
International Standard



333

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Coal — Determination of nitrogen — Semi-micro Kjeldahl method

Charbon — Dosage de l'azote — Méthode semi-micrométrique de Kjeldahl

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been authorized has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 333 was developed by Technical Committee ISO/TC 27, *Solid mineral fuels*.

This third edition was submitted directly to the ISO Council, in accordance with clause 6.11.2 of part 1 of the Directives for the technical work of ISO. It cancels and replaces the second edition (i.e. ISO 333-1979), which had been approved by the member bodies of the following countries:

Austria	India	Romania
Belgium	Italy	South Africa, Rep. of
Canada	Japan	Spain
Chile	Mexico	Turkey
Czechoslovakia	Netherlands	United Kingdom
Denmark	New Zealand	USSR
France	Poland	Yugoslavia
Germany, F.R.	Portugal	

No member body had expressed disapproval of the document.

The second edition, which superseded ISO 333-1975, incorporated the modifications which had been circulated as draft Amendment 1 to the member bodies in October 1977. This draft amendment had been approved by the member bodies of the following countries:

Australia	Germany, F.R.	South Africa, Rep. of
Austria	India	Turkey
Belgium	Iran	United Kingdom
Bulgaria	Japan	USA
Canada	Mexico	USSR
Chile	Netherlands	Yugoslavia
Czechoslovakia	Poland	
France	Romania	

No member body had expressed disapproval of the document.

Coal — Determination of nitrogen — Semi-micro Kjeldahl method

1 Scope and field of application

This International Standard specifies a method of determining the nitrogen content of hard coal, brown coal and lignite by the semi-micro Kjeldahl method.

NOTE — An alternative macro method for coal is given in ISO 332.

2 References

ISO 332, *Coal — Determination of nitrogen by the macro Kjeldahl method*.

ISO 1170, *Coal and coke — Calculation of analyses to different bases*.

3 Principle

A known mass of the sample is heated with concentrated sulphuric acid in the presence of a mixed catalyst to convert the nitrogen into ammonium sulphate, from which the ammonia, released by steam distillation from alkaline solution, is absorbed in boric acid and determined by titration with sulphuric acid.

In bituminous coals and anthracite, the nitrogen is fairly uniformly distributed, even when the seam is banded. In some brown coals and lignites, the nitrogen varies in the different bands of the seam, and sampling difficulties make it undesirable to employ a semi-micro method using only a 0,1 g sample; in these circumstances, the macro Kjeldahl method specified in ISO 332, using a 1 g sample should be adopted for such banded brown coals and lignites.

4 Reagents

All reagents shall be of recognized analytical quality, and distilled water or water of equivalent purity shall be used throughout.

4.1 Mixed catalyst, containing by mass:

- 32 parts of anhydrous potassium sulphate;
- 1 part of selenium powder;
- 5 parts of mercury(II) sulphate.

Grind the above reagents in a mortar and mix them thoroughly.

4.2 Sucrose.

4.3 Sulphuric acid, ρ , approximately 1,84 g/ml, approximately 98 % (m/m).

4.4 Boric acid solution, saturated.

Dissolve 60 g of boric acid in 1 litre of hot water, cool and allow to stand for 3 days before decanting the clear liquid.

4.5 Sodium sulphide, alkaline solution.

Dissolve 20 g of sodium sulphide nonahydrate ($\text{Na}_2\text{S} \cdot 9\text{H}_2\text{O}$) in water, and dilute to 50 ml; add a solution of 240 g of sodium hydroxide in 600 ml of water, and mix thoroughly.

4.6 Sulphuric acid, standard volumetric solution, $c(1/2 \text{H}_2\text{SO}_4) = 0,01 \text{ mol/l}$.

4.7 Mixed indicator solution.

Solution A — Dissolve 0,125 g of 4'-dimethylaminoazobenzene-2-carboxylic acid (methyl red) in 60 ml of ethanol or industrial spirit, and dilute to 100 ml with water.

Solution B — Dissolve 0,083 g of 3,7-bisdimethylamino-phenothiazinium chloride (methylene blue) in 100 ml of ethanol or industrial spirit. Store in a dark glass bottle.

Mix equal volumes of solutions A and B. Discard the mixed solutions after 1 week.

5 Apparatus

5.1 **Graduated glassware**, conforming to the International Standards prepared by ISO/TC 48, *Laboratory glassware and related apparatus*.

5.2 **Digestion flask**, of borosilicate glass, of bulb capacity 50 ml, preferably pistol-shaped, with a light blown bulb of borosilicate glass which is a loose fit in the neck of the flask, to prevent loss of acid.

5.3 **Distillation apparatus**: a suitable water/steam distillation apparatus of borosilicate glass, fitted with a splash head to arrest the passage of any entrained sodium hydroxide from the distillation flask (see figure 1).

5.4 Receiver: a wide-necked, flat-bottomed conical flask, capacity 100 ml.

5.5 Burette, capacity 25 ml.

5.6 Heating arrangement, to heat simultaneously two or more flasks inclined at about 35° from the vertical. A suitable arrangement is illustrated in figure 2.

5.7 Analytical balance, capable of weighing to an accuracy of 0,1 mg.

6 Preparation of sample

The coal used for the determination of nitrogen content is the analysis sample ground to pass a sieve of 212 µm aperture. Expose the sample in a thin layer for the minimum time required for the moisture content to reach approximate equilibrium with the laboratory atmosphere (this is particularly important for brown coals and lignites).

Before commencing the determination, mix the air-dried sample for at least 1 min, preferably by mechanical means.

7 Procedure

7.1 Digestion

Weigh, to the nearest 0,1 mg, about 0,10 g of the sample and transfer carefully to the digestion flask (5.2). Add 2,0 g of the mixed catalyst (4.1) and shake to mix. Add 4 ml of the sulphuric acid (4.3) and mix again.

Switch on the electric heating unit at approximately half load for 20 min, and then at maximum load for 10 min before placing the flask on the unit. Alternatively, with gas heating, place the digestion flask over the fully aerated flame of a micro-burner and adjust the flame so that clearing of the solution is effected in a time of 7 to 10 min, for example by using a flame 50 mm high with the lowest part of the bulb of the flask 40 mm above the top of the burner. After the solution becomes clear, continue boiling to give a total digestion time of 25 to 30 min, in order to complete the conversion of the nitrogenous compounds into ammonium sulphate.

NOTE — The total digestion time should be rigorously followed for the conditions specified.

7.2 Distillation

During the digestion, steam out the distillation apparatus (5.3) (see the note), close the connection to the distillation flask, and blow out the waste from the previous distillation. Pour 20 ml of the alkaline sodium sulphide solution (4.5) into the distillation flask through the funnel, and rinse with water. Measure 2 ml of the boric acid solution (4.4) into the receiver (5.4), and add 4 drops of the mixed indicator solution (4.7), adjusting a block under the receiver so that the end of the condenser tube dips below the surface of the liquid.

Allow the digest to cool for 5 min, and dilute by adding 10 ml of distilled water, in drops at first, and shaking, until the reaction is less violent. Pour the diluted digest through the tap funnel into the distillation flask; rinse the digestion flask into the tap funnel with water, then rinse the tap funnel with water. The total volume of liquid in the distillation flask should not exceed half the capacity of the flask, or frothing and priming may occur.

Heat the distillation flask with a small flame and pass steam into the apparatus. Distil for 5 min from the time the steam enters the condenser, at a rate of about 4 ml of distillate per minute. Lower the receiver so that the condenser end is about 25 mm above the surface of the liquid, and continue distillation for 1 min longer. The contents of the receiver should remain cold. Rinse the end of the condenser tube with water.

Add a few drops of the mixed indicator solution (4.7) to the distillate and titrate the ammonia present in the distillate with the sulphuric acid solution (4.6) until the grass-green colour changes to steel-grey, a further drop then giving the purple (acid) colour.

NOTE — The distillation apparatus should be conditioned by steaming through for 30 min before commencing a batch of distillations. There is no need, however, to do this between individual distillations in a batch.

7.3 Blank test

Carry out a blank test in exactly the same manner, but using 0,1 g of the sucrose (4.2) instead of the sample.

NOTE — If the splash head removes all entrained sodium hydroxide, the results of the blank test should not exceed 0,1 ml of 0,01 mol/l sulphuric acid (4.6). Steam removes alkali compounds from some glasses and, if higher blank results are found, the central tube of the condenser should be replaced by a fused silica or borosilicate glass tube.

8 Expression of results

The nitrogen (N) content of the sample as analysed¹⁾, expressed as a percentage by mass, is given by the formula

$$\frac{1,4 \, c \, (V_1 - V_2)}{m}$$

where

V_1 is the volume, in millilitres, of the sulphuric acid solution (4.6) used in the determination;

V_2 is the volume, in millilitres, of the sulphuric acid solution (4.6) used in the blank test;

c is the actual concentration, expressed in moles per litre, of the sulphuric acid solution (4.6);

m is the mass, in grams, of sample taken.

The results (preferably the mean of duplicate determinations, see 9.1) shall be reported to the nearest 0,01 %.

1) Calculation of the results to other bases is dealt with in ISO 1170.

9 Precision of the method

Nitrogen	Maximum acceptable differences between results (calculated to the same moisture content)	
	Same laboratory (Repeatability)	Different laboratories (Reproducibility)
	0,05 % absolute	0,10 % absolute

9.1 Repeatability

The results of duplicate determinations, carried out at different times in the same laboratory by the same operator with the same apparatus on representative portions taken from the same analysis sample, shall not differ by more than the above value.

9.2 Reproducibility

The means of the results of duplicate determinations, carried out in each of two laboratories on representative portions taken

from the same sample after the last stage of sample preparation, shall not differ by more than the above value.

10 Test report

The test report shall include the following particulars :

- a) the identification of the product tested ;
- b) the reference of the method used ;
- c) the results and the method of expression used ;
- d) any unusual features noted during the determination ;
- e) any operation not included in this International Standard, or regarded as optional ;
- f) the date of the test.

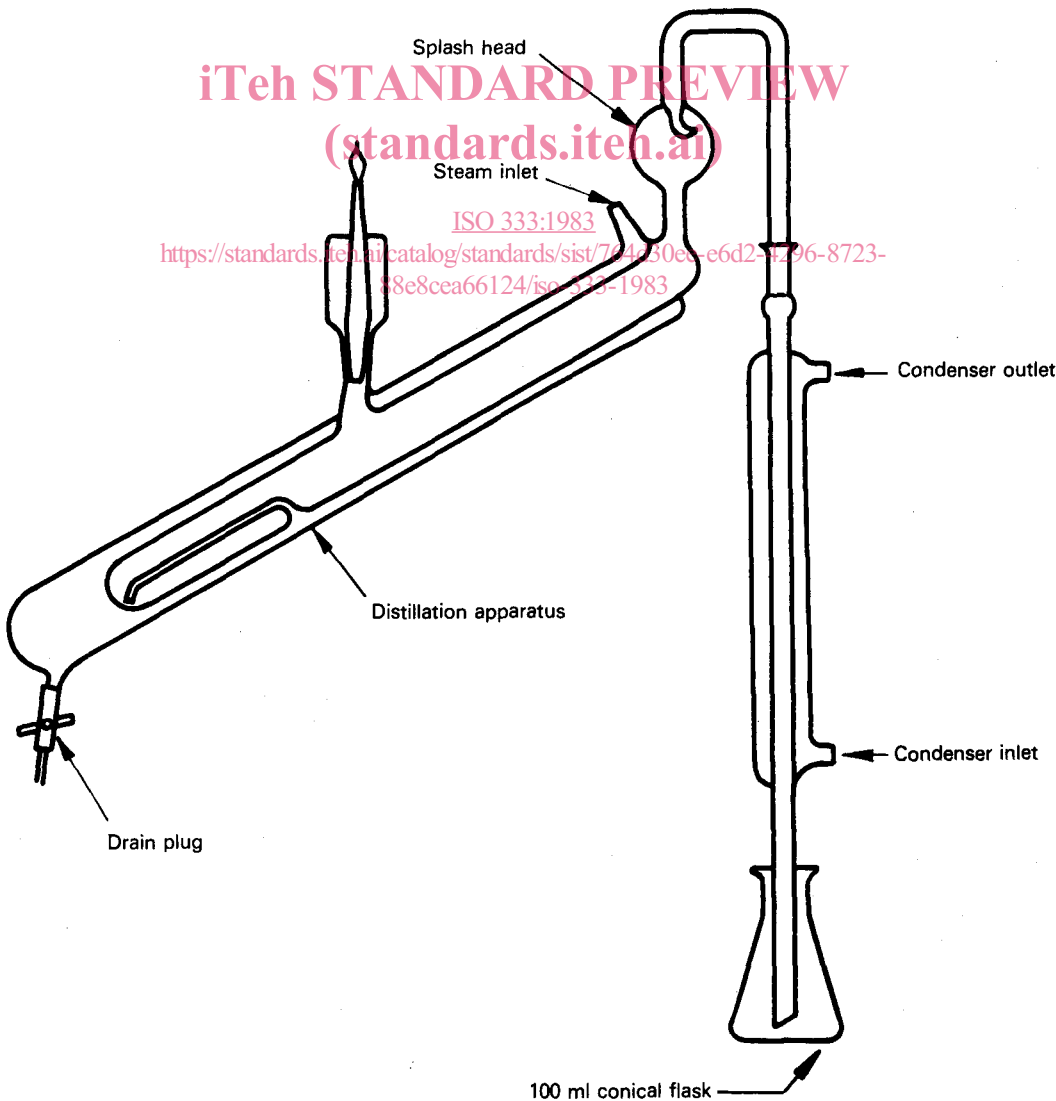
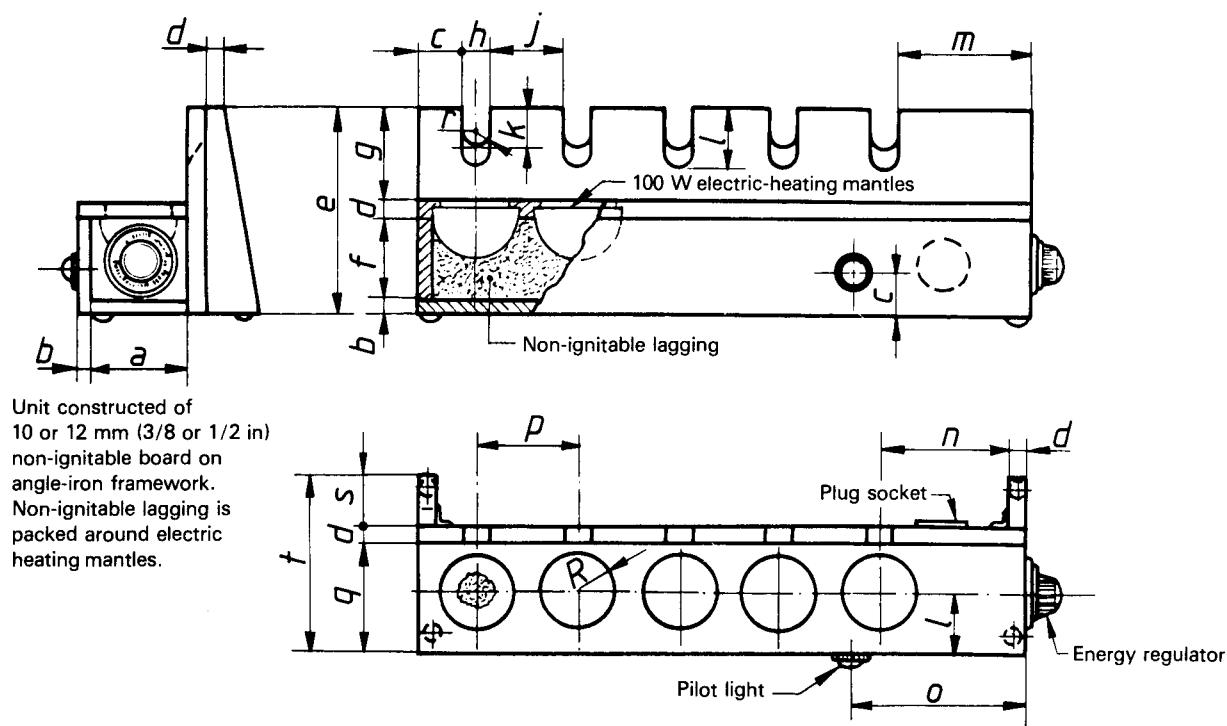


Figure 1 — Suitable distillation apparatus



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Dimensions	mm ¹⁾	in
a	73	2 7/8
b	9,5	3/8
c	31,8	1 1/4
d	12,7	1/2
e	152	6
f	60	2 3/8
g	69	2 3/4
h	19	3/4
j	57	2 1/4
k	28,5	1 1/8
l	44,5	1 3/4
m	98	3 7/8
n	95	3 3/4
o	130	5 1/8
p	76	3
q	82	3 1/4
r	9,5	3/8
R	28,5	1 1/8
s	38	1 1/2
t	133	5 1/4

1) These dimensions have been rounded off.

Figure 2 — Electric digestion unit suitable for semi-micro Kjeldahl method