NATIONAL BUREAU OF STANDARDS REPORT

5224

STAIN INDICES OF TWENTY-ONE ASPHALTS

FIRST SUPPLEMENT TO NBS REPORT NO. 4732
REPORT ON THE EVALUATION OF TWENTY-ONE
COATING-GRADE ROOFING ASPHALTS

by

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and
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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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ABSTRACT

The stain indices of the 21 asphalts discussed in NBS Report No. 4732 were measured in accordance with A.S.T.M. Procedure D1328-54T. The indices ranged from 4 to 26. No correlation was found between stain index and penetration, softening point or durability. Reasons for this lack of correlation are discussed.

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1. INTRODUCTION

On 1 July 1956 a report was sent to the Research Committee describing the properties and weathering characteristics of 21 coating-grade roofing asphalts.[1/] Subsequent work on the mechanism of the weathering of asphalt indicated that one phase of weathering was related to the ability of some of the components of the maltenes to migrate to the surface of the exposed coating and

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1/ "Report on the Evaluation of Twenty-One Coating-Grade Roofing Asphalts", NBS Report No. 4732, 1 July 1956.

react with oxygen in the presence of light. It was proposed to investigate the use of the stain index determination, ASTM D1328-54T (Staining Properties of Asphalts), as a measure of the migration because it measures the movement of some of the component oils to the surface of the asphalt.

2. EXPERIMENTAL

The apparatus and conditions of test are described in ASTM D1328-54T.[2/]

The asphalts are those discussed in detail in NBS Report No. 4732.

3. RESULTS AND DISCUSSION

The results, the average of two determinations differing by no more than two papers, of the stain index determinations are compiled in Table 1, along with some of the other characteristics of the 21 asphalts. The stain indices varied from 26 for Ambit asphalt to 4 for C810. However, except for the highest and lowest two, all of the indices fell within the range of 10 to 20. Thus, the stain index, like many of the other attributes of blown asphalts, appears to be more characteristic of the type of material than of any individual specimen of that type, and an average of 15 ±5 papers seems to be characteristic of air-blown coating-grade asphalts.

[2/] ASTM D1328-54T, Staining Properties of Asphalt, 1690-1694, Part 3 of ASTM Book of Standards, 1955.

TABLE 1. PROPERTIES OF ASPHALTS

Asphalt	Stain Index[a]	Softening Point	Pen. 32	Pen. 77	Pen. 115	Pen. Index[b]	Sp. Gr. at 77	Durability 51-9C Cycle	Loss at 400-hr. 22-1 Cycle
								Days	%
Ambit	26 (22)	216	9	20	36	4.8	1.030	53	6.8
C1175	24 (20)	231	15	18	36	5.3	1.023	25	9.6
M200	20 (14)	224	11.2	17.0	26	4.8	0.999	75	6.3
Shallow Water	19 (16)	222	17	26	41	5.6	1.010	72	6.9
Union	19 (13)	230	14	18	36	5.3	1.026	90	7.1
C210	18 (13)	223	10	17	30	4.8	1.015	43	9.7
C1342	18 (12)	234	11	16	19	4.4	1.026	57	9.8
Columbia	16 (12)	205	14.5	20.7	34.6	4.2	1.003	86	6.1
Talco	16 (12)	223	11	18	28	4.9	1.035	43	5.4
Kansas II	16 (12)	208	11.5	20.5	36.9	4.3	1.008	88	7.3
East Venezuela	15 (11)	226	8	13	20	4.2	1.024	47	6.0
Envoy	15 (10)	216	10	16	32	4.3	1.035	44	8.0
Kansas I	14 (12)	229	7	14.5	21.5	4.8	1.015	87	6.5
Catalytic	14 (11)	221	11	19	31	4.9	1.028	68	7.0
Shell	14 (10)	230	11	18	35	5.2	1.028	101	7.3
Oklahoma	13 (9)	215	14	22	46	4.9	0.998	150	6.8
Mid East	13 (8)	228	8	11	20	4.3	1.031	38	7.5
Louisiana	12 (7)	216	10	12	22	3.8	1.007	84	5.7
Lagunillas	10 (6)	220	8	13	22	4.1	1.032	47	4.6
Mexico-12	8 (4)	196	8	18	34	3.4	1.076	95	8.0
C810	4 (0)	216	1	4	5	2.1	1.047	81	2.4

[a] Stain Index according to ASTM D1328-54T. Numbers in parentheses represent dark oil movement by daylight observation.

[b] Penetration Index from J. P. Pfeiffer and P. M. Van Doormal, "Classifying Asphalts by Means of Penetration Index", National Petroleum News, Tech. Ed., Feb. 23, 1938.

The processing of the four asphalts outside of this range differed in some respects from that of the other asphalts. Ambit (S.I. = 26) was catalytically blown; C1175 (S.I. = 24) was reconstituted with reclaimed lube stock; Mexico #12 (S.I. = 8) was not fully blown (S.P. = 196°F); and C810 (S.I. = 4) was steam reduced to a penetration of 20/30 before blowing. Although the asphalt designated "Catalytic" (S.I. = 14) was also catalytically blown (from a Lagunillas flux), its properties fell within the normal range.

The stain index represents the farthest penetration of the aromatic white oils, as observed by their fluorescence under ultraviolet light. It is believed that during weathering the oils, both light and dark, migrate to the surface of the asphalt, where they are degraded in the presence of light. However, the dark oils are consumed more rapidly than the white oils during normal weathering. Hence, the movement of the dark oils is also of interest. The numbers in parentheses in column 2 of Table 1 represent the farthest movement of the dark oils during the stain index determination. The dark oils stained between two and six, usually four, papers less than the white oils. Because diffusion varies with the square root of the molecular weight, one would expect the dark oils, because of their higher molecular weight, to diffuse less than the white oils under the same conditions. This qualitative deduction and observation are

borne out quantitatively for the two asphalts for which molecular weight data are available. In NBS Report No. 4861[3/] the molecular weights for these components of asphalts C210 and M200 were reported as follows:

	C210	M200
White Oils	450	500
Dark Oils	745	900

The ratio of the square roots of the molecular weights of the light and dark oils of C210 is 0.778 and that for those of M200 is 0.746, whereas, the ratios of the papers stained are 0.724 and 0.702, for the two asphalts, respectively. Considering the tolerances in both determinations, this agreement is very good.

However, when an attempt is made to compare these two asphalts or to correlate stain index with the usual rheological properties or durability, difficulties are encountered. Asphalt M200 contains higher molecular weight oils and also has a higher stain index. There also seems to be no relation between stain index and penetrations, penetration index or softening point, the rheological properties by which asphalts are usually characterized. The reasons for this lack of correlation, especially in a qualitative sense, are not clear, for it would be expected that the softer, higher-penetration asphalts would have more of the light, more

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3/ "The Chemical Changes Occurring During the Degradation of Two Coating Asphalts", N.B.S. Report No. 4861, 1 October 1956.

fluid oils and, consequently, a higher stain index. Apparently, the forces that hold an asphalt together, i.e., the ability of the asphaltenes to hold on to the oils, are sufficiently strong to distort the effects of diffusion.

This property is also related to the durability of asphalt, for it has been observed that it is very difficult to separate the maltenes from the asphaltenes in asphalts that weather well. However, there is no apparent correlation between durability, as presently determined, or weight loss, and stain index.

In summary, it may be concluded that there is no apparent correlation between stain index and durability, weight loss, or any of the rheological properties of coating-grade asphalts normally measured.

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to Government Agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. A major portion of the Bureau's work is performed for other Government Agencies, particularly the Department of Defense and the Atomic Energy Commission. The scope of activities is suggested by the listing of divisions and sections on the inside of the front cover.

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The results of the Bureau's work take the form of either actual equipment and devices or published papers and reports. Reports are issued to the sponsoring agency of a particular project or program. Published papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three monthly periodicals, available from the Government Printing Office: The Journal of Research, which presents complete papers reporting technical investigations; the Technical News Bulletin, which presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions, which provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: The Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports, and Miscellaneous Publications.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.25) and its Supplement ($0.75), available from the Superintendent of Documents, Government Printing Office. Inquiries regarding the Bureau's reports and publications should be addressed to the Office of Scientific Publications, National Bureau of Standards, Washington 25, D. C.


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