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Petroleum and related products — Determination of shear stability of lubricating oils containing polymers — Method using a tapered roller bearing

Pétrole et produits connexes — Détermination de la stabilité au cisaillement des huiles lubrifiantes contenant des polymères — Méthode avec roulement à rouleaux coniques

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 26422 was prepared by Technical Committee ISO/TC 28, *Petroleum products and lubricants*.

ISO 26422 is based on DIN 51350-6, which has also been adopted by the Coordinating European Council (CEC) as CEC-L-45-99.

Petroleum and related products — Determination of shear stability of lubricating oils containing polymers — Method using a tapered roller bearing

WARNING — The use of this International Standard may involve hazardous materials, operations and equipment. This International Standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this International Standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.

1 Scope

This International Standard specifies a method of determining the shear stability of polymer-containing lubricating oils, including pressure fluids, by the four-ball tester as specified in ISO 20623, but using a tapered roller bearing. The test results allow prediction of the in-service permanent viscosity loss.

NOTE Other International Standards exist which evaluate viscosity loss of polymer-containing oils. The method specified in this International Standard subjects fluids to a higher shear rate than, for example, the diesel injector nozzle shear test in ISO 20844. It is particularly appropriate for lubricants being used in high shear applications, such as components with gears and roller bearings. In such applications, the shear rate in the ISO 20844 test method can be too low to generate a realistic permanent shear of the fluid.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 355, *Rolling bearings — Tapered roller bearings — Boundary dimensions and series designations*

ISO 3104, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 20623, *Petroleum and related products — Determination of the extreme-pressure and anti-wear properties of fluids — Four ball method (European conditions)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
percentage viscosity loss
R_V
measure of shear stability calculated in accordance with the following equation:

$$R_V = \frac{\nu_0 - \nu_1}{\nu_0} \times 100$$

where

ν_0 is the kinematic viscosity at 100 °C of the unsheared oil, expressed in mm^2/s;

ν_1 is the kinematic viscosity at 100 °C of the sheared oil, expressed in mm^2/s

NOTE 1 A small value indicates a high shear stability.

NOTE 2 The tapered roller bearing test is also known in the industry as the KRL (Kegelrollenlager) principle.

4 Principle

Using the splash lubrication method, a volume of 40 ml of the lubricating oil is tested at a constant temperature of 60° C in a tapered roller bearing driven by the four-ball tester. The test is carried out at constant speed and the load applied during a given running time is 5 000 N. The kinematic viscosity of the lubricating oil is determined at a temperature of 100° C before and after the test. The percentage viscosity loss, R_V, is calculated from these two viscosities.

NOTE Other temperatures to determine shear loss, such as 40° C, can be requested by some classification systems.

5 Reagents and materials

5.1 Cleaning solvents, appropriate to the material last tested. For mineral oils, light hydrocarbons and acetone are suitable. For some hydraulic fluids, a low molecular mass alcohol will assist in the first cleaning stage.

6 Apparatus

6.1 Four-ball tester, as specified in ISO 20623.

6.2 Tapered roller bearing, metric series 32008 X, in accordance with ISO 355. The single row tapered roller bearing assembly consists of an inner race with cage and roller assembly and an outer race.

NOTE 1 It is advisable that the inner and outer races be considered to be a matched pair when obtained from the supplier and these components not be interchanged with those of other sets of bearings.

NOTE 2 Precision has only been evaluated on SKF 32008 X/Q bearings (Q for optimized contact geometry and bearing surfaces).

NOTE 3 The adapter shown in Figure 1 is available from several producers. It is advisable only to use adapters that have been proven in tests run in accordance with CEC-L-45-99.

6.3 Shear stability testing apparatus[1], as shown in Figure 1.

6.4 Temperature control device, for controlling the temperature of the oil to a temperature of 60 °C ± 1 °C, using a temperature measuring device located in the shear stability test apparatus.

6.5 Viscometer, an appropriate glass capillary viscometer meeting the requirements of ISO 3105 or a suitable automated viscosimeter should be used for the determination of kinematic viscosity in accordance with ISO 3104.

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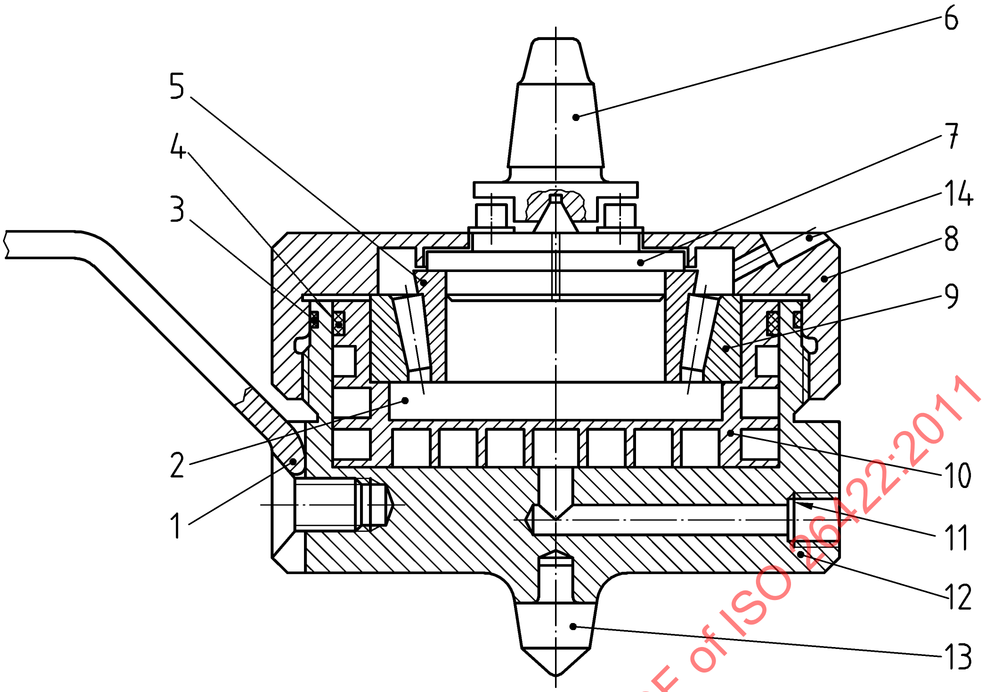
1) Information on suitable products available commercially can be obtained from DIN-Bezugsquellen für normgerechte Erzeugnisse im DIN Deutsches Institut für Normung e.V., Burggrafenstraße 6, D-10787 Berlin, Germany. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of these products.



Key

1 torque reaction arm
2 test lubricant
3 O-ring
4 O-ring
5 inner race
6 drive spindle
7 drive assembly for inner race
8 tightening nut
9 outer race
10 temperature control device
11 coolant inlet
12 housing
13 conical mounting point
14 location of temperature probe

Figure 1 — Shear stability testing apparatus

7 Preparation

7.1 Preparing the tapered roller bearing and testing apparatus assembly

7.1.1 Prior to the test, clean the housing, housing cover and tapered roller bearing inner and outer race with a cleaning solvent (see 5.1) and dry in a stream of dry air or with a clean, dry, lint-free cloth.

7.1.2 Inspect the O-rings (See Figure 1, items 3 and 4) fitted to the housing and housing cover to ensure that they are properly located and free from damage.

7.1.3 The bearing inner and outer race should be carefully inspected for evidence of mechanical damage, surface deposits, corrosion and thermal staining. Normal wear of the cup and rollers is indicated by a matt grey surface with light circumferential scratching. If damage due to pitting, scoring or surface staining is observed, the cup and cone should be replaced as an assembly. If surface deposits cannot be removed by the procedure detailed in this subclause (7.1), the bearing assembly should be discarded and replaced.

7.2 Assembly of the shear stability testing apparatus

NOTE The numbers in parentheses in this subclause correspond to the items in Figure 1.

7.2.1 Fit the outer race (9) into the cleaned housing (12) and fill with (40 ± 0,5) ml of the test sample.

7.2.2 Press the cleaned inner race (5) onto the drive assembly (7) for the inner race and ensure that it is seated correctly.

7.2.3 Place the inner race and inner race drive assembly into the prepared housing, ensuring that the rollers are fully seated in the outer race. Screw the housing cover into position and fully tighten it using hand pressure only.

7.2.4 Locate the assembled testing apparatus into the four-ball tester, ensuring that the drive spindle (6) engages with the drive assembly (7) for the inner race. Apply a load of (5 000 ± 200) N.

7.2.5 Connect the temperature probe (located at 14) and temperature control device (10) and check their function.

7.2.6 Running in the tapered roller bearing

Before starting the test, ensure that the SKF 32008 X/Q bearing has been run in in accordance with the running-in procedure shown in Figure 2.

NOTE The specified fluid RL 181 is becoming obsolete. Therefore, the CEC group is developing a new running-in and reference procedure, using RL 209 and RL 210.

7.3 Test conditions

The test conditions are specified in Table 1.

Table 1 — Test conditions

Test parameter	Test condition
rotational motor speed	approximately (1 475 ± 25) min^{-1}
lubricating oil temperature	(60 ± 1) °C
lubricating oil test quantity	(40 ± 0,5) ml
test load	(5 000 ± 200) N
test duration	1 740 000 revolutions, equivalent to approximately 20 h

For some applications, longer test runs may be appropriate. 200 h tests can correlate well with some high severity conditions in manual transmissions or axles.

The basis for specifying the test duration is a theoretical nominal rotational speed of 1 450 min^{-1} for asynchronous motors. When motors with other rotational speeds are used, the test durations should be adjusted accordingly.

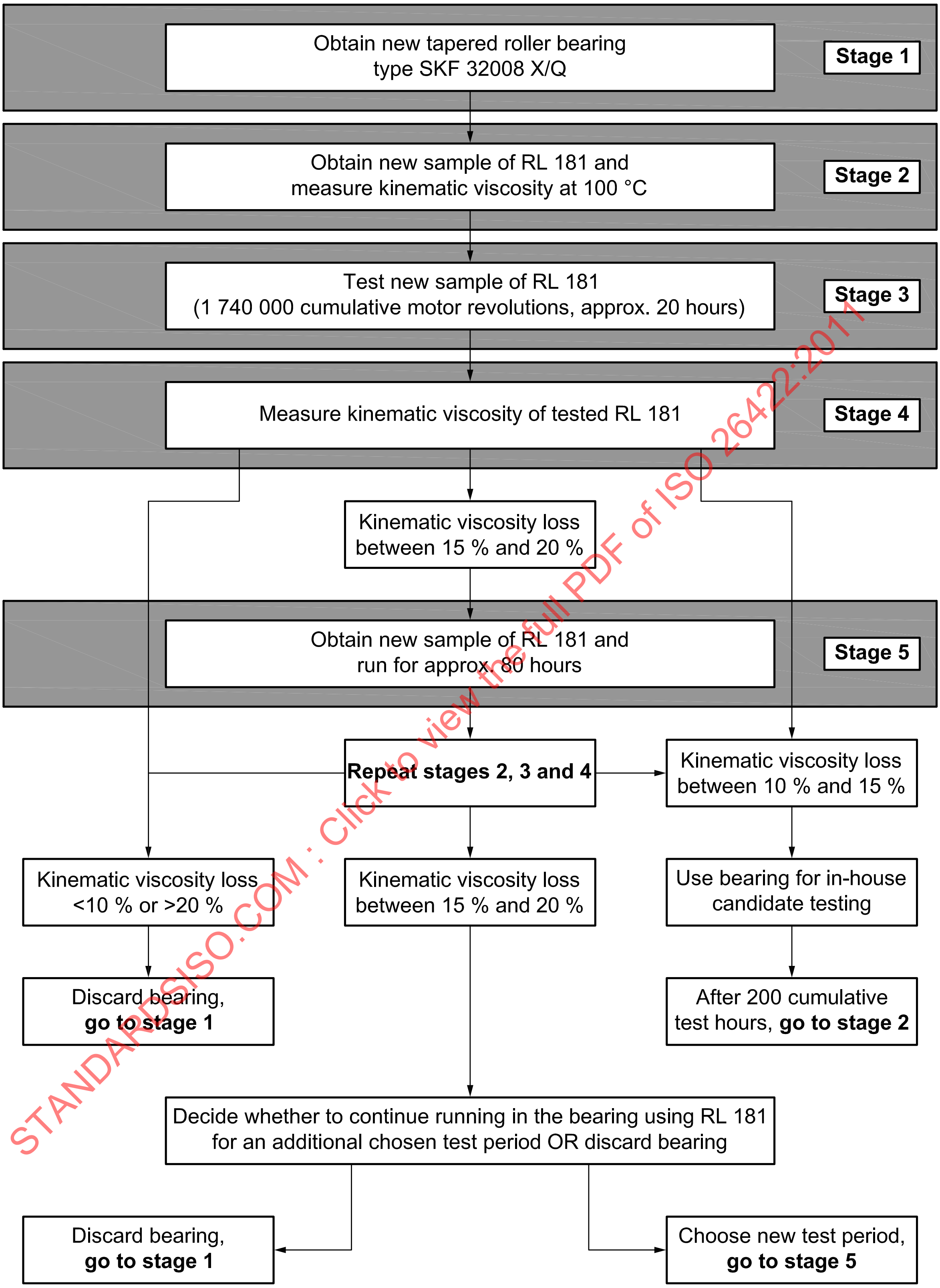


Figure 2 — Running-in procedure chart (see Clauses 5 to 8 for details)

8 Procedure

NOTE New bearings often result in a shear loss of above 15 % for RL 181 and need pre-conditioning (running-in process, see Figure 2).

8.1 After carrying out the check specified in 7.2.5, and before starting the motor, switch on the heater control unit and pre-heat the test sample to (50 ± 1) °C.

8.2 Once the temperature specified in 8.1 has been reached, set the temperature control to (60 ± 1) °C and start the motor.

8.3 The test run shall be finished at the end of the given test duration (see Table 1).

8.4 Determine the kinematic viscosity of the lubricating oil at 100 °C as specified in ISO 3104 before and after shearing. Calculate the percentage viscosity loss, R_V, in accordance with the equation in definition 3.1.

9 Referencing

In order to check whether the apparatus functions properly, reference tests shall be run. The laboratory shall run to the matrix given in Table 2. The only current set of limits is for oil RL 181, which should give results of greater than 10 % and less than 15 % shear loss. If the result for RL 181 is outside these limits, see the running-in procedure in 7.2.6. Only when the test rig meets the limits given for oil RL 181 can the installation be used for candidate evaluation.

Table 2 — Frequency of reference testing

Test number	Reference oil		
	RL 181	RL 209	RL 210
1	X		
10	X		
11		X	
20	X		
30	X		
31			X
40	X		
50	X		
51		X	
60	X		
70	X		
71			X
80	X		
(etc.)			

10 Reporting of results

Report the following:

— percentage viscosity loss, R_V, as a percentage, rounded to the nearest 0,1 %, as specified in 8.4;

— test duration.

EXAMPLE Using a tapered roller bearing (TRB), the percentage viscosity loss after a test run of 20 h, equivalent to 1 740 000 revolutions of the motor, is 29,55 %.

R_V (TRB; test duration C) = 29,6 %

11 Precision

11.1 General

The precision information given in Table 3 has been developed from quality check measurements. Since no repeat measurements were executed, a full statistical treatment using the provisions given in ISO 4259 was not possible. Therefore, the precision values given in this clause constitute precision estimates only for reproducibility.

NOTE The data sets used for this precision estimation are based on the results generated within the CEC SG-T-045 working group from approximately 15 laboratories. The laboratories used between one and five test rigs, from approximately 1 000 single quality check measurements, using reference oils RL 181, RL 209 and RL 210, over a period between the years 2000 and 2007.

11.2 Repeatability, r

In the long run, the difference between two test results obtained by the same operator with the same apparatus under constant operating conditions on identical test material would, in the normal and correct operation of the test method, exceed any published repeatability values in only one case in 20. However, there are currently no precision estimates available for repeatability.

11.3 Reproducibility, R

In the long run, the difference between two single and independent test results for a test duration of 20 h obtained by different operators working in different laboratories on identical test material would, in the normal and correct operation of the test method, exceed the estimated values given in Table 3 in only one case in 20.

Table 3 — Precision estimates for reproducibility (percentage viscosity loss)

Parameter	Reference oil		
	RL 181	**RL 209**	**RL 210**
number of measurements	649	209	147
mean percentage viscosity loss	12,5	8,1	22,0
standard deviation	1,42	1,61	2,09
estimated reproducibility	3,9	4,5	5,8