भारतीय मानक

तार और बिटूमनी सामग्री की परीक्षण विधियाँ — कटबैक बिटूमेन के संसाधन बिन्दु (क्यूरिंग इंडेक्स) का निर्धारण

Indian Standard

METHODS FOR TESTING TAR AND BITUMINOUS MATERIALS — DETERMINATION OF CURING INDEX FOR CUTBACK BITUMENS

ICS 75.140

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Price Group 3

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards after the draft finalized by the Bitumen, Tar and Their Products Sectional Committee, had been approved by the Petroleum, Coal and Related Products Division Council.

Cut-back bitumens are blended by dissolving penetration grade bitumens in petroleum oils like naphtha, kerosene oil or heavy petroleum oils. The function of these oils is to offer temporary fluidity for ease of construction operation. After the construction, the oils evaporate in due course of time leaving behind the original bitumen.

Thus the quantity of oil present and the penetration of the residual bitumen are of paramount importance. Immediately after the construction, the basic questions before the engineer are as to how long will it take for the oil to evaporate and what restrictions have to be imposed on traffic speed to prevent dislodgement of stones under the action of traffic.

Distillation test offers quick and easy means of knowing the quantity of oil present in the cutback and the time for evaporation of these oils can also be computed if the vapour pressure of oil fractions distilling at various temperatures is known. The cumulative evaporation time so computed is known as curing index. A cutback bitumen is deemed to have cured out when its float test values at 50 °C reaches 120 s.

In reporting the results of a test or analysis in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

The Composition of the committee responsible for formulation of this standard is given in Annex A .

Indian Standard

METHODS FOR TESTING TAR AND BITUMINOUS MATERIALS — DETERMINATION OF CURING INDEX FOR CUTBACK BITUMENS

1 SCOPE

This standard covers the methods for determination of curing index of cutback bitumens.

2 NORMATIVE REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated are valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
334 : 2002	Glossary of terms relating to bitumen and tar (*third revision*)
1211 : 1978	Methods for testing tar and bituminous materials: Determination of loss on heating (*first revision*)

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 334, in addition to the following shall apply.

3.1 Curing Index

Curing index is a test procedure which indicates in numerical terms the comparative rate of curing of cutback bitumen under standard conditions. The procedure enables one to make a much closer comparison of the rate of cure of cutback bitumens than is possible by the use of distillation test results.

3.2 Cured Out Point

Field experience indicates that the cold mix asphaltic concrete using RC-3 shall be considered cured out when not more than 0.4 percent by mass of volatiles and/or water remained in the mixture. The consistency of RC-3 residue to above volatile content is found average about 120 s float test at 50°C. This consistency is considered as the cured out point for all cutback bitumens.

4 APPARATUS

4.1 Oven, conforming to **3.1** of IS 1212.

4.2 Distillation Flask, conforming to **3.1.1** of IS 1213.

4.3 Thermometer, of high distillation range, total immersion type having a range of -2°C to 400°C.

4.4 Condenser, conforming to **3.1.3** of IS 1213.

4.5 Adapter, conforming to **3.1.4** of IS 1213.

4.6 Shield, conforming to **3.1.5** of IS 1213.

4.7 Crow Receiver, conforming to **3.1.6** of IS 1213.

4.8 Residue Container, conforming to **3.1.7** of IS 1213.

5 PROCEDURE

5.1 In developing the test procedure, the time in hours required for the cutback bitumen residue to be reduced to the cured out point is determined by mixing 12.8 g of the cutback material with 200 g of a standard dry aggregate at 60°C. The mixture is then placed in a revolving shelf oven and held at 60°C until cured out point is reached. The mixture is removed from the oven and weighed from time to time. The curing curve is obtained by plotting the percent loss by volume in the cutback, against the time using the following equation to calculate the percent loss by volume:

$$L_{vt} = \frac{100\,(L_t)\,V_c}{m\,(100 - A)}$$

where

L_{vt} = loss by volume in time t, percent of total cutback;

V_c = percent volatile by volume in cutback to 360°C as determined by standard distillation test;

A = percent bitumen by mass in cutback when distilled to 360°C;

L_t = mass loss of volatile in time t; and

m = mass of cutback bitumen used in the mixture.

Curing curves of the cutback RC-1, RC-2 and RC-3 are shown in Fig.1 and Fig. 2. The dotted lines in Fig. 3 refers to volatile loss during mixing known as 'flash off'.

5.2 Since the oven curing procedure is rather time consuming, the following method is developed for predicting the curing curve of Fig. 1 and Fig. 2 with good accuracy and for determining the time required

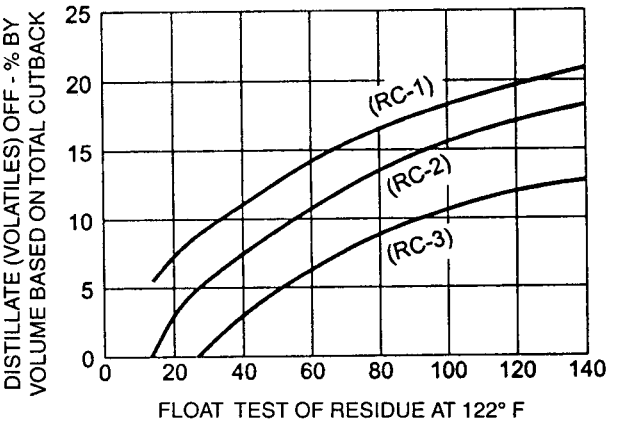

FIG. 1 CONSISTENCY CURVES — RC CUTBACKS

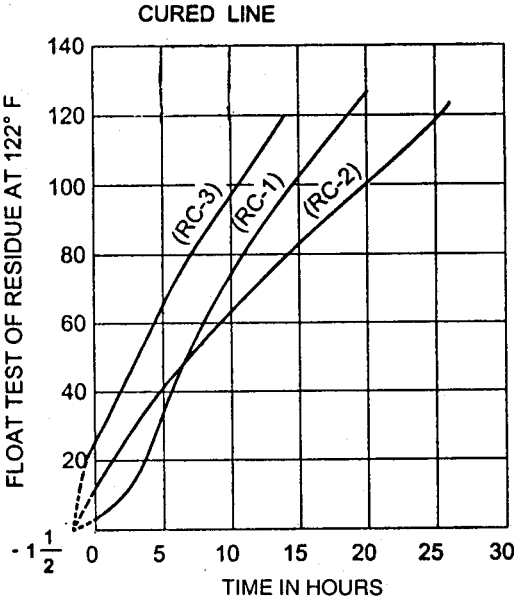

FIG. 2 CURING CURVES — RC CUTBACKS

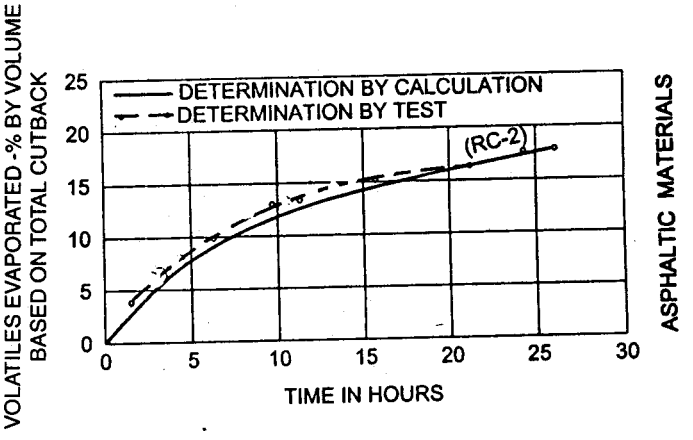

FIG. 3 EVAPORATION — RC CUTBACKS

to reduce the residue to the cured out point (float value of 120 s at 50°C). The necessary information is the percent loss of volatiles at the cured out point (or the entire curve of Fig. 1 of percent volatile loss against float test time if the entire curve is to be determined) and the result of the standard distillation test showing total percentage of distillate off by volume to 160°C, 175°C, 225°C, 260°C, 315°C and 360°C in addition to initial boiling point temperature.

5.3 The procedure is resumed for establishing the curing index of cutback bitumens as given in **5.3.1** to **5.3.4**.

5.3.1 Run regular distillation test in accordance with IS 1212 including determination of initial boiling point.

5.3.2 Run partial distillation taking off 50 percent, 70 percent and 85 percent of the total distillate to 360°C as determined by the standard distillation test. Partial distillations are run according to IS 1212 with the exception that the residue is allowed to partially cool (10 min to 15 min) in the flask before pouring up.

5.3.3 For each residue from the partial evaporation tests, determine the float value at 50°C. Plot the curve showing the relationship between the percentage distillate by volume and the float test of residue. By interpolation, find the cured out distillate loss corresponding to 120 s float.

5.3.4 Using the values given in Table 1, calculate the curing index value in accordance with the method illustrated.

6 CALCULATION

6.1 The percentage of each material (Δx) boiling between any two successive temperatures is considered as a separate liquid with average vapour pressure Px and average molecular weight Mx. Then it is found that the time increment t required for evaporation of this fraction shall be obtained by the equation. The total time (T) required for the evaporation of all the fractions up to any given temperature shall be expressed by Equation 1:

$$T = \frac{K\Delta_1}{M_1P_1} + \frac{K\Delta_2}{M_2P_2} + \frac{K\Delta_x}{M_xP_x} \quad \ldots (1)$$

6.2 For each fraction, the average molecular weights are determined and the average vapour pressure is determined at 60°C. The value of K is determined by correlating the values from the test evaporation curves and calculated cures to have a value of 10. The values of $K/MP = 10/MP$ are shown in Table 1 for various boiling points intervals from 93°C to 327°C.

where

M = estimated average molecular weights of hydrocarbons distillate in temperature range shown

P = vapour pressures from Cox chart

Table 1 Values of 10/MP for given Cutback Boiling Point Interval

(*Clauses* 5.3.4 *and* 6.2)

Boiling Point Interval, °C (1)	Value of 10/MP (2)	Boiling Point Interval, °C (1)	Value of 10/MP (2)
93 - 160	0.05	249 - 260	7.95
99 - 160	0.08	254 - 260	8.90
104 - 160	0.09	Intermediate cut	
110 - 160	0.10	160 - 175	0.30
116 - 160	0.11	175 - 190	0.51
121 - 160	0.13	190 - 225	1.30
127 - 160	0.14	225 - 232	4.46
132 - 160	0.16	232 - 316	26.00
138 - 160	0.18	Final cuts	
143 - 160	0.20	225 - 232	2.90
149 - 160	0.23	225 - 238	3.25
154 - 160	0.25	225 -243	3.39
160 - 175	0.30	225 - 249	3.57
166 - 175	0.34	225 - 254	3.97
171 - 175	0.36	225 - 260	4.46
177 - 190	0.52	260 - 260	11.10
182 - 190	0.58	260 - 271	12.20
193 - 225	1.05	260 - 277	13.30
199 - 225	1.63	260 - 282	3.80
204 - 225	1.81	260 - 288	15.60
210 - 225	1.95	260 - 293	17.20
216 - 225	2.16	260 - 299	19.40
221 - 225	2.35	260 - 304	21.70
227 - 260	5.10	260 - 310	24.10
232 - 260	5.10	260 - 316	26.00
238 - 260	6.50	316 - 321	91.00
243 - 260	7.15	316 - 327	106.00

Example — The determination of curing index by calculation proceeds as follows:

For RC-2, a cured out point float test of 120 s is shown at 16.8 percent distillate off by volume. The distillation test gives the following results:

Temperature °C	*Percent of Total Cutback off by Volume*
145	Initial point
160	1.0
175	3.0
190	5.8
225	13.4
260	17.5
315	19.0
340	20.5

By interpolation, the cured out temperature at which 16.8 percent by volume has distilled over is found to be $225 + \frac{16.8 - 13.4}{17.4 - 13.4}(260 - 225)$ or $225 + 29.0 = 254$ or 255 rounded off to the nearest multiple of 5°C.

The curing index is then calculated using the Equation 2, and the values given in Table 1.

$$T = \frac{K\Delta_1}{M_1P_1} + \frac{K\Delta_2}{M_2P_2} + \frac{K\Delta_x}{M_xP_x} \quad \ldots 2$$

Boiling Point Interval, °C	*Increment Percent Distillate in Interval, x*	*Value of* $\frac{10}{MP}$	$\Delta_i = \frac{10\Delta x}{MP}$	$T = \Sigma\Delta_i$
145 - 160	1.0	0.20	0.20	0.20
160 - 175	2.0	0.30	0.60	0.80
175 - 190	2.8	0.51	1.43	2.23
190 - 225	7.6	1.30	9.88	12.11
225 - 260	3.4	3.97	13.50	25.61

Curing index is 26 h, the nearest whole number.

7 RECOMMENDATION FOR SPECIFYING CURING INDEX

7.1 The need for accurately controlling the curing index/curing rate of cutback bitumens has been explained for RC and MC grades above. For other type of bitumens, the recommended values of curing index are given in Table 2

Table 2 Recommended Values of Curing Index

Material	Curing Index, *h*
(1)	(2)
RC - 3	12
Bitumen 80/100 + 6.5 percent kerosene oil	0
Bitumen 80/100 + 10 percent kerosene oil	14
Bitumen 80/100 + 14.5 percent kerosene oil	27

7.2 A curing index of 25 h to 40 h is considered adequate for general use of asphaltic concrete. For surface dressing work, a curing index of about 15 h gives best results.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

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