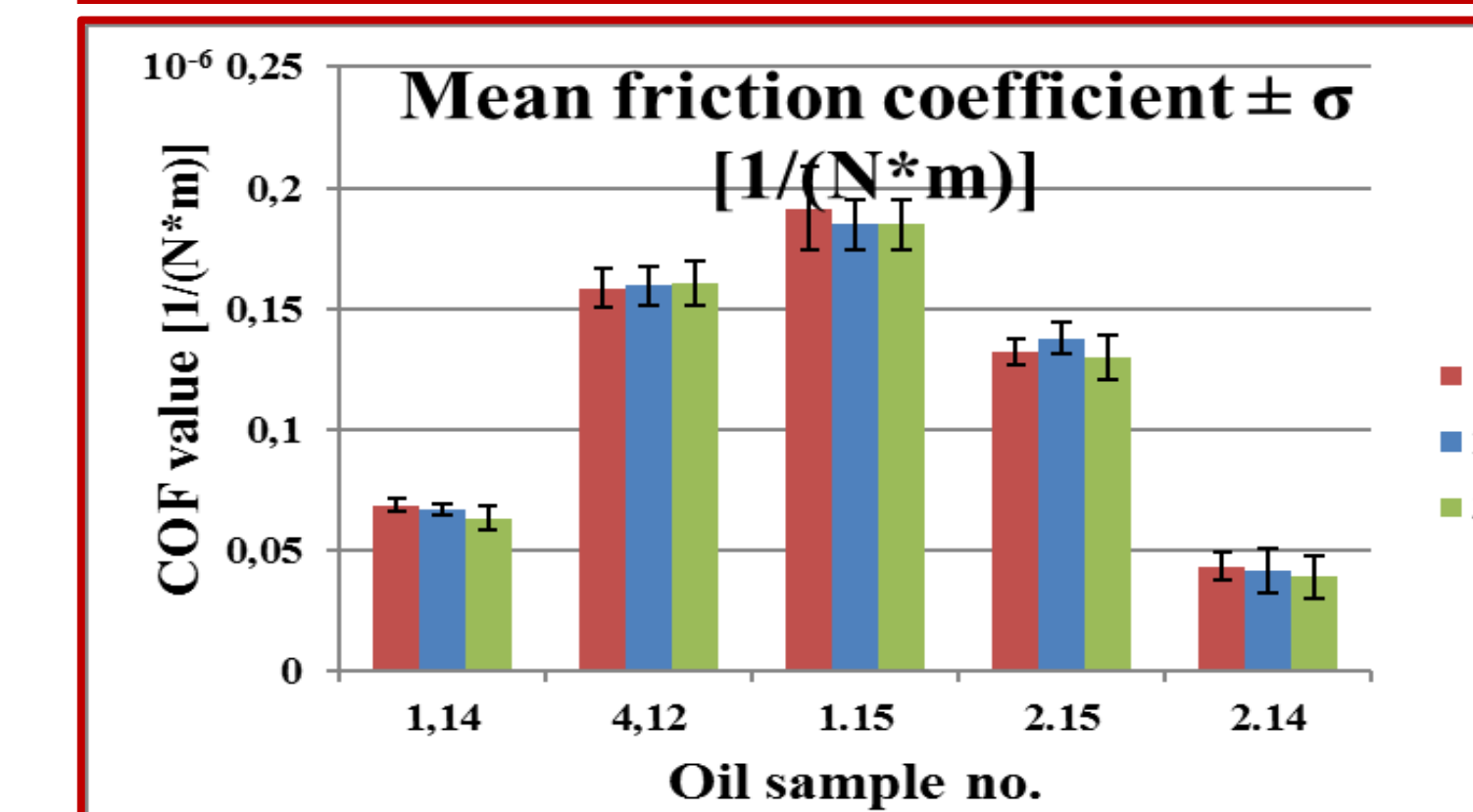
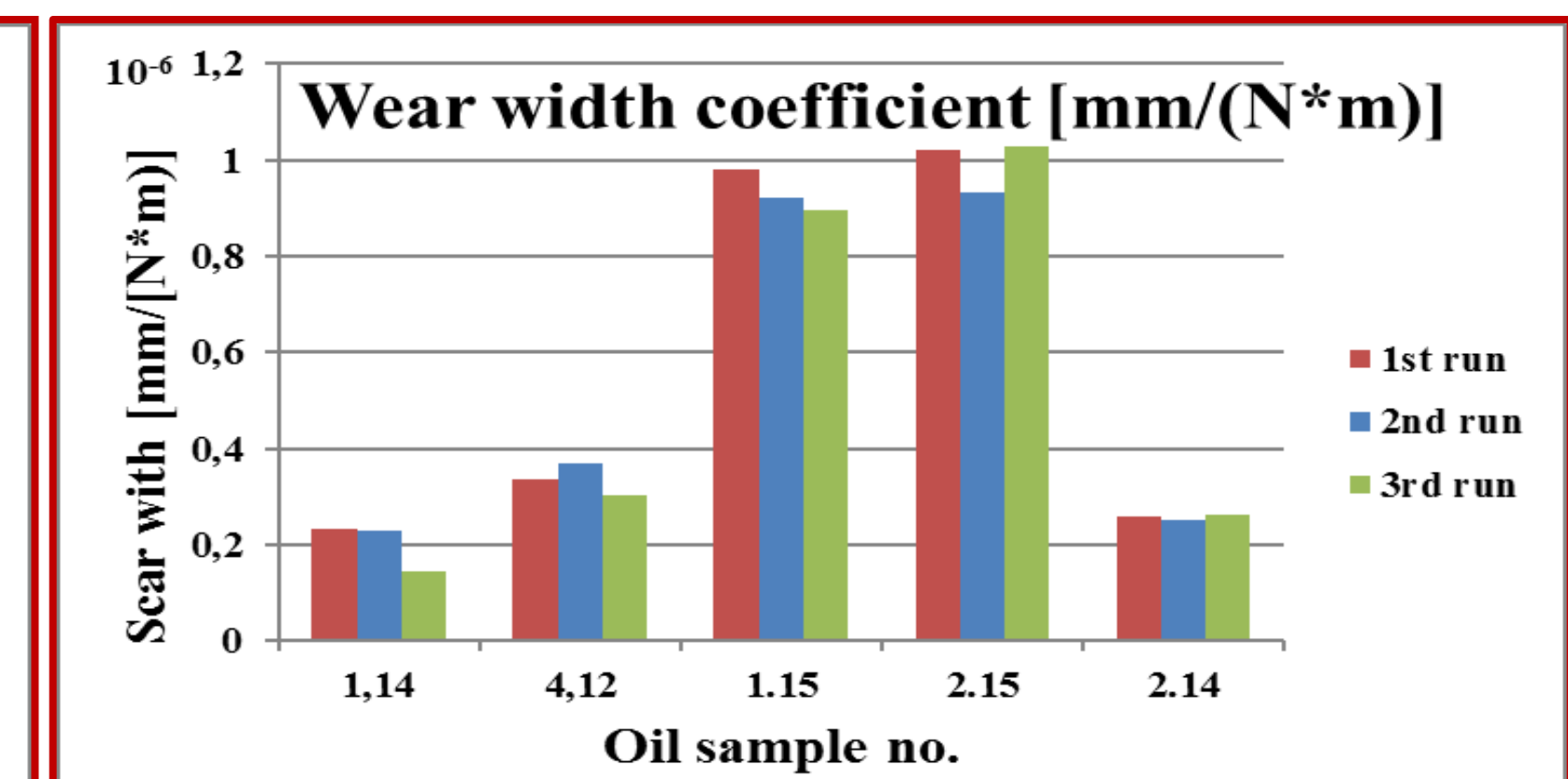
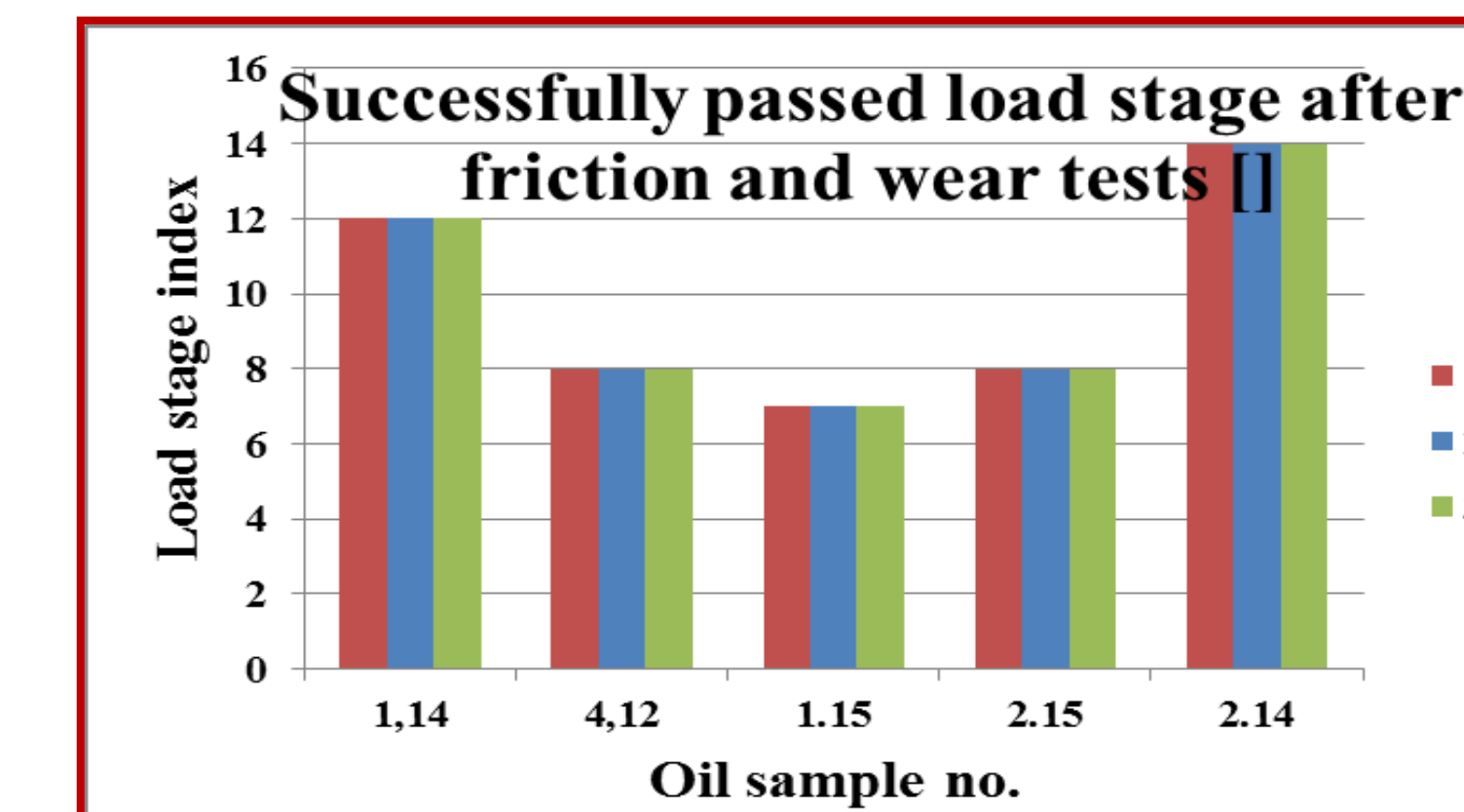
- 1 Oscillation block
- 2 Head plate with
 - 2a Friction force sensors
 - 2b Receiving device for the lower specimen
- 3 Device for parallel movement of the upper specimen, in extension of the oscillation drive axle
 - 3a Upper specimen holder
 - 3b Lower specimen holder
- 4 Loading device axle

Evaluation of Friction and Wear Behavior

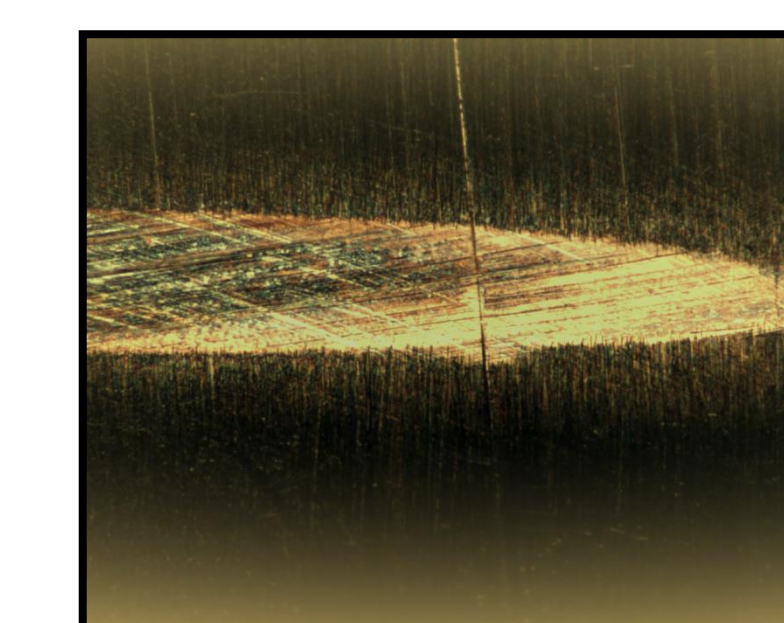
To evaluate the friction and wear behavior of the gear oils, a modified DIN 51834-4 procedure is used, with the following variations:

- Test temperature: 98°C
- Running-in phase: load-increasing steps until test load is reached
- Test duration: 120 min, starting after running-in phase
- Test force: last load step without adhesive failure
- If adhesive failure occurs during the test, the next lower load step is selected.
- Positive result after completing three tests with the same test load without failure.
- 2.0 mm stroke at a frequency of 50 Hz
- The test is assessed in terms of friction parameters and wear scar width on the cylinder.

Friction and Wear Test Results



Sample 1.14



For good friction behavior, the edges of the wear scar taper off.

Sample 4.12



For bad friction behavior, the cylinder roller tilts due to adhesive events, resulting in a widened wear scar.

Conclusion

The results show that the test environment of the SRV tribometer is suited to characterize and differentiate gear oils regarding their end point characteristics and their friction and wear. The results from these tests are a first indication for the behavior of the lubricants when in use in real applications. Additionally, the SRV test system can act as a pre-selection for further bench testing and field trials. However, to assess its full capability in these tests, more testing is needed with a large amount of samples.