APPARATUS FOR THE DEVELOPMENT OF PERFORMANCE TEST FOR LUBRICANTS AND ENGINE FUELS

TEST CONFORMABLE
CEC L-14-A-79
IP 249/77
ASTM D 3945-86
DIN 51382

Evaluation of the Mechanical Shear Stability of Lubricating Oils Containing Polymers

APPROVED TEST METHOD

CEC CODIFICATION SYSTEM

CEC STANDARD TEST METHODS are codified according to a system consisting of nine letters and digits arranged in five groups, the latter four being separated by a hyphen; thus:

(i) the CEC initials

(ii) a letter indicating the field of application or the nature of the standard test procedure, where:

- L indicates test procedures for LUBRICANTS (engine or transmission) using standard engines or test apparatus.
- F indicates test procedures for FUELS, using standard engines or test apparatus.
- A indicates the specification of any laboratory APPARATUS that the CEC has developed in relation to test procedures.
- M indicates METHODS, or CODES of PRACTICE, used for:
  —the evaluation of the performance of engines, transmissions or other mechanical components using reference fuels or lubricants under specified running conditions, *or*:
  —the evaluation of the condition of engines, transmissions, or other mechanical components after completion of a test, *or*:
  —the evaluation of fuels or lubricants using specified engines, transmissions, or other mechanical components when operated under specified running conditions.

(iii) two or three digits indicating the chronological order of the procedure in one of the above classes.

(iv) a capital letter indicating the status of the procedure, thus:

- X for EXPERIMENTAL procedures; these are undergoing correlation programmes.
- T for TENTATIVE procedures; correlation programmes on these have been completed.
- A for APPROVED procedures; the Tentative stage on these has been completed and final modifications have been made.

EXPERIMENTAL procedures are available only to CEC member organisations; all others are generally available.

(v) two figures indicating the year in which the procedure was agreed and accorded status by Council.

REFERENCE FUELS and REFERENCE LUBRICANTS for use in correlation programmes or test development are codified RF and RL respectively, followed by a number. Details of Reference and Standardisation Lubricants are to be found in the CEC Handbook of Reference/Standardisation Oils for Engine/Rig Tests.

INTRODUCTION

A variety of lubricating oils, in particular multi-grade engine oils, contain polymeric additives, which reduce the tendency of the oils to change viscosity as temperature changes.

The continuous shearing of a lubricating oil, e.g. in an engine, results in a reduced effectiveness of these polymeric additives. It therefore became necessary to investigate this performance aspect with a standard laboratory rig test. The test method presented herewith was primarily developed for the testing of polymer-containing engine oils. The temperature of 100°C, at which the percentage viscosity drop is observed in this test, was chosen for this type of lubricating oil on the basis of the viscosity classification for engine oils. For hydraulic oils a test temperature of 40°C was chosen.

The results according to this test method characterize the "shear stability" of the test oil, the "percent viscosity loss" being used as the criterion of stability.

As mentioned in paragraph 3 of this test method, the percent viscosity loss is inversely proportional to the shear stability, i.e. small numerical values for the percent viscosity loss mean a high shear stability. This definition may seem illogical in the first instance but it was deliberately adopted in this test method because it is used in methods and specifications already in use (e.g. ASTM-D-2603-70, IP294/73T and DIN-51382) and it seemed desirable to avoid the possibility of confusion.

The present test method is intended for the evaluation of the shear stability of finished oils only and not for the shear stability of polymers alone. The latter is defined as a "shear stability constant".

The method described has been given full approval by the Co-ordinating European Council, with the reference number CEC L-14-A-78.

Results obtained from tests according to the ASTM-D-2603-70 standard method of test for sonic shear stability of polymer-containing oils of the American Society for Testing and Materials (ASTM), Philadelphia Pa., USA, do not lend themselves for comparison with this standard method.

The test method will also be used for hydraulic fluids. In this case shear stability is of special concern for hydraulic fluids that show a high VI and are intended for use in hydraulic equipment in the open.

Evaluation of the Mechanical Shear Stability of Lubricating Oils Containing Polymers

CEC L-14-A-78

1. SCOPE

This method is intended for the testing of lubricating oils containing polymers. Lubricating oils which may contain solid contaminants should not be introduced into the apparatus (e.g. used engine oils). Special precaution is needed, if hydraulic oils contain light volatile material.

2. PURPOSE OF TEST

This method provides a means for evaluating the shear stability of polymer containing oils. The shear stability estimated by this procedure permits conclusions to be drawn with respect to the permanent drop in viscosity to be expected in service.

3. DEFINITION

The shear stability according to this standard method is defined as the percent drop in viscosity computed from the following formula:

$$\text{Percent drop in viscosity} = \frac{\nu_0 - \nu_1}{\nu_0} \times 100 \times F \qquad (1)$$

where: ν_0 = kinematic viscosity of the unsheared oil
ν_1 = kinematic viscosity of the sheared oil
F = correction factor (for calculation see section 10)

Note: A small numerical value indicates a high shear stability.

4. UNITS

% for percent viscosity drop.
cSt for kinematic viscosity.
The SI-unit for the kinematic viscosity is m^2/s.
$1\ mm^2/s = 1 \times 10^{-6} m^2/s = 1$ centistoke = 1 cSt.

5. OUTLINE OF METHOD

A sample volume of 170 cm^3 is subjected to a specified number of cycles in the apparatus, the principal components of which are a two-cylinder fuel injection pump and an injection nozzle set to 175 bar.*

The kinematic viscosity of the untreated sample and also of the sheared sample is measured according to DIN 51562 or ASTM D-445.

For engine oils containing polymers, the number of cycles is 30; the kinematic viscosity is measured at 100°C.

For hydraulic oils containing polymers, the number of cycles is 250; the kinematic viscosity is measured at 40°C.

* 1 bar = 1.0197at.

Repeatability

(same operator, same apparatus)

Duplicate results by the same operator should be regarded as satisfactory if they do not deviate from one another by more than the corresponding values quoted in the following table.

Reproducibility

(different operators, different apparatus)

Results obtained by each of two different laboratories should be regarded as satisfactory if they do not deviate from one another by more than the corresponding values quoted in the following table:

Percent Viscosity Loss	Repeatability (%)	Reproducibility (%)
Engine Oils	1.5	4.5
Hydraulic Oils	2.0	3.5

APPENDIX

1. Spray nozzle.
2. Atomisation chamber.
3. Outlet of the atomisation chamber.
4. Distributor plate.
5. Glass container with cooling jacket.
6. Three-way cock downstream of cooler.
7. Glass container.
8. Three-way cock downstream of glass container
9. Support column.
10. Connection with pump-suction opening.
11. Double-plunger injection pump.
12. Pump setting screw.
13. Electric motor.
14. Venting screw/pump.
15. Stroke counter.
16. Pressure tubing from pump to injector.
17. Return line for overflowing liquid.
18. Manometer
19. Filter cartridge
20. Nozzle holder

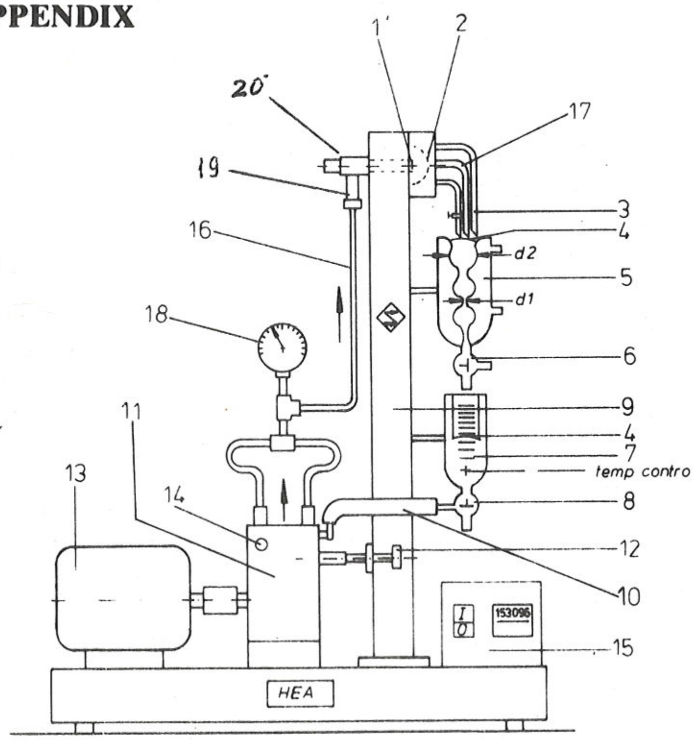
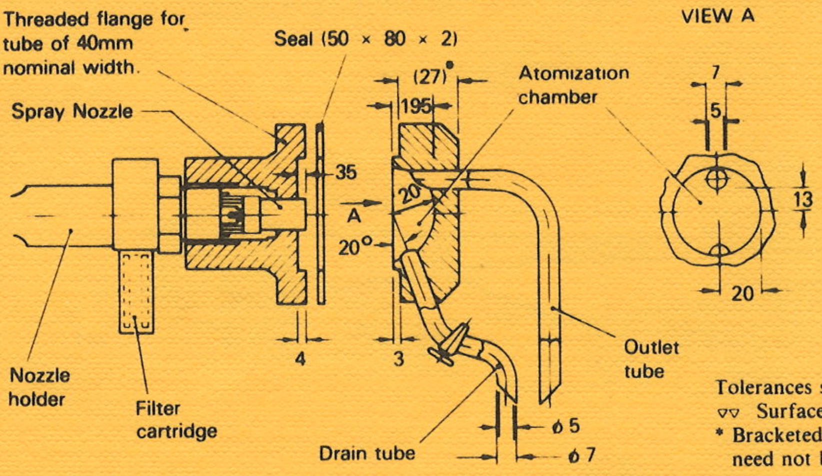


FIGURE 1 · APPARATUS FOR SHEAR STABILITY TESTING.

List of special spare parts to this Shear Testing Apparatus

Diesel injection fuel pump
Nozzle holder KD 43
Spray nozzle DN 8 S2, calibrated
Filter cartridge
Glass container with cooling jacket
Glass container with graduation 250 ml
Digital stroke counting compl.
Digital counter only
Readswich for counter
Atomization chamber
Distributor plate with books

Distributor plate only
Thermometer 100°C with hull
Manometer 0-250 bar
Cog belt
Digital Thermometer with feeler compl.
Pressure tubing from pump to atom. chamber
Contactor
Nozzles test apparatus
Calibration Oil RL 34, 1 liter
Cabinet for sound absorbing,
sound softer than 78%



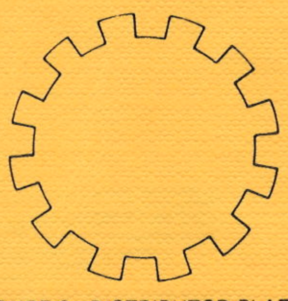


FIGURE 3 DISTRIBUTOR PLATE

Tolerances see DIN 7168, page 1
▽▽ Surface sequence 1 DIN 3141
* Bracketed measure (27) referring to model shown need not be observed.

FIGURE 2 ATOMISATION CHAMBER WITH SPRAY NOZZLE AND NOZZLE HOLDER

The dimensions shown in Fig. 2 for the atomisation chamber (2) should be observed.

A Bosch DN 8 S2-type pintle nozzle injector should be used as spray nozzle (1) and a Bosch KD 43 SA 53/13 with filter cartridge as nozzle holder. The injector opening pressure is to be set at 175 bar under static conditions with diesel fuel, using a nozzle tester. After pressure testing the nozzle should be cleared of all diesel fuel.

With a brand-new nozzle the pressure setting should be followed by a 4-hr. running-in period with the calibration oil.

The two glass containers (5 and 7), approx. 250 cm^3, are open at the top and can be closed below with a three-way cock (6 and 8). These three-way cocks (6, 8) should be of the cone type with a non-exchangeable solid plug (cf. DIN 12 544), bore 8 mm nominal size. The rubber tubing (10) connects the three-way cock (8) with the pump (11).

The glass container (5) is designed as a condenser, i.e. it has a jacket for circulating the cooling liquid. The inner glass wall is designed similarly to a spherical condenser. The diameter d_1 is approx. 50 mm, the diameter d_2 approx. 25 mm, the length, L, approx. 180 mm.

For distributing the test fluid, a distributor plate (4) should be fitted on the glass container (5) so that uniform run-down on the glass wall is ensured. A watch glass of approx. 40 mm diameter with serrated edge, allowing the oil to pass through (Fig. 3) may be used as a distributor plate. A protruding edge should be provided in the upper part of the glass container (5) to hold the distributor plate.

The glass container (7) has an inner diameter of approx. 45 mm and contains a similar distributor plate in order to prevent channelling in the liquid during the test. The glass container (7) is graduated in 25 cm^3 intervals. The temperature control point is placed immediately above the outlet of glass container (7) (cf. Fig. 1).

A double-plunger injection pump, type Bosch PE 2 A 90 D 300/3 S 2266 is used for pressure build-up.

The electric motor (13) is a three-phase AC motor with 1.1 kW output and 925 $\pm$ 25 rpm.

The stroke counter (15) for counting the pump strokes is fitted with an automatic cut-off.

The dead space for oil between the three-way cock (8) and the outlet of the nozzle (1) must be 20 $\pm$ 5 cm^3.

An oil pressure gauge may be connected to the pressure line (16).