Nov. 17, 1959 J. J. HEITHAUS, JR 2,913,389

PAVING ASPHALT COMPOSITIONS

Filed July 30, 1956 2 Sheets-Sheet 1

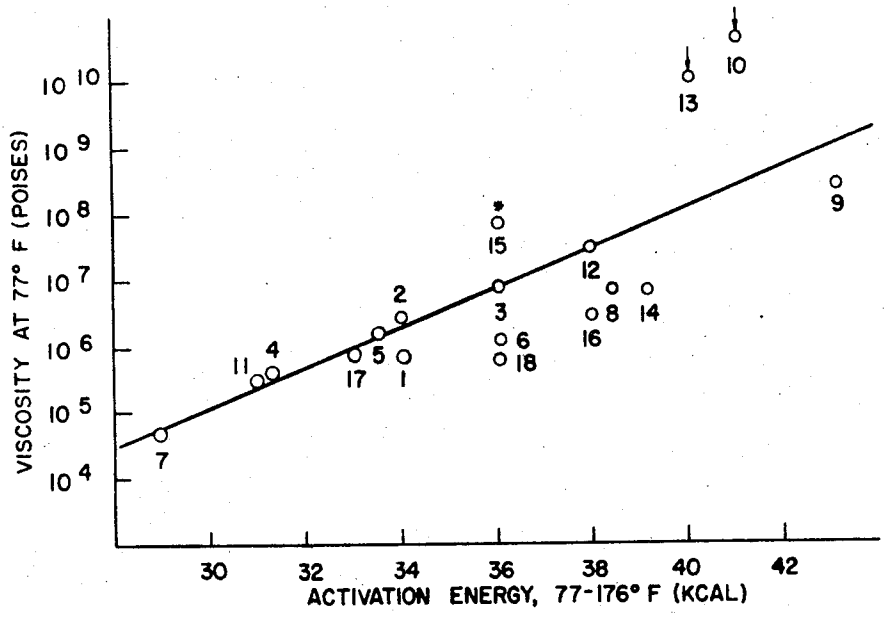


FIG. I
TEMPERATURE SUSCEPTIBILITY
OF ASPHALT VISCOSITY

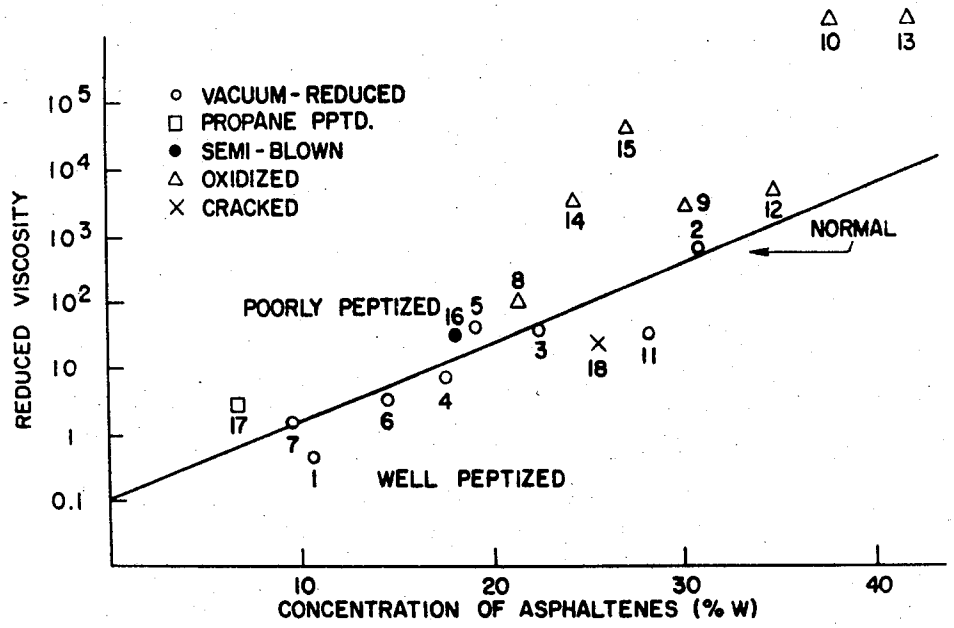


FIG. II
REDUCED VISCOSITY AT 77° F OF
ASPHALTENES AS A FUNCTION OF
ASPHALTENE CONCENTRATION

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PAVING ASPHALT COMPOSITIONS

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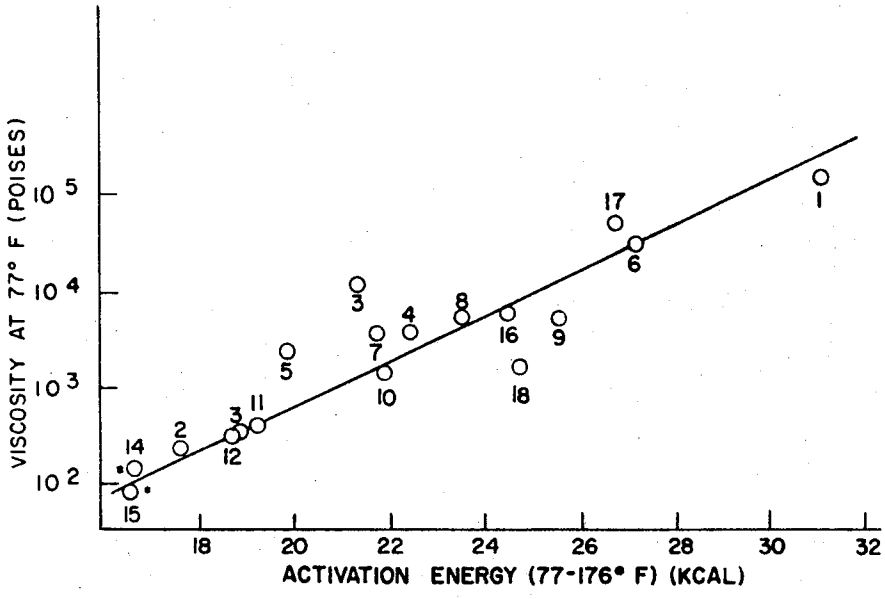


FIG. III
TEMPERATURE SUSCEPTIBILITY
OF MALTENE VISCOSITY

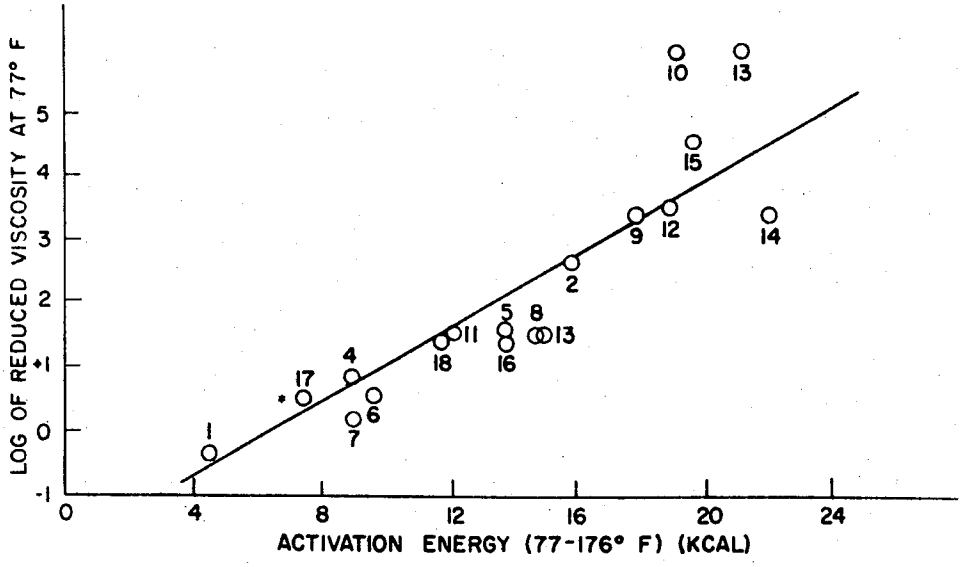


FIG. IV
TEMPERATURE SUSCEPTIBILITY
OF REDUCED VISCOSITY

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2,913,389

PAVING ASPHALT COMPOSITIONS

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Application July 30, 1956, Serial No. 600,750

3 Claims. (Cl. 208—23)

This invention is directed to improved paving grade asphalt compositions. More particularly, it is concerned with the improvement in viscosity-temperature coefficients of said compositions.

The rheological properties of a body by which it resists deformation under an applied force may be called "consistency." The consistency of a material is made up of two components, namely, elasticity and viscosity. An elastic deformation disappears eventually after the force is removed, while a viscous deformation is not recoverable. Most asphalts can show both elastic and viscous behavior. However, under most service conditions, one or the other will usually predominate. When a body is deformed rapidly, the stresses set up will tend to result from the deformation of elastic elements in the substance, while at low rates of deformation the stresses are more likely to be due to viscous flow. This is expressed by the ratio of elastic modulus to the coefficient of viscosity. If the ratio is large, the elastic elements of the material are relatively stiff, so that the viscous elements tend to deform more readily and the stresses resulting from viscosity assume greater importance. In general, elastic stresses are negligible if the shear rate is small by comparison with the ratio. In many paving asphalts, the ratio is so large that elasticity becomes evident only in vibration.

The stresses exerted on a pavement by stationary and moving vehicles are in the order of 10^6 to 10^7 dynes per square centimeter. While there is some elastic deformation under such loads, the highway designer will be concerned much more with the viscosity of the mass at any given temperature. That is, he must know whether the pavement will be expected to flow excessively when loaded at that temperature. Another type of pavement stress which is probably just as important, is that caused by thermal contraction. The rates of shear in a bituminous road during severe cooling are extremely low; therefore, the stresses set up will be due to viscosity. An asphaltic concrete pavement is in danger of cracking from this cause if the viscosity of the binder is much greater than 10^7 poises at 77° F.

Hence, it will be seen that for paving grade asphaltic compositions the primary property upon which the life and quality of the road will depend, comprises the viscosity at any given temperature, or, in other words, the viscosity-temperature coefficient. It is, of course, highly desirable to have this coefficient as low as possible in paving grade asphalts. While the pavement will crack, due to thermal contraction, if the binder is too hard at low temperatures, the asphalt should be viscous enough at maximum ambient temperatures (140–150° F.) so that the pavement remains stable under track and the asphalt does not flush to the surface. However, the asphalt must become fluid at a temperature which is not too high so that mixing and transportation may be accomplished easily and economically.

It is an object of the present invention to improve

paving grade asphalt compositions. It is another object of the present invention to improve the viscosity characteristics of said compositions. It is a more particular object of the invention to provide an asphalt paving grade composition having optimum viscosity-temperature coefficient. More particularly, the object comprises providing an asphaltic composition having a low viscosity-temperature coefficient. Other objects will become apparent during the following description of the invention.

Now, in accordance with the present invention, it has been found that paving grade asphalt compositions having superior viscosity-temperature relationships comprise those in which the maltenes predominate in high viscosity components having low viscosity-temperature coefficients and asphaltenes having a reduced tendency to associate at relatively low operating temperatures. More particularly, according to this invention, it has been found that paving grade compositions having surprisingly low viscosity-temperature coefficients comprise between about 5 and about 50% by weight of highly blown vacuum flasher bottoms combined with from about 95 to about 50% by weight of propane asphalt obtained by the propane precipitation of asphaltic components from short residue. Still more particularly, the present invention comprises the combination in the above-recited percentage ranges of a highly blown asphalt having a softening point above about 200° F. and a propane asphalt having a penetration at 77° F. greater than about 200, the ring-and-ball softening point of the propane asphalt being below about 125° F.

Expressed in terms in direct accordance with the findings discussed hereinafter, the highly blown asphalt should not only have the specified minimum softening point of 200° F., but also should have a penetration at 77° F. less than about 15. Also, the maltenes contained in the propane asphalt component should have a viscosity in excess of about 30×10^3 poises at 77° F. Furthermore, in order to obtain the maximum effect with respect to optimum viscosity-temperature coefficient of the recited composition, the propane asphalt should have a viscosity activation energy of less than about 30 kilocalories calculated by the formula discussed hereinafter. In such a composition the maltene fraction of the propane asphalt should have a viscosity activation energy between about 20 and about 28 kilocalories in the temperature range 77 to 176° F. Asphalt compositions possessing the recited set of rheological characteristics will exhibit optimum viscosity-temperature coefficients within the range of use of paving grade asphalts. It will be emphasized, of course, that this same set of physical characteristics is not necessarily those desired in asphalts to be utilized for other purposes, such as roofing felt saturants or coating compositions.

Asphalts may be described as derived by four general types of processes. These comprise straight run asphalts, obtained by the atmospheric or vacuum distillation of lower boiling components to leave a bottoms product; cracked asphalts which comprise the bottoms product obtained from a combined cracking and distillation process; propane asphalts obtained by the precipitation of asphaltic components from lubricating oils or residues by the addition thereto of low molecular weight (C_2–C_7) alkanes such as propane; and blown asphalts which comprise oxidized materials normally obtained by blowing air or another oxygen-containing gas through any one of the foregoing types of asphalt at an elevated temperature, either in the presence or absence of blowing catalysts, such as ferric chloride, phosphoric acid, aluminum chloride, or other known materials. These general classes of asphaltic substances are characterized normally by well-known specifications including penetration, softening

point, penetration index, and ductility. However, it has been found that these descriptive characteristics of asphalts do not completely indicate whether or not a particular asphalt will have properties suitable for the best operation as a paving grade composition. It has been indicated, as will be seen hereinafter, that the components of the composition and their response to temperature change must be analyzed and considered when endeavoring to arrive at an optimum paving grade asphalt composition.

Table I following describes the commonly accepted properties of a number of asphalts falling within the four general classes discussed above.

According to the data presented above, there is no clear indication from the viscosity-temperature susceptibility data so obtained to indicate which asphalt of the group tested would be of particular suitability as a paving grade composition. From this it may be presumed that no one of the asphalts so tested would be outstanding for this intended purpose.

The formula for activation energy for viscous flow is essentially that described by Eyring and given in "The Theory of Rate Processes" (McGraw-Hill Book Company, 1941, pp. 477–516) by Glasstone, Laidler and Eyring.

Table I.—Composition and properties of asphalts studied

Asphalt		Pen at 77° F.	S.P., °F. (R. & B.)	Pen. Index	Ductility at 77° F., cm.	Analysis, percent w.[a]			
Designation	Method of Processing					Asphaltenes	Strong Resins	Weak Resins	Oil-Wax
(1)	Vac.-reduced plus lube extract	102	109.5	−1.4	150+	10.8	43.0	33.5	12.7
(2)	Vac.-reduced	93	126	+1.1	150+	31.1	23.5	28.5	16.9
(3)	do	36	136.5	−0.1	150+	22.7	32.5	35.1	9.7
(4)	do	160	107	−0.3	130	17.5	33.8	35.2	13.5
(5)	39% (3) plus 61% (4)	97	117	−0.2	150+	19.4	33.7	34.4	12.5
(6)	Vac.-reduced	101	115.5	−0.3	126	14.7	32.3	44.3	8.7
(7)	do	300+	90		Too soft	9.6	36.1	40.6	13.7
(8)	Oxidized from (7)	62	128	+0.2	150+	21.6	35.3	31.4	11.7
(9)	do	29	153	+1.1	6.8	30.3	32.2	24.5	13.0
(10)	do	13	210	+3.6	1.3	38.1	35.0	17.5	9.4
(11)	Vac.-reduced	190	104	−0.3	140	28.4	30.9	27.5	13.2
(12)	Oxidized from (11)	44	138	+0.5	82	34.9	41.0	19.0	5.1
(13)	do	15	200	+3.3	4.8	42.0	36.7	16.1	5.2
(14)	Oxidized short residue	185	123.5	+3.5	13.5	24.6	29.6	23.9	21.9
(15)	do	97	160.5	+5.5	2.6	27.4	30.9	20.2	21.5
(16)	Semi-blown: 31% (7) plus 69% (8)	103	121	+0.6	101	18.2	34.6	34.4	12.8
(17)	Propane ppt'd	99	115	−0.5	150+	6.8	38.2	50.5	4.5
(18)	Cracked	91	113.5	−1.0	150+	26.0	27.0	39.1	7.9

[a] Asphaltenes determined with n-pentane; resins and oil-wax determined by chromatographic absorption on Attapulgus clay, oil-wax being that portion eluted with n-pentane, weak resins that eluted with benzene, strong resins by difference.

In spite of the differences exhibited in the various properties listed in Table I among the asphalts tested, the temperature susceptibility of the viscosity of these asphalts does not differ greatly from one sample to another. This can be demonstrated by determining the viscosity of the individual asphalts over a range of temperatures to which paving grade asphalts may be expected to be subjected during their useful life. For the present investigation this was confined to a range between 77° F. and 176° F. Within this range the log viscosity vs. reciprocal of absolute temperature line is essentially a straight line and hence, the viscosity-temperature susceptibility can be expressed in terms of slope of this line. Table II which follows indicates the temperature susceptibility expressed both in terms of slope and also in terms of activation energy which is an expression involving the slope multiplied by a constant to give activation energy in terms of kilocalories. The constant employed was 0.00456.

Table II.—Temperature susceptibility of viscosity

Asphalt	Slope of log ν vs. 1/T Plot ($\times 10^{-4}$) 77–176	Activation Energy = 0.00456 × slope (kcal.) 77–176
(1) Vac.-reduced Poso-Coalinga	7.5	34
(2) Vac.-reduced Baxterville	7.4	34
(3) Vac.-reduced Venezuelan	7.9	36
(4) Vac.-reduced Venezuelan	6.86	31.3
(5) Vac.-reduced Venezuelan	7.35	33.5
(6) Vac.-reduced WT-KH	7.89	36.0
(7) Vac.-reduced WT-KH	6.3	29
(8) Oxidized from (7)	8.40	38.3
(9) Oxidized from (7)	9.5	43
(10) Oxidized from (7)	9	40
(11) Vac.-reduced Santa Maria	6.79	31.0
(12) Oxidized from (11)	8.31	37.9
(13) Oxidized from (11)	8.8	40
(14) Oxidized short residue	8.5	39
(15) Oxydized short residue	7.9	36
(16) Semi-blown WT-KH	8.31	37.9
(17) Propane ppt'd	7.2	33
(18) Cracked residue	7.9	36

Fig. I comprises a plot of activation energy against viscosity at 77° F. for each of these asphalts. An arbitrary "normal line" can be drawn on this plot and when drawn as indicated in Fig. I, it will be seen that the highly oxidized asphalts (10, 13 and 15) have relatively lower temperature coefficients, whereas cracked asphalt (18), 101 pen. vacuum-reduced asphalt (6), lightly oxidized asphalts (8, 9 and 14) have significantly higher than normal temperature susceptibilities. It will be noted from Fig. I that a deficiency exists with respect to asphalts of proper viscosity at 77° F. but at the same time having a low viscosity-temperature coefficient, or, in other words, a relatively low activation energy for a given viscosity at 77° F. While samples 10, 13 and 15 exhibit low coefficients, their viscosities are outside the range which may be used as paving grade asphalts, since it has been found that any asphalt having a viscosity greater than about 10^7 poises at 77° F. shows a high tendency to crack during its service life. Consequently, one of the principal objects leading to the present invention was to obtain a composition having a viscosity at 77° F. below 10^7 poises, but, at the same time, having an activation energy which would lie substantially above the normal line represented in Fig. I.

In the investigation leading to the present invention, it was considered essential to analyze the various components of the asphalts listed in Table. I. In order to determine the properties of these components, it was necessary to isolate the latter, of which the maltenes were first investigated. The maltenes were isolated by precipitation of asphaltenes at room temperature with normal pentane, the maltenes remaining in pentane solution. Using a capillary viscometer (as described by Rhodes et al., Engineering News Record, vol. 115, page 714 (1935)), the viscosity of the maltenes so isolated was determined. These are given in Table III which follows.

Table III.—Viscosity of maltene fractions

	Viscosity (poises) at—		
	77° F.	122° F.	176° F.
(1) Vac.-red. Poso-Coalinga, 102 pen	124×10^3	1,210	36.4
(2) Vac.-red. Baxterville, 93 pen	0.244×10^3	18.4	2.1
(3) Vac.-red. Venezuelan, 36 pen	10.6×10^3	536	38.2
(4) Vac.-red. Venezuelan, 160 pen	3.43×10^3	123	9.3
(5) Vac.-red. Venezuelan, 97 pen	2.35×10^3	132	12.6
(6) Vac.-red. WT-KH, 101 pen	26.8×10^3	398	21.2
(7) Vac.-red. WT-KH, 300+ pen	3.53×10^3	95.4	11.4
(8) Oxidized from (7), 62 pen	4.64×10^3	128	9.6
(9) Oxidized from (7), 29 pen	4.74×10^3	77.0	5.8
(10) Oxidized from (7), 13 pen	1.52×10^3	33.2	4.8
(11) Vac.-red. Santa Maria, 190 pen	0.411×10^3	20.7	2.7
(12) Oxidized from (11), 44 pen	0.318×10^3	20.4	2.2
(13) Oxidized from (11), 15 pen	0.337×10^3	23.1	2.3
(14) Oxidized WTE short residue, 185 pen.	0.140×10^3	10.3	1.7
(15) Oxidized WTE short residue, 97 pen.	0.0890×10^3	5.5	1.16
(16) Semi-Blown, WT-KH, 103 pen	5.86×10^3	105	9.5
(17) Propane ppt'd, 99 pen	45.1×10^3	1,150	40.4
(18) Cracked residue, 91 pen	1.40×10^3	23.7	2.1

It will be seen by an examination of the above table, that the maltenes vary widely in their viscosity from one asphalt to another.

Table IV gives the viscosity characteristics of the asphalts whose other properties are described in Table I. Comparison can be made directly between the viscosity of the whole asphalts as given in Table IV and the viscosity of the maltenes isolated from each of these asphalts as recorded in Table III. Surprising differences will be noted not explainable upon the facts discussed so far. Note especially that the viscosity of the propane asphalt maltenes is surprisingly high and is, in fact, the highest of any of the samples tested at 176° F. The viscosity of the maltenes cannot be predicted from the viscosity of the asphalts from which they are derived, as a comparison of these two tables will indicate.

Table IV.—Flow properties of various asphalts

Asphalt	Pen. at 77° F.	Viscosity (poises)[a] at —		
		77° F.	122° F.	176° F.
(1) Poso-Coalinga vac.-red	102	0.720×10^6	0.0426×10^5	0.090×10^3.
(2) Baxterville vac.-red	93	2.52×10^6	0.21×10^5	0.347×10^3.
(3) Venezuelan vac.-red	36	7.40×10^6	0.43×10^5	0.522×10^3.
(4) Venezuelan vac.-red	160	0.380×10^6	0.0288×10^5	0.0989×10^3.
(5) Venezuelan vac.-red	97	1.44×10^6	0.102×10^5	0.210×10^3.
(6) WT-KH vac.-red	101	1.37×10^6	0.0377×10^5	0.103×10^3.
(7) WT-KH vac.-red	300+	0.052×10^6	0.00568×10^5	0.0256×10^3.
(8) Oxidized from (7)	62	7.05×10^6	0.249×10^5	0.288×10^3.
(9) Oxidized from (7)	29	230×10^6	6.6×10^5	2.47×10^3.
(10) Oxidized from (7)	13	4×10^{10}[b]	$5{,}050\times10^5$	770×10^3.
(11) Santa Maria, vac.-red	190	0.299×10^6	0.0249×10^5	0.0835×10^3.
(12) Oxidized from (11)	44	28.0×10^6	1.49×10^5	1.24×10^3.
(13) Oxidized from (11)	15	1.0×10^{10}	620×10^5	250×10^3.
(14) Oxidized short residue	185	6.8×10^6	0.20×10^5	0.246×10^3.
(15) Oxidized short residue	97	67×10^6	13.7×10^5	4.7×10^3.
(16) WT-KH, semi-blown	103	2.73×10^6	0.0467×10^5	0.123×10^3.
(17) Propane ppt'd	99	0.83×10^6	0.0530×10^5	0.138×10^3.
(18) Cracked residue	91	0.81×10^6	0.0360×10^5	0.0574×10^3.

[a] At zero rate of shear.
[b] At shear rate $=4\times10^{-6}$ sec.$^{-1}$

Since the maltenes constitute the continuous phase of an asphalt and the asphaltenes are present in the form of micelles therein, the viscosity of an asphalt will be a function of the viscosity of the maltenes and the concentration of the asphaltenes. In general, there will also be specific effects due to the solubility or peptizability of the asphaltenes in the particular maltenes surrounding them. The poorer the solvent power of the maltenes, the greater will be the tendency for the asphaltenes to associate into large micelles. Assuming that these considerations are valid, the viscosity and peptization of the asphaltenes can be considered more clearly by calculating the "reduced viscosity" of the asphaltenes according to the following formula:

$$\text{Reduced viscosity}=\frac{1}{c}\left(\frac{\nu}{\nu_0}-1\right)$$

wherein ν is the viscosity of the asphalt, ν_0 is the viscosity of the maltene fraction and c is the concentration of asphaltenes in the asphalt expressed as percent by weight. Table V which follows presents the calculated reduced viscosities of the asphaltenes in the various asphalts whose properties are given in Table I.

Table V.—Reduced viscosities of asphaltenes in various asphalts

Asphalt	Reduced Viscosity[a] at		
	77° F.	122° F.	176° F.
(1) Poso-Coalinga, 102 pen	0.00044×10^3	0.00023×10^3	0.14
(2) Baxterville, 93 pen	0.36×10^3	0.037×10^3	5.3
(3) Venezuelan, 36 pen	0.031×10^3	0.0035×10^3	0.56
(4) Venezuelan, 160 pen	0.0063×10^3	0.0013×10^3	0.55
(5) Venezuelan, 97 pen	0.032×10^3	0.0039×10^3	0.81
(6) WT-KH, 101 pen	0.0034×10^3	0.00058×10^3	0.26
(7) WT-KH, 300+ pen	0.0014×10^3	0.00052×10^3	0.13
(8) Oxidized (7), 62 pen	0.070×10^3	0.0090×10^3	1.3
(9) Oxidized (7), 29 pen	1.6×10^3	0.28×10^3	14
(10) Oxidized (7), 13 pen	68×10^3	40×10^3	4,200
(11) Santa Maria, 190 pen	0.026×10^3	0.0042×10^3	1.0
(12) Oxidized (11), 44 pen	2.5×10^3	0.21×10^3	16
(13) Oxidized (11), 15 pen	72×10^3	64×10^3	2,600
(14) Oxidized WTE short residue, 185 pen.	2.0×10^3	0.081	5.8
(15) Oxidized WTE short residue, 97 pen.	27×10^3	9.1×10^3	150
(16) Semi-blown, WT-KH, 103 pen.	0.026×10^3	0.0024×10^3	0.65
(17) Propane ppt'd., 99 pen	0.0026×10^3	0.00053×10^3	0.36
(18) Cracked residue, 91 pen	0.022×10^3	0.0058×10^3	1.0

[a] Reduced viscosity $=\frac{1}{c}\left(\frac{\nu}{\nu_0}-1\right)$, where ν=viscosity of asphalt, ν_0=viscosity of maltene fraction and c=concentration of asphaltenes, percent w. (In high polymer studies, c is usually expressed as grams solute/100 cc. of solution; since, however, the specific gravity of most asphalts is near unity, the use of percent w. does not introduce a serious discrepancy.)

The relationship of the reduced viscosity of asphaltenes to the concentration of the latter in the whole asphalts is plotted in Fig. II, wherein the line designated as the "normal" comprises the line of best fit for the unblown asphalts. It will be seen that the blown asphalts all lie substantially above this line, thus indicating their poor peptization of asphaltenes. It is to be noted also that the straight run (vacuum-reduced) asphalts all lie on or slightly below the normal line and represent asphalts in which the asphaltenes are well peptized by the maltenes which are present.

As indicated previously, the total temperature coefficient of viscosity of an asphalt depends upon two principal factors. The first is the temperature susceptibility of the inter-micellar phase, which corresponds approximately to the maltene fraction, and, secondly, a component due to the dissociation of the large asphaltene micelles with increasing temperature. The viscosities of the various maltenes included in this investigation have been given in Table III. Table VI gives the temperature susceptibilities of these maltenes.

Table VI.—Temperature susceptibility of maltene viscosity

Maltenes ex Asphalt	Slope of log Viscosity vs. 1/T curve ($\times 10^{-3}$) 77–176	Activation Energy 0.00456× slope (kcal.) 77–176
(1) Poso-Coalinga	6.8	31
(2) Baxterville	3.9	18
(3) Venezuelan	4.7	21
(4) Venezuelan	4.9	22
(5) Venezuelan	4.3	20
(6) WT-KH	5.9	27
(7) WT-KH	4.8	22
(8) Oxidized from (7)	5.1	23
(9) Oxidized from (7)	5.6	25
(10) Oxidized from (7)	4.8	22
(11) Santa Maria	4.2	19
(12) Oxidized from (11)	4.1	19
(13) Oxidized from (11)	4.2	19
(14) Oxidized short residue	3.7	17
(15) Oxidized short residue	3.6	17
(16) Semi-Blown WT-KH	5.3	24
(17) Propane ppt'd	5.8	27
(18) Cracked residue	5.4	25

As with the complete asphalts, the temperature susceptibilities of maltenes must be compared at similar viscosity levels. Fig. III is a plot of the viscosity-temperature coefficient of the maltenes against the viscosity thereof, an arbitrary normal line being drawn through the maximum number of points. Comparison of this graph with Fig. I will show that there is little correspondence between the temperature susceptibility of a whole asphalt and that of the maltenes contained in it.

The component of temperature susceptibility due to the dissociation of asphaltene micelles is found from a plot of the logarithm of reduced viscosity of asphaltenes against the reciprocal of absolute temperature. The slopes of the curves (which are substantially straight lines) thus constructed are listed in Table VII which follows.

Table VII.—Temperature coefficient of reduced viscosity

Asphalt	Slope of Log (reduced vis.) vs. 1/T plot ($\times 10^{-3}$) 77–176° F.	Activation Energy= 0.00456× slope (kcal.) 77–176° F.
(1) Poso-Coalinga	0.98	4.4
(2) Baxterville	3.5	16
(3) Venezuelan	3.3	15
(4) Venezuelan	2.0	9.2
(5) Venezuelan	3.0	14
(6) WT-KH	2.1	9.7
(7) WT-KH	2.0	9.1
(8) Oxidized (7)	3.3	15
(9) Oxidized (7)	3.9	18
(10) Oxidized (7)	4.2	19
(11) Santa Maria	2.6	12
(12) Oxidized (11)	4.2	19
(13) Oxidized (11)	4.7	21
(14) Oxidized WTE Sht. Res	4.8	22
(15) Oxidized WTE Sht. Res	4.3	20
(16) Semi-Blown WT-KH	3.0	14
(17) Propane ppt'd	1.6	7.5
(18) Cracked Residue	2.6	12

Fig. IV comprises a plot of the temperature susceptibility of asphaltenes versus the reduced viscosity thereof.

Examination of the various temperature coefficients in terms of the arbitrary norms established in the figures shows the asphaltic components to have the characteristics listed in Table VIII.

Table VIII

	Temperature Coefficient (77–176° F.) of—		
	Maltene Vis.	Association	Asphalt Vis.
(1) Poso-Coalinga Vac.-Red	High	Low	High.
(2) Baxterville Vac.-Red	Normal	Normal	Normal.
(3) Venezuelan Vac.-Red	Low	High	Do.
(4) Venezuelan Vac.-Red	Normal	Normal	Do.
(5) Venezuelan Vac.-Red	Low	High	Do.
(6) WT-KH Vac.-Red	Normal	do	High.
(7) WT-KH Vac.-Red	Low	do	Normal.
(8) Oxidized (7)	Normal	do	High.
(9) Oxidized (7)	High	Normal	Do.
(10) Oxidized (7)	Normal	Low	Low.
(11) Santa Maria Vac.-Red	do	Normal	Normal.
(12) Oxidized (11)	do	do	Do.
(13) Oxidized (11)	do	Low	Low.
(14) Oxidized WTE short residue	do	High	High.
(15) Oxidized WTE short residue	do	Low	Low.
(16) Semi-Blown WT-KH	do	High	High.
(17) Propane ppt'd	Low	Normal	Normal.
(18) Cracked residue	High	do	High.

An asphalt having an improved low temperature susceptibility should, upon the basis of the above considerations, meet the following requirements: (1) The use of maltenes of low temperature susceptibility. (2) The use of asphaltenes of low tendency to dissociate at increasing temperatures. (3) Maintenance of association at a low level since the temperature coefficient of dissociation is generally greater at high degrees of association.

In regard to (1) it will be seen from Table VIII and Fig. III that the maltenes of lowest temperature susceptibility are numbers (3), (5) and especially (17), the latter being a propane precipitated asphalt. With respect to requirement (2) above, asphaltenes of reduced dissociation tendencies are found only in the highly blown products. Finally, requirement (3) is satisfied only by the use of highly viscous maltenes so that the reduced viscosity of the asphalt is low.

Based upon the above considerations, it is concluded that the temperature susceptibility of paving grade asphalts in the range of temperatures to be encountered in service will be benefited by the presence of a substantial amount of a highly blown asphalt, namely, one having a softening point in excess of about 200° F. as determined by the ASTM ring-and-ball method. Another substantial component providing the maltenes of low temperature susceptibility and of high viscosity comprises propane asphalts.

Illustrative of the compositions so provided is the example which follows:

A highly air-blown deep flasher bottoms having a penetration of 10 and a softening point of 229° F. was combined with an asphalt produced by the addition of propane to a West Texas Ellenburger short residue. The propane asphalt had a softening point of 98° F. and a penetration in excess of 250. A composition of 30% of the former with 70% of the latter gave an asphalt having a penetration of 94 and a softening point of 116° F. This combined material had the following viscosity-temperature characteristics:

Temperature (° F.)	Viscosity (poises)
77	1.3×10^{6}.
122	5.97×10^{4}.
176	816.

Calculations from the above data give a temperature susceptibility for this asphalt composition in the range of 77–176° F. corresponding to an activation energy of only 28 kilocalories. Comparison with data appearing in Fig. I will show that this susceptibility is lower than that of any other asphalt studied, regardless of viscosity level, and is at least 5 kilocalories better than a normal asphalt of the same viscosity at 77° F.

The compositions of this invention should comprise

those having penetrations between about 50 and about 200 and softening points within the range from about 100 to about 140° F. as determined by the ASTM ring-and-ball method. They may comprise from about 5 to about 50% by weight of highly blown asphalts, preferably obtained by vacuum flashing or other straight run crude reduction methods. This component should have a softening point in excess of about 200° F. and preferably above 215° F. The propane asphalts to be combined therewith comprise those obtained by precipitation of asphaltic components from short residues or reduced crudes by addition thereto of propane or other alkane having from 2 to 7 carbon atoms per molecule in a ratio of between about 1 to about 20 parts of liquid alkane to 1 part by volume of the short residue or reduced crude. The propane asphalt should contain maltenes having a viscosity at 77° F. within the range from about 30×10^3 to about 100×10^3 poises and said maltenes should have an activation energy value from about 20 to about 30 kilocalories between 77° F. and 176° F.

These asphalts when combined in the normal manner with other road building components are found to have superior paving characteristics and extended service life.

I claim as my invention:

1. An asphalt composition having a viscosity activation energy in kilocalories of less than 3.3 log (viscosity at 77° F., poises) +10.7 as calculated by the formula:

$$0.00456\left(\text{slope of log } \nu \text{ vs. } \frac{1}{T} \text{ plot}\right)\times10^{-3}$$

$$=\text{Activation energy in kilocalories}$$

wherein ν=viscosity in poises and T=absolute temperature in degrees Kelvin, said composition comprising between about 5% and about 50% by weight of blown vacuum flasher bottoms having a penetration at 77° F. (100 g. load, 5 seconds) less than about 15, and a ring-and-ball softening point higher than about 215° F. and between about 95% and about 50% by weight of an asphalt precipitated from short residue by the addition of propane thereto and having a penetration at 77° F. (100 g. load, 5 seconds) greater than about 200 and a ring-and-ball softening point below about 125° F., said propane-precipitated asphalt having a maltene fraction, the viscosity of which is in excess of about 3×10^3 at 77° F. said maltene fraction having a viscosity activation energy, calculated by the above formula, of between about 20 and about 30 kilocalories in the temperature range 77–176° F.

2. A paving grade asphalt composition comprising 70% by weight of asphalt precipitated by addition of propane to vacuum reduced crude and having a penetration at 77° F. (100 g. load, 5 seconds) greater than about 200 and a ring-and-ball softening point below about 125° F., and 30% by weight of highly blown vacuum flasher bottoms having a penetration at 77° F. (100 g. load, 5 seconds) less than about 15 and a ring-and-ball softening point above about 200° F., said composition having a low viscosity-temperature coefficient in the range of paving service temperatures.

3. A paving grade asphalt composition having a viscosity activation energy of less than about 10 kilocalories between 77 and 176° F., said composition comprising between about 5% and about 50% by weight of a blown vacuum flasher asphalt having a penetration at 77° F. (100 g. load, 5 seconds) less than about 15 and a ring-and-ball softening point above about 200° F., and between about 95% and about 50% by weight of an asphalt precipitated by propane addition to vacuum flasher short residue, said propane-precipitated asphalt having a penetration at 77° F. (100 g. load, 5 seconds) greater than about 200 and a ring-and-ball softening point below about 125° F.

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