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ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION

R 501

DETERMINATION OF THE CRUCIBLE SWELLING NUMBER OF COAL

1st EDITION
September 1966

BRIEF HISTORY

The ISO Recommendation R 501, *Determination of the Crucible Swelling Number of Coal*, was drawn up by Technical Committee ISO/TC 27, *Solid Mineral Fuels*, the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question by the Technical Committee began in 1951 and led, in 1960, to the adoption of a Draft ISO Recommendation.

In October 1962, this Draft ISO Recommendation (No. 551) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies:

Australia	Italy	Spain
Austria	Japan	Sweden
Belgium	Netherlands	Switzerland
Brazil	New Zealand	Turkey
Chile	Poland	United Kingdom
Czechoslovakia	Portugal	U.S.A.
Denmark	Republic of	U.S.S.R.
Germany	South Africa	Yugoslavia
India	Romania	

One Member Body opposed the approval of the Draft:

France

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council which decided, in September 1966, to accept it as an ISO RECOMMENDATION.

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DETERMINATION OF THE CRUCIBLE SWELLING
NUMBER OF COAL

1. SCOPE

This ISO Recommendation describes the method of determining the swelling properties of a coal when heated in a covered crucible.

2. PRINCIPLE

The coal is heated in a covered crucible under standard conditions to a final temperature of 820 ± 5 °C. The coke button obtained is classified by comparison with the outlines of a set of standard profiles. The number of the profile most closely corresponding to the coke button obtained is the crucible swelling number.

Gas or electrical heating may be used. When using an electrically heated apparatus the results obtained should be the same (within $1/2$ unit) as those obtained by the gas heating method.

3. SAMPLE

The air-dried coal to be tested is ground to pass a 0.2 mm sieve (see Note 1, page 12). Very fine grinding and undue exposure of the ground coal to the atmosphere should both be avoided since they are liable to lead to erroneous results. The coal should be ground on the same day that the test is carried out. With coals especially liable to oxidation the test should be carried out as soon as possible and not more than 2 hours after grinding, unless the sample can be stored in an inert atmosphere.

4. GAS HEATING METHOD

4.1 Apparatus

4.1.1 *Crucible and lid* (Fig. 1). Translucent silica crucible, squat form, and silica lid (see Note 2, page 12) with ring handle. Crucibles and lids of other ceramic materials may be used provided that the results agree with those obtained with silica crucibles. The crucible should conform to the following specifications:

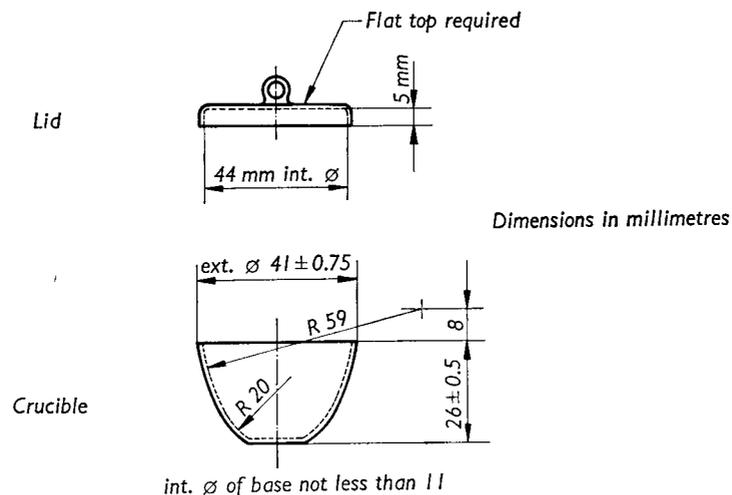|	
External height	26 ± 0.5 mm
External diameter at top	41 ± 0.75 mm
Minimum internal diameter at base.........	11 mm
Mass	11 to 12.75 g
Capacity	16 to 17.5 ml

Fig. 1. — **Crucible with lid for swelling test**

4.1.2 *Pierced silica lid* (Fig. 2). Similar to that above but with a 6 mm hole to accommodate the thermocouple.
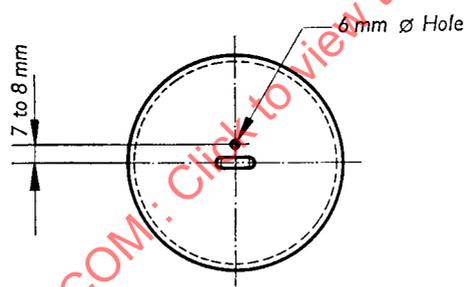

Fig. 2. — **Pierced crucible lid**

4.1.3 *Triangle.* Consisting of silica tubing of 6 to 6.5 mm external diameter mounted on nickel/chromium wire, the length of side being approximately 65 mm (see Note 3, page 12).

4.1.4 *Burner.* Capable of giving the required standard heating conditions; the following types have been found satisfactory:

  (*a*) A Teclu type burner; with coal gas of calorific value of about 4500 kcal/m³, the internal diameter of the burner tube should be approximately 12.5 mm.

  (*b*) A Meker type burner; with natural gas of calorific value of about 9300 kcal/m³, the external diameter of the burner grid should be approximately 30 mm.

4.1.5 *Gauge.* A gas pressure gauge.

4.1.6 *Draught shield.* Made from asbestos cement piping approximately 15 cm in length, 10 cm internal diameter and 11 cm external diameter. At one end the piping has three slots 2.5 cm deep in which the wire portions of the silica triangle rest (Fig. 3).
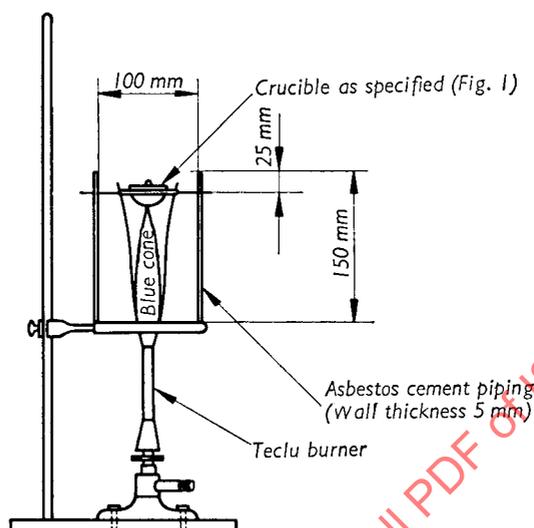

FIG. 3. — **Apparatus for the gas heating method**

4.1.7 *Thermocouple.* Of fine wire of diameter not greater than 0.23 mm if made of platinum or 0.45 mm if made of base metal. The ends of the couple are in the form of a flattened loop.

4.1.8 *Weight.* A 500 g weight.

4.2 Preparation of apparatus

Assemble the apparatus as shown in Figure 3. Place an empty crucible on the silica triangle and support it on the draught shield. Adjust the gas and air supplies to the burner so that the temperature of the inner surface of the base of the crucible reaches $800 \pm 10\,°C$ in 1 minute 30 seconds and $820 \pm 5\,°C$ in 2 minutes 30 seconds from first igniting the gas.

If a Teclu type burner is used it will generally be found that a flame approximately 30 cm long, with the crucible positioned just above the tip of the blue cone, will give the standard temperature conditions.

If a Meker type burner is used, the crucible is placed approximately 1 cm above the burner grid and the flame adjusted so that the standard temperature conditions are attained.

The temperature is measured by means of the thermocouple inserted through the pierced lid and having its unprotected junction and a portion of each wire in contact with the centre of the base of the empty crucible.

The apparatus should be checked at frequent intervals to ensure that the standard conditions apply.

4.3 Procedure

Before commencing the determination, mix the air-dried sample of coal thoroughly for at least one minute, preferably by mechanical means.

Weigh 1.00 to 1.01 g of the freshly ground coal into a dry crucible and lightly tap the crucible about 12 times on the bench to level the surface of the coal. Cover the crucible with the unpierced lid and place it upright on the silica triangle supported in the draught shield. Light the gas and heat at the predetermined rate for such time as is required for the flame of the burning volatile matter to die out and in any case for at least 2 minutes 30 seconds. Turn off the gas and allow the crucible to cool.

Remove the residue carefully from the crucible.

If the residue is non-coherent, i. e. mostly loose powder, no further examination is needed and this result is designated swelling number O.

If the residue is coherent coke button but is not swollen, place it on a flat surface and rest the 500 g weight on it. If the button supports the 500 g weight without breaking into more than two or three hard pieces, it is designated swelling number 1; if it crumbles, or disintegrates, then it is designated swelling number $\frac{1}{2}$.

If the coke button is swollen compare it with the standard numbered profiles shown in Figure 4. The button is rotated about its axis so that its largest profile is presented for comparison; the result is designated by the swelling number inscribed in the outline in Figure 4 which it most nearly matches. A method of viewing to avoid the effect of parallax is shown in Figure 5.

Carry out five tests; after each test burn off the carbon residue and wipe the crucible with a clean cloth.
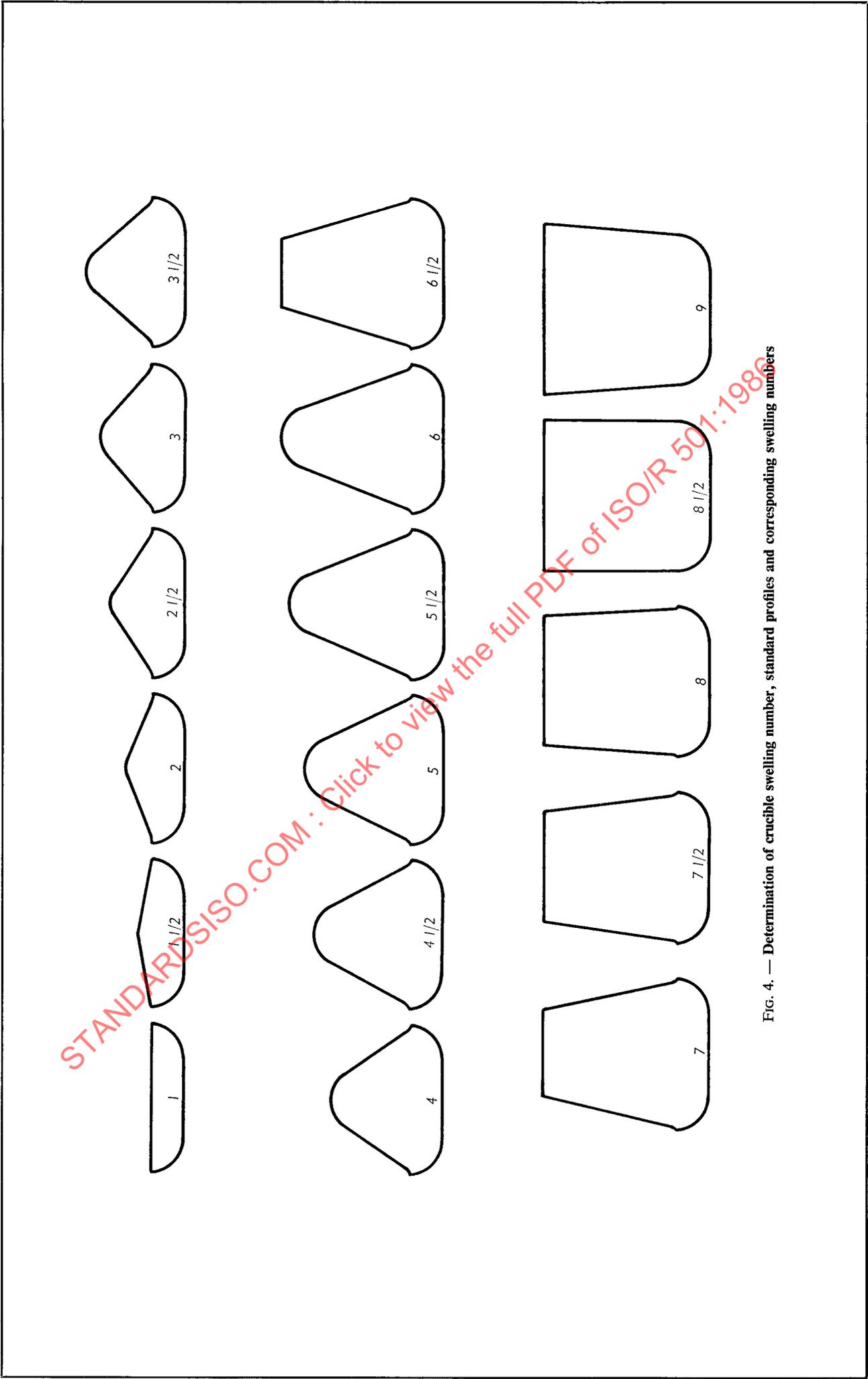
FIG. 4. — Determination of crucible swelling number, standard profiles and corresponding swelling numbers