

British Standard Methods of test for

Petroleum and its products

Part 50. Cone penetration of lubricating grease

(Identical with IP 50/69(79))

Méthodes d'essai du pétrole et des produits pétroliers
Partie 50. Pénétrabilité au cône des graisses lubrifiants

Verfahren zur Prüfung von Erdöl und Erdölprodukten
Teil 50. Konuspenetration von Schmierfetten

Foreword

BS 2000 comprises a series of test methods for petroleum and its products that have been published previously by the Institute of Petroleum (IP) and have been accorded the status of British Standards. Each method should be read in conjunction with BS 2000 : Part 0 'General introduction', which gives details of the BSI/IP agreement for publication of the series, lists more than 60 methods scheduled to be published in this way in 1982 and 1983, and provides general information on safety precautions, sampling and other matters.

The numbering of the other Parts follows that of the corresponding methods published in 'IP Standards for petroleum and its products, Part 1 Methods for analysis and testing'. BS 2000 : Part 50 is thus identical with IP 50/69, which was reapproved in 1979. This IP method was previously published in A5 format as BS 5296*, which has now been re-numbered and issued in the BS 2000 series. It is intended to issue further revisions when necessary in line with any technical changes that may be made in subsequent editions of this IP method.

This Part is technically equivalent to ISO 2137-1972 and incorporates the recommendations of the European Committee for Standardization (CEN) for the unification of national standards for this test method.

Caution. Attention is drawn to the safety precautions mentioned in Part 0 of this British Standard.

NOTE. The titles of the publications referred to in this Part of this British Standard are listed on the inside back cover.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

*Now withdrawn.

Method (identical with IP 50/69(79)¹)

ORIGINAL METHOD²

SCOPE

1. (a) This method covers five procedures for measuring the consistency of lubricating greases by penetration of a standard cone. This method includes procedures for the measurement of undisturbed, worked, prolonged worked, and block penetrations. Penetrations up to 400 may be measured. With the alternative method, penetrations up to 475 may be measured.

NOTE 1: The National Lubricating Grease Institute has classified greases according to their consistency as measured by the worked penetration. The classification is as follows:

NLGI grade	Worked penetration range
000	445 to 475
00	400 to 430
0	355 to 385
1	310 to 340
2	265 to 295
3	220 to 250
4	175 to 205
5	130 to 160
6	85 to 115

NOTE 2: The procedure for the measurement of penetration of petrolatum is described in Method ASTM D937-IP 179, Test for Penetration of Petrolatum.³

NOTE to note 2. BS 2000 : Part 179 is identical with IP 179.

(b) Undisturbed and unworked penetrations do not generally represent the consistency of greases in use as effectively as do worked penetrations. The latter are usually preferred for inspecting lubricating greases.

(c) Penetration of block greases can be obtained on those products which are sufficiently hard to hold their shape. These greases generally have penetrations below 85.

DEFINITIONS

2. (a) *Penetration* of lubricating grease is the depth, in tenths of a millimeter, that a standard cone penetrates the sample under prescribed conditions of weight, time, and temperature.

(b) *Working* is the subjection of a lubricating grease to the shearing action of the standard grease worker.

(c) *Undisturbed Penetration* is the penetration at 77°F (25°C) of a sample of lubricating grease in its container as originally received with no disturbance.

NOTE 3: The penetrations of soft greases are dependent upon the diameter of the container. Therefore, greases having undisturbed and unworked penetrations above 265 should be tested in containers having the same diameter limitations as those of the worker cup. The results on greases having penetrations below 265 are not significantly affected if the diameter of container exceeds that of the worker cup.

(d) *Unworked Penetration* is the penetration at 77°F (25°C) of a sample of lubricating grease which has received only minimum disturbance in transfer from the sample can to a grease-worker cup or dimensionally equivalent container.

(e) *Worked Penetration* is the penetration of a sample of lubricating grease after it has been brought to 77°F (25°C) and then subjected to 60 double strokes in a standard grease worker.

(f) *Prolonged Worked Penetration* is the penetration of a sample of lubricating grease after being worked more than 60 double strokes. The sample initially at a temperature of 59 to 86°F (15 to 30°C) is subjected to a prescribed number of strokes in a standard grease worker, brought to 77°F (25°C) in 1.5 h, worked an additional 60 double strokes, and penetrated.

(g) *Block Penetration* is the penetration at 77°F (25°C) of a sample of lubricating grease that is sufficiently hard to hold its shape.

¹ Under the standardization procedure of the Society, this method is under the jurisdiction of the ASTM Committee D-2 on Petroleum Products and Lubricants.

In the IP, this method is under the jurisdiction of the Standardization Committee.

² See Alternative Method for penetrations above 400.

³ *Annual Book of ASTM Standards*, Part 23.

SUMMARY OF METHOD

3. The penetration is determined at 77°F (25°C) by releasing the cone assembly from the penetrometer and allowing the cone to drop for 5 sec. Undisturbed penetrations are determined on the sample as received in its original container. Unworked penetrations are taken on samples transferred with a minimum of disturbance to a container suitable for test purposes. Worked penetrations are determined immediately after working the sample for 60 double strokes in the standard grease worker. Prolonged worked penetrations are determined on samples worked more than 60 double strokes. Block penetrations are determined on a freshly prepared face of a cube cut from a block of grease with a standard cutter.

APPARATUS

4. (a) *Penetrometer* – A penetrometer, similar to that shown in Fig. 1, shall be used to measure the penetration of the standard cone in the grease. The cone

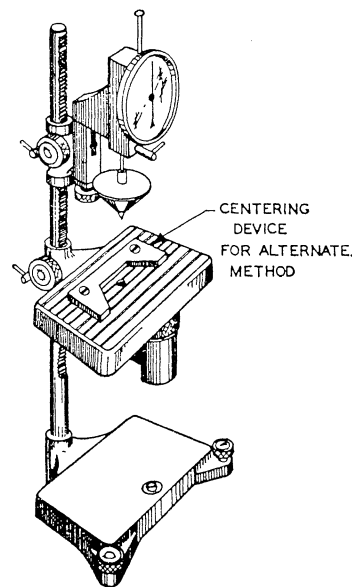


Fig. 1. Penetrometer.

assembly or the table of the penetrometer shall be adjustable to enable accurate placement of the tip of the cone on the level surface of the grease while maintaining a 'zero' reading on the indicator. The cone should fall, when released, without appreciable friction for at least 4.00 cm. The tip of the cone should not hit the bottom of the sample container. The instrument shall be provided with levelling screws and a spirit level to maintain the cone shaft in a vertical position.

(b) *Cone*, as specified in Appendix I.

(c) *Grease Worker*, as specified in Appendix I.

(d) *Grease Cutter*, having a sharp, rigidly-mounted, bevelled blade, essentially as specified in Appendix I, for preparing samples for block penetration.

(e) *Water Bath*, capable of regulation to $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$) and designed to bring the assembled worker to test temperature conveniently. If the bath is to be used also for samples for undisturbed and unworked penetrations, means should be provided for protecting the grease surface from water. A cover should also be provided to maintain air temperature above the sample at 77°F (25°C). An air bath, maintained at $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$), is required for determining block penetration; a tightly sealed container placed in the water bath will suffice.

NOTE 4: A constant-temperature test room or an air bath may be used instead of the water bath.

(f) *Spatula*, corrosion-resistant, square-ended, having a stiff blade 32 mm wide and at least 150 mm long.

PROCEDURE FOR UNDISTURBED PENETRATION

5. (a) *Sample* – The sample shall remain in its original container. The surface of the grease must be essentially level and even with the top of the container

NOTE to clause 4. Add item (g) 'Timer, registering to 0.1 s', for uniformity with ISO 2137 and as required in 5(d).

[Notes 3 and 5]. When mutually agreed upon by interested parties, the diameter of the container can be larger than that of the worker cup and the grease surface can be below the top of the container.

NOTE 5: The undisturbed penetration of a grease usually varies with the age of the sample. For references purposes, a mutually agreeable length of storage should be established.

(b) *Preparing Sample for Measurement* – Bring the temperature of the sample to $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$) by placing it, immersed within 1 in of the rim, in the covered water bath for 1 h [Note 4]. Take care that water is not allowed to get on the surface of the grease. After 1 h, remove the container from the bath and wipe off the water [Notes 6 and 7].

NOTE 6: If the initial sample temperature differs from 77°F (25°C) by more than about 15°F (8°C), or if an alternative method of adjusting the sample to 77°F (25°C) is used, allow sufficient additional time to assure that the sample is at $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$) before proceeding. Also, if the sample is larger than 0.5 kg, allow sufficient additional time to assure that the sample is at $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$). Testing may proceed if the sample is at a uniform temperature of $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$).

NOTE 7: When mutually agreed upon by interested parties, the surface of the grease may be levelled before testing by removing the top portion of the sample with a suitable scraper to a depth of about 3 mm below the lowest depression. Care should be taken to minimize the disturbance of the underlying grease.

(c) *Cleaning Cone and Shaft* – Clean the penetrometer cone carefully before each test. Bending of the cone shaft can be avoided by holding it securely in its raised position while cleaning. Do not permit grease or oil on the penetrometer shaft, as they can cause drag on the shaft assembly. Do not rotate the cone, as this may cause wear on the release mechanism.

(d) *Penetration Measurement* – Place the cup on the penetrometer table, making certain that it cannot teeter. Set the mechanisms to hold the cone in the 'zero' position, and adjust the apparatus carefully so that the tip of the cone just touches the centre of the test sample. Watching the shadow of the cone is an aid to accurate setting. Release the cone shaft rapidly, and allow it to drop for 5.0 ± 0.1 sec. The release mechanism should not drag on the shaft. Gently depress the indicator shaft until stopped by the cone shaft and read the penetration from the indicator.

If the sample has a penetration over 200, centre the cone carefully in the container; this sample can then be used for only one test. If the sample has a penetration of 200 or less, perform three tests in a single container, spacing these tests on three radii 120° apart and midway between the centre and side of the container so that the cone will neither strike the side of the container nor impinge on the disturbed area made in a previous test.

(e) *Additional Testing* – Make a total of three tests on the sample (either in three containers or in one, as described in Paragraph (d)), and report the average value, to the nearest unit, as the *undisturbed penetration* of the sample.

NOTE to 5(e). Test results should additionally be reported as having been obtained in accordance with BS 2000 : Part 50.

PROCEDURE FOR UNWORKED PENETRATION

6. (a) *Sample* – Sufficient sample (at least 0.5 kg) to overfill the cup of the standard grease worker shall be required. If sample size is insufficient and penetration ranges from NLGI grade 0 to 4, use Method ASTM D1403/IP 310. If the transferred penetration is above 200, at least three times the amount needed to fill the cup shall be required.

(b) *Preparing Sample for Measurement* – Place the empty assembled grease worker or metal container of equal inside dimensions and an appropriate amount of the sample in a metal container in the water bath maintained at 77°F (25°C) [Notes 4 and 6] for sufficient time to bring the temperature of the sample to $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$). Transfer from the container a portion of the sample, preferably in one lump, to overfill the cup of the grease worker or a metal container of equal inside dimensions [Note 3]. Make this transfer in such a manner that the grease will be worked as little as possible. Jar the container to

NOTE to 6(a). A method technically equivalent to ASTM D1403/IP 310 is under discussion internationally as ISO/DIS 6298, but in the UK view, is not required for international trade. It is recommended that this alternative method should only be used by agreement between the purchaser and the supplier of the grease being tested.

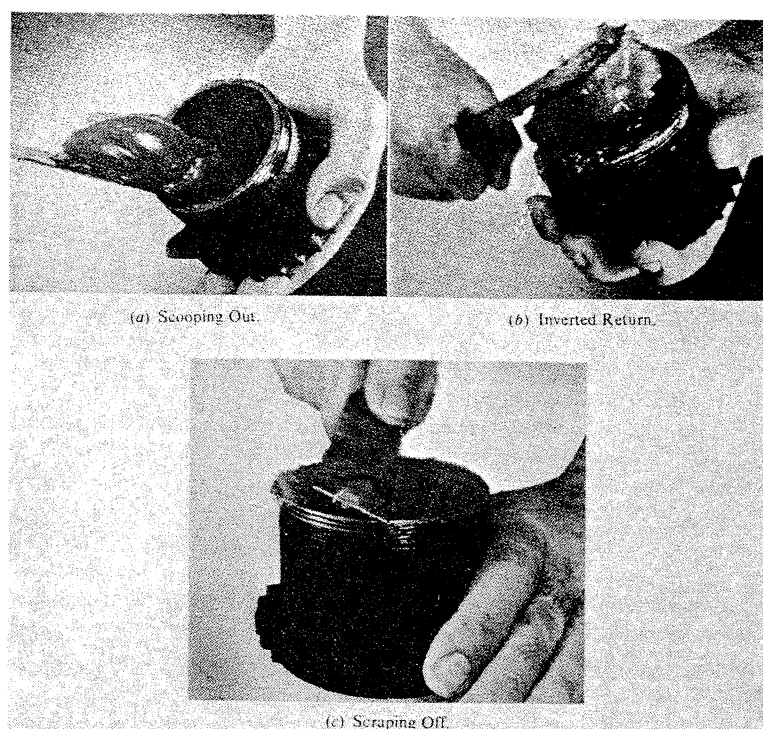


Fig. 2. Preparing worked sample for penetration measurement.

drive out trapped air and pack the grease with the spatula, with as little manipulation as possible to obtain a cupful without air pockets. Scrape off the excess grease extending above the rim by moving the blade of the spatula, held inclined towards the direction of motion at an angle of 45° , across the rim of the cup (Fig. 2(c)). Do not perform any further levelling or smoothing of the surface throughout the determination of unworked penetration and determine the measurement immediately.

(c) *Penetration Measurement* – Determine the penetration of the sample, as described in Section 5 (c), (d) and (e), and report the average value, to the nearest unit, as the *unworked penetration* of the sample.

NOTE to 6(c). See note to 5(e).

PROCEDURE FOR WORKED PENETRATION

7. (a) *Sample* – Sufficient sample (at least 0.5 kg) to overfill the cup of the standard grease worker shall be required. If sample size is insufficient and penetration ranges from NLGI Grade 0 to 4, use Method ASTM D1403, IP 310.

(b) *Working* – Transfer sufficient sample to the cup of the clean grease worker to fill it heaping full (moulded up about 13 mm at the centre), avoiding the inclusion of air by packing with the spatula. Jar the cup from time to time as it is being packed to remove any air inadvertently entrapped. Assemble the worker and, with the vent cock open, depress the plunger to the bottom. Insert a thermometer through the vent cock so that its tip is in the centre of the grease. Place the assembled worker in the water bath maintained at 77°F (25°C) [Notes 4, 6, and 8] until the temperature of the worker and contents are $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$) as indicated by the thermometer. Then remove the worker from the bath and wipe off the excessive water adhering to its surfaces. Remove the thermometer and close the vent cock. Subject the grease to 60 full 67 to 71.5 mm double strokes of the plunger, completed in about 1 min, and return the plunger to its top position. Open the vent cock, remove the top and plunger, and return to the cup as much of the grease clinging to the plunger as may readily be removed. As the worked penetration of a lubricating grease may change significantly on standing, proceed in accordance with Paragraphs (c), (d), and (e) without delay.

NOTE to 7(a). See note to 6(a).

NOTE 8: If it is desired to immerse the portion of the worker above its closure, take care that the lid is watertight in order to prevent the entrance of water to the worker.