BS 2096:1954

Method of testing oil-fired rotary dryers for use in asphalt and coated macadam plant

UDC 625.85.088:66.047 – 63

Co-operating organizations

The Road Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:—

Air Ministry*
Asphalt Roads Association*
Association of Consulting Engineers (Incorporated)
Ballast, Sand and Allied Trades Association
British Road Tar Association*
British Tarpaviors' Federation*
Cement and Concrete Association*
County Surveyors' Society*
D.S.I.R. — Road Research Laboratory*
Federation of Civil Engineering Contractors*
Federation of Coated Macadam Industries*
Federation of Manufacturers of Contractors Plant*
Institute of Petroleum
Institution of Civil Engineers*
Institution of Highway Engineers*
Institution of Municipal Engineers*
Institution of Structural Engineers
Ministry of Transport and Civil Aviation*
Road Emulsion Association*
Roads Improvement Association

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:—

Association of Road Surface Dressing Contractors
British Compressed Air Society
British Engineers' Association
British Granite and Whinstone Federation
British Slag Macadam Federation
Contractors' Plant Association
D.S.I.R. — Building Research Station
Limestone Federation
Ministry of Supply
Ministry of Works
National Federation of Building Trades Employers
Reinforced Concrete Association
Road Roller Manufacturers
War Office

This British Standard, having been approved by the Road Engineering Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 4 March 1954

ISBN 0 580 34145 3

Amendments issued since publication

Amd. No.	Date	Comments

Contents

Foreword

This standard makes reference to the following British Standards:—

BS 63, *Single-sized roadstone and chippings.*

BS 594, *Rolled asphalt, asphaltic bitumen and fluxed lake asphalt (hot process).*

BS 802, *Tarmacadam and tar carpets (granite, limestone and slag aggregate).*

BS 812, *Methods for the sampling and testing of mineral aggregates, sands and fillers.*

BS 1241, *Tarmacadam and tar carpets (gravel aggregate).*

BS 1621, *Bitumen macadam with crushed rock or slag aggregate.*

BS 1690, *Fine cold asphalt.*

BS 2040, *Bitumen macadam with gravel aggregate.*

The output of a mixing plant is often determined by the output of its drying and heating unit, and so far there has not been an accepted basis for measuring the performance of this unit under standardized conditions.

To meet this need the plant manufacturers, the plant users and the Road Research Laboratory (Department of Scientific and Industrial Research) have co-operated with the Road Engineering Industry Standards Committee, in the production of the present standard.

This standard provides a method of testing oil-fired rotary dryers of both continuous and batch types under conditions of composition and temperature agreed between the parties concerned.

When the user does not lay down particular conditions, the recommended test conditions given in Part 2 may be used to cover the production of rolled asphalt, coated macadam and fine cold asphalt. These recommendations also form a basis upon which a manufacturer can state the output of oil-fired rotary dryers.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 7 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Part 1. General conditions

1 Scope

This British Standard lays down a standard method for testing oil-fired rotary aggregate dryers of both continuous and batch types, and for reporting the results. Recommended test conditions corresponding to the requirements in the manufacture of rolled asphalt, coated macadam and fine cold asphalt are included for use when special test conditions are not laid down, and as a basis upon which manufacturers may declare the output of dryers.

2 Conditions of test

Before starting the test the feed of the dryer shall be adjusted to the rated output of the plant and the following conditions of test shall be approved:—

Type of aggregate to be used.

Grading of aggregate.

Moisture content in aggregate.

Temperature at discharge.

Moisture content in aggregate after drying.

Where special test conditions are not laid down the recommended conditions of test given in Table 1 may be adopted for dryers to be used in the manufacture of rolled asphalt, coated macadam or fine cold asphalt.

3 Measurements required

The following measurements shall be made:—

a) The output of aggregate in tons per hour.

b) The moisture content
c) The temperature
d) The grading of the aggregate } before and after drying.

e) The fuel consumption in gallons per hour and in gallons per ton of output.

NOTE The temperature and humidity of the air shall be recorded and an indication given of the strength of the wind.

4 Duration of test

The test period shall be at least 30 minutes. Immediately before the beginning of the test period the dryer shall be run under test conditions for at least 15 minutes, or for such longer time as may be required for stable conditions to be obtained. No variation in conditions shall be made during the period of the test except minor variations (made either manually or automatically) in burner settings to control the temperature.

5 Consistency of aggregate feed

Means shall be provided to maintain a constant composition and constant rate of feed throughout the test period. The ratio of material passing and retained on an ⅛ in. mesh should be accurately controlled. A constant feed shall be maintained until the last test results have been recorded.

In testing batch dryers the time cycle shall be constant throughout the period of test.

6 Test procedure

a) *Output*. The output shall normally be measured at the outlet of the dryer. Where practicable the entire quantity of aggregate dried during the test period shall be discharged as directly as possible into tared vehicles and weighed on an approved weighbridge.

When the test is carried out in the course of normal production or on large continuous dryers, where it is not convenient to weigh the whole output, at least six measurements shall be made, taking the discharge for short periods only, at regular intervals. A tared container should be moved into position to catch the whole flow, or the flow diverted to such a container, for a period which can be accurately timed by a stop watch (e.g. 10 sec.–30 sec. according to the capacity of the dryer being tested). The rate of flow in tons per hour shall be calculated from the weight of the aggregate in the container.

b) *Determination of moisture content*. At least six samples of the aggregate shall be taken at approximately even intervals throughout the test period, from both the feed and the discharge ends of the dryer. Where possible, quantities of about ½ cwt. shall be taken by catching the whole flow in a container inserted into the stream of material. Each of these batches shall be reduced on a sample splitter or "quartered" to give a final sample of about 10 lb. which shall be put into a suitable previously-weighed container, for subsequent determination of the moisture content. Where possible the sample and container shall be weighed immediately to obtain the weight of the sample and its moisture. Care shall be taken to minimize the loss of moisture, particularly from warm material, during the sampling procedure. If immediate weighing is not possible, then an air-tight container shall be used, such as a lever-lid tin, and this container and its contents shall be weighed before unsealing. A balance capable of weighing up to 7 kg., readable and accurate to 1.0 g., shall be used.

The sample should be thoroughly dried either in a well-ventilated oven at 105–110 °C. (221–230 °F.) for 24 hours, or by heating over a burner in an open tray, with constant stirring, for 30 minutes after all visible evidences of moisture have disappeared. This method of drying should be repeated on the first sample to ensure that no further loss of weight occurs.

The moisture content of the sample is the difference between the initial and final dried weight expressed as a percentage of the final weight.

If the system of feeding the dryer is such that the above method of sampling would not give reasonably representative samples of mixed constituents at the feed end, then separate sets of samples shall be taken from each constituent of the feed, their moisture contents measured independently, and the average moisture content calculated from the ratios of the various constituents used in the mixed feed material.

This ratio may have to be estimated from the grading as referred to under d).

c) *Temperature measurement*. When the feed is from open stock piles, two or three readings of input temperature (measured by inserting a thermometer deeply into the heap) will be adequate. Should there be, reason to expect variations in feed temperature (e.g. when feeding from bulk storage bins of pre-dried material), then samples should be taken by the same method and of the same frequency as laid down below for the outlet temperature determination.

Temperature measurements shall be made on the aggregate leaving the dryer at regular intervals during the period of the test, so that at least six results are obtained during the period of the test. The samples shall be taken by inserting a lagged container[1)] into the stream of aggregate, leaving the dryer so as to catch the whole flow for a period sufficient to collect about 20–30 lb. of material. A lid shall be placed on the lagged container and the aggregate inside shall be mixed gently at intervals for five minutes to allow the temperature of the different particle sizes to even out; the temperature shall then be determined. A can of 3 in. diameter by 6 in. deep may be used on asphaltic materials where the sand content is greater than 50 per cent.

The thermometers used should have a range appropriate to the temperature of the materials, say 0–50 °C. (32–122 °F.) for the feed materials, and 0–260 °C. (32–500 °F.) for the discharge, and their thermal capacity should not exceed that of a mercury-in-glass thermometer of about ¼ in. diameter.

The thermometer used for the discharge temperature should be kept in some of the hot material of each batch till the following batch is ready.

d) *Grading of aggregate*. During the process of "quartering" the batches referred to in b) a sufficient quantity shall be retained from each batch for drying and sieving in accordance with BS 812[2)]. The sample dried for determination of moisture content, if of adequate size, may be used for this grading.

If two or more constituents of the aggregate are fed in sequence through the same feed hopper, samples taken as described in b) may not be representative of the mixed feed materials. In such cases, accurate sieve analysis of the feed cannot be made. An approximation should be made by taking sets of samples, each set comprising a sample of each constituent of the feed as brought to-the feed hopper.

These samples should be graded separately and the composite grading obtained by combining the results in the proportions of each constituent used in the feed. If this result is not in reasonable agreement with the grading of the discharged materials, then combinations of different proportions of the constituent gradings should be tried, due allowance being made for possible loss of fines during drying, until ratios are found which give a composite grading as close as possible to that of the discharged material. The proportions so found shall be taken as those of the feed material for the purposes of estimation of the moisture content in b).

e) *Oil consumption*. The total quantity of oil used during the test period shall be measured to an accuracy of ± 2½ per cent. Where possible, a small service fuel tank mounted on a scale, or so connected that it can be weighed or measured accurately by dipping at the beginning and end of the test period, should be used, and the quantity of oil burned calculated from the difference in readings.

[1)] Before taking the first sample, the container should be brought to temperature by taking a few trial samples before the start of the test period

[2)] BS 812, "*Methods for the sampling and testing of mineral aggregates, sands and fillers*"

Alternatively, the oil level in the main tank should be measured at the beginning and end of the period. The duration should be such that the change of level is at least 1½ in. and the measurement should be made to an accuracy of $\pm$ $^1/_{16}$ in. If a change of level as indicated is not achieved, a service tank must be fitted. All other conditions affecting the level should be the same at the beginning and end of the period. If the tank is of such a shape that the surface area of the oil can be accurately measured, and does not vary appreciably between the two levels, then the quantity can be calculated from the change of level.

If the tank shape is irregular, the quantity should be measured indirectly. When the burners are off, the level should be restored to the initial position. Oil should then be drawn off into separate containers, in which it can be measured, until the level in the tank falls to the lower test level. The quantity drawn off shall be taken as the consumption during the test. In some circumstances it may be more convenient to add a measured quantity of oil to raise the level in the tank from the lower to the higher test level.

The oil consumption shall be expressed in gallons per hour, and in gallons per ton of aggregate dried, the type, calorific value and specific gravity of oil used being specified.

Part 2. Recommended conditions of test (For use when special conditions are not laid down)

7 Recommended conditions of test

When special conditions of test are not laid down, use of the conditions given in Table 1 are recommended to cover the production of rolled asphalt, coated macadam, and fine cold asphalt.

Table 1 — Recommended conditions of test

	Rolled asphalt[a]	Coated macadam[b]	Fine cold asphalt[d]
Feed			
Type of aggregate	Crushed rock or gravel	Crushed rock, gravel or slag	Crushed rock or slag
	Per cent by wt.	*Per cent by wt.*	
Grading	½ in. stone (40 to 60 retained ⅜ in.) 25 ± 5 Sand (Table 4a, BS 594) 75 ± 5 100	½ in.–⅛ in. (40 to 60 retained ⅜ in.) 80 ± 5 ⅛ in. dust 20 ± 5 100	As Table 2, BS 1690
Temperature	Not less than 5 °C. (41 °F.)	Not less than 5 °C. (41 °F.)	Not less than 5 °C. (41 °F.)
Moisture content	Damp condition 1½–2½ per cent by wt. Wet condition 5–7 per cent by wt.	Damp condition 1–2 per cent by wt. Wet condition 2½–5 per cent by wt.	Damp condition 1½–2½ per cent by wt. Wet condition 5–7 per cent by wt.
Discharge			
Temperature	200 °C.–230 °C. (380 °F.–446 °F.)	Damp condition not more than 80 °C. (176 °F.) Wet condition not more than 110 °C. (230 °F.)[c]	For damp materials—Not more than 95 °C. (203 °F.) For wet material—Not more than 120 °C. (248 °F.)
Moisture content	Not more than 0.5 per cent by wt.	Not more than 0.5 per cent by wt.	Not more than 0.5 per cent by wt.

[a] See BS 594, "*Rolled asphalt, asphaltic bitumen and fluxed lake asphalt (hot process)*".
[b] See BS 802, "*Tarmacadam and tar carpets with crushed rock or slag aggregate*".
BS 1621, "*Bitumen macadam with crushed rock or slag aggregate*".
BS 2040, "*Bitumen macadam with gravel aggregate*".
BS 1241, "*Tarmacadam and tar carpets (gravel aggregate)*".
[c] Should material originally in a wet condition be required to have an outlet temperature less than 110 °C. then a cooling unit or other special method would be required.
[d] See BS 1690, "*Fine cold asphalt*".

Appendix Typical form for recording the results of British Standard test on oil-fired rotary dryer

Date.....

Dryer by (manufacturer's name).....

Type of dryer (batch or continuous).....

Main duty. Preparation of aggregate for— { Hot asphalt / Coated macadam / Fine cold asphalt / Special composition, give details } .....

Rated output with $\frac{\text{damp}}{\text{wet}}$ feed.....tons per hour.

Test conditions

Air temperature ..... °F. (or °C.). Humidity.....

Wind conditions (if dryer tested in the open).....

Type of aggregate (Trade group) .....

(according to B.S. 63) .....

Approx. grading of aggregate (to B.S. ..... or give percentage passing main sieves.....)

Sand/stone ratio (for asphalt dryer).....

If coupled to dust collector, state type.....

Position of burner in use (where alternative positions are available).....

Test records

Start of test run .....hours.....min.

End of test run .....hours.....min.

Approx. time running before start of test.....hours.....min.

Duration of test run.....min.

Feed materials, average temperature .....°F. (or °C.).

Time each charge in dryer (batch dryers) .....min.

Approximate time of passage of material (continuous dryers) .....min.

Angle of inclination to horizontal .....°

Speed of dryer ..... r.p.m.

Feed materials

Sample No.	1	2	3	4	5	6	etc.
Time taken—min. from start							
Temperature							
Moisture content percentage of dry weight							
Grading — Percentage retained / Percentage passing (in. 1½, 1½, 1, ¾, ½, ⅜, ¼, ⅛; No. 7, No. 72, No. 200 — BS sieve)							

Type of thermometer used for discharge material . . . . . .
Method of sampling and taking temperature . . . . . .

Discharged materials

Sample No.	1	2	3	4	5	6	etc.
Time taken—min. from start							
Temperature °F. (or °C.)							
Moisture content percentage of dry weight							
Grading — Percentage retained / Percentage passing (in. 1½, 1½, 1, ¾, ½, ⅜, ¼, ⅛; No. 7, No. 72, No. 200 — BS sieve)							

Type of thermometer used for discharge material . . . . . .
Method of sampling and taking temperature . . . . . .

Average feed temperature .....°F. (or °C.).

Average discharge temperature .....°F. (or °C.).

Average rise in temperature .....°F. (or °C.).

Average moisture content in feed ..... per cent.

Average moisture content in discharge ..... per cent.

Average reduction in moisture content ..... per cent.

Total output during test run .....tons.....cwt.

Method of estimating output.....

Rate per hour .....tons.....cwt.

Calorific value of fuel used .....B.T.U's. per lb. (or gal.).

Specific gravity of fuel used .....

Fuel burned during test run ..... gal.

Fuel consumption per hour ..... gal.

Fuel consumption per ton of aggregate ..... gal.

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL