

Description

HIGH QUALITY ASPHALT CONTAINING PITCH AND METHOD OF PREPARING THE SAME

Technical Field

- [1] The present invention relates, generally, to high quality asphalt containing pitch that is generated as a by-product in a solvent deasphalting process and a method of preparing the same, and more particularly, to high quality asphalt in which wax content and ductility after a thin film oven test are improved by mixing a typical vacuum residue with pitch that has a controlled chemical composition and is obtained from a mixture comprising an atmospheric residue and a petroleum distillate similar to the atmospheric residue using a solvent deasphalting unit, and to a method of preparing such high quality asphalt.

Background Art

- [2] According to a conventional method of preparing asphalt using a vacuum distillation unit as shown in FIG. 1, an atmospheric residue produced using a crude distillation unit is subjected to a vacuum distillation process to separate a vacuum residue having controlled penetration, which is then directly produced into asphalt.
- [3] The asphalt thus produced is used as material for paving roads. As such, important properties of the asphalt, such as penetration, penetration index, softening point, viscosity, wax content, and ductility after a thin film oven test, should be considered. Among these properties, penetration, which is a measure of the hardness of asphalt, should be most fundamentally satisfied in order to use asphalt as material for paving roads. Further, upon evaluation of the quality of asphalt, the wax content and ductility after a thin film oven test are mainly considered. As such, as the wax content decreases and the ductility after the thin film oven test increases, the quality of the asphalt is regarded as improved.
- [4] In the case where a vacuum residue is directly made into asphalt, a crude oil group suitable for the production of asphalt is selectively combined and is then supplied into a crude distillation unit, after which the separation temperature of the vacuum residue is controlled using a vacuum distillation unit to achieve desired penetration. Further, the other main properties may have dependency on the crude oil supplied into the crude distillation unit. As such, in order to produce asphalt having low wax content and high ductility after the thin film oven test, the crude oil group to be treated in the crude distillation unit must be chosen appropriately. However, because the price of the crude oil is a significant portion of the operating expense of refining plants, economic benefits may be undesirably negated.

- [5] In addition, direct production of the vacuum residue into high quality asphalt suffers because a vacuum gas oil produced along with the vacuum residue using the vacuum distillation unit is used as a feedstock of high-value processes such as hydrocracking and fluid catalytic cracking, undesirably causing low quality of relatively expensive vacuum gas oil or low yield upon operation of the vacuum distillation unit to ensure the quality of asphalt. In this regard, US Publication No. 2004-163996 discloses a method of preparing asphalt using a vacuum residue or an atmospheric residue as a feedstock.
- [6] Meanwhile, in particular consideration of the chemical structure of the vacuum residue used in the direct production into asphalt, the chemical structure of the atmospheric residue and vacuum residue is composed of a saturate, an aromatic, resin, and asphaltene. As such, it is known that a low wax content is realized when the amount of saturate is low and that high ductility after a thin film oven test is achieved when the amounts of saturate and asphaltene are low and the amounts of aromatic and resin are high. Upon vacuum distillation, since the vacuum gas oil and the vacuum residue are separated from each other due to the separation temperatures thereof, it is difficult to selectively increase the amounts of aromatic and resin in the vacuum residue from the point of view of the chemical structure in order to improve the wax content and ductility after a thin film oven test. Moreover, the chemical structure of the vacuum residue cannot but depend on the crude oil.

Disclosure of Invention

Technical Problem

- [7] Leading to the present invention, intensive and thorough research on high quality asphalt and preparation methods thereof, carried out by the present inventors aiming to avoid the problems encountered upon direct production of a vacuum residue into high quality asphalt as mentioned above, resulted in the finding that a solvent deasphalting process is used to produce pitch having a controlled chemical composition, which is then mixed with a typical vacuum residue and a similar light petroleum distillate, thus producing high quality asphalt having superior wax content and ductility after a thin film oven test.
- [8] As object of the present invention is to provide high quality asphalt having superior wax content and ductility after a thin film oven test.
- [9] Another object of the present invention is to provide a method of preparing such high quality asphalt.

Technical Solution

- [10] In order to accomplish the above objects, the present invention provides high quality asphalt, which contains pitch obtained by subjecting a mixture comprising a

first vacuum residue and a first petroleum distillate to solvent deasphalting.

- [11] In addition, the present invention provides a method of preparing high quality asphalt, comprising conducting crude distillation and vacuum distillation to produce a vacuum residue for use in preparation of the asphalt, the method using pitch obtained by subjecting a mixture of the vacuum residue, produced through the vacuum distillation, and a first petroleum distillate, which is lighter than the vacuum residue and has high amounts of aromatic and resin, to solvent deasphalting.

Brief Description of the Drawings

- [12] The above and other objects, features and advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

- [13] FIG. 1 is a schematic view showing a conventional process of preparing straight-run asphalt from a vacuum residue produced using a vacuum distillation unit; and

- [14] FIG. 2 is a schematic view showing a process of preparing high quality asphalt using a mixture of pitch, resulting from solvent deasphalting, and a light distillate, according to the present invention.

Best Mode for Carrying Out the Invention

- [15] Hereinafter, a detailed description will be given of the present invention.

- [16] According to the conventional method of producing asphalt described above, asphalt is directly produced from a vacuum gas oil (VGO) and a vacuum residue (VR) produced using a vacuum distillation unit (VDU) after subjecting an atmospheric residue (AR) produced using a crude distillation unit (CDU) to vacuum distillation. With reference to FIG. 1, the vacuum gas oil is subjected to hydrocracking and fluid catalytic cracking and thus refined into kerosene and gas oil, and gasoline, and the vacuum residue is directly produced into asphalt.

- [17] However, asphalt according to the present invention contains pitch which is obtained by mixing a first petroleum distillate including the atmospheric residue produced using the crude distillation unit with a first vacuum residue produced using the vacuum distillation unit and then subjecting the mixture to solvent deasphalting (SDA). Preferably, in order to control the penetration, the pitch is mixed with a second vacuum residue and/or a second petroleum distillate, thus obtaining asphalt. The asphalt thus obtained has excellent wax content and ductility after a thin film oven test.

- [18] FIG. 2 illustrates a process of preparing high quality asphalt of the present invention. As shown in FIG. 2, the first vacuum residue produced using the vacuum distillation unit is appropriately mixed with the first petroleum distillate including the atmospheric residue, after which the mixture is subjected to solvent deasphalting, leading to deasphalted oil and pitch. The deasphalted oil is refined through hy-

drocracking and fluid catalytic cracking, and the pitch is mixed with the second vacuum residue and the second petroleum distillate to control the penetration thereof, therefore preparing the asphalt of the present invention.

[19] The mixing ratio of the first vacuum residue to the first petroleum distillate is preferably 10~90 wt%. If the ratio is less than 10 wt%, the effect of aromatic and resin contained in the first petroleum distillate is low. On the other hand, if the ratio exceeds 90 wt%, the amount of light oil is increased in the pitch upon deasphalting and thus the quality of the asphalt is worsened.

[20] In the present invention, the petroleum distillate, which may be mixed with the vacuum residue as a feedstock of a solvent deasphalting process and a final mixing process, includes a heart cut vacuum gas oil (HCVGO) resulting from vacuum distillation and/or a slurry oil (SLO) resulting from fluid catalytic cracking, in addition to the above atmospheric residue.

[21] According to the present invention, the solvent deasphalting process should be conducted such that the penetration of the pitch resulting from solvent deasphalting is similar to (almost the same as) or slightly lower than that of the vacuum residue to make the pitch itself, or the mixture of the pitch and the vacuum residue and/or petroleum distillate, into asphalt. In the case where the penetration of the mixed asphalt is lower than the standard, it may be controlled by further adding a distillate lighter than the vacuum residue, such as an atmospheric residue, a heart cut vacuum gas oil, and/or a slurry oil.

[22] As the solvent used in the solvent deasphalting process, a C3~C6 n-paraffin or iso-paraffin solvent is mainly used. Further, in order to control the penetration of the pitch, the use of C3~C4 paraffin solvents or mixtures thereof is preferable. In addition, the yield of the pitch, which varies with the ratio of the atmospheric residue and the vacuum residue as the feedstock and the operation conditions, typically falls in the range of about 10~90 vol%. When the yield of the pitch is high, soft semi-finished products having high pitch penetration are obtained, and the properties of the deasphalted oil are improved. When the number of carbons of the solvent is low and the operating temperature of the solvent deasphalting process is high, the yield of the pitch is increased and thus the absolute amounts of aromatic and resin are high. However, if the yield of the pitch is too high, the standard for the penetration of asphalt products is difficult to satisfy. In addition, a light distillate is present in a large amount, and thus, ductility after the thin film oven test may be deteriorated due to the promotion of oxidation upon the measurement of ductility after the thin film oven test. Consequently, it is important to appropriately control the yield of the pitch depending on the properties of the feedstock of the solvent deasphalting process.

[23] In the present invention, the solvent deasphalting process is preferably conducted at

a pitch extraction temperature of 43~93°C in the presence of n-propane or 115~150°C in the presence of n-butane/iso-butane at a pitch extraction pressure of 30~46 kg/cm²g, in the interest of improving ductility after the thin film oven test and decreasing wax content.

[24] Table 1 below shows the properties of the atmospheric residue (AR) and vacuum residue (VR) as the feedstock and of the deasphalted oil (DAO) and pitch produced from the above residue mixture through the solvent deasphalting process. As is apparent from Table 1, since the pitch has a lower amount of saturate than that of the vacuum residue, it advantageously has a low wax component. Further, the amounts of aromatic and resin are high, realizing excellent ductility after a thin film oven test. This is because the solvent used in solvent deasphalting is paraffin-based, and thus, the saturate having high chemical affinity is somewhat separated via the deasphalted oil, and the aromatic and resin components having relatively lower affinity are not dissolved in the solvent and are transferred to the pitch.

[25] Thus, according to the present invention, not only the atmospheric residue but also other petroleum distillates containing high amounts of aromatic and resin are used as the feedstock along with the vacuum residue, such that the saturate is removed in the form of deasphalted oil, and the aromatic and resin are transferred to the pitch, resulting in a distillate that is advantageous in terms of wax content and ductility after a thin film oven test, among the properties of asphalt.

[26] Table 1

[27] Properties of AR, VR, DAO and Pitch in Solvent Deasphalting

[28]

	AR	VR	DAO	Pitch
Nitrogen, wt%	0.27	0.42	0.06	0.52
Sulfur, wt%	3.21	4.87	2.20	4.99
Nickel/Vanadium, wppm	24.3/71	46.8/135.8	Trace/Trace	45.2/136.9
Distillation, D2887				
IBP	297	454	266	
5%	365	514	339	
30%	463	597	438	
50%	535	647	488	
70%	623	699	539	
90%			604	
95%			633	
FBP	750+	750+	699	
Recovered, %	91.7	83.0	100.0	
Specific Gravity, 15/4	0.9757	1.0293	0.9177	1.0514
Conradson Carbon Residue, wt%	10.73	23.34	0.99	25.68
Chemical Composition				
Saturate		4.5		0.7
Aromatic		61.8		66.4
Resin		13.7		15.2
Asphaltene		20.0		17.7

Mode for the Invention

[29] A better understanding of the present invention may be obtained in light of the following examples which are set forth to illustrate, but are not to be construed to limit the present invention.

[30] Example 1

[31] A feedstock comprising the atmospheric residue (AR) and the vacuum residue (VR) having the properties shown in Table 1, mixed at a volume ratio of 18:11, was subjected to solvent deasphalting under the conditions shown in Table 2 below, thus producing deasphalted oil and pitch. The results are shown in Table 3 below. In order to control the penetration of the pitch thus obtained, a heart cut vacuum residue was further added, leading to asphalt. The properties of the asphalt thus obtained are shown in Table 4 below.

[32] As is apparent from Table 4, in the case where the asphalt was prepared using the pitch, it had higher amounts of aromatic and resin and a lower amount of saturate than those of conventional asphalt obtained from the vacuum residue produced using a vacuum distillation unit, and thus high quality asphalt having low wax content and high ductility after a thin film oven test could be produced. Since the penetration of the asphalt was lower by about 6 than that of the vacuum residue, the asphalt comprising the pitch had much higher ductility after a thin film oven test upon correction of the penetration.

[33] Table 2

[34] Conditions of Solvent Deasphalting: 61% Pitch

[35]

Feed	AR/VR (18/11 vol.)
Solvent	Propane
Pitch Yield, wt%	61
Pressure, kg/cm ² g	45.7
Temp. of Asphaltene Separator, °C	83

[36]

[37] Table 3

[38] Feed of Solvent Deasphalting and Properties of Product: 61% Pitch

[39]

	Feed	DAO	Pitch
Specific Gravity, 15/4	0.9888	0.9177	1.0514
API Gravity	11.60	22.69	3.08
Nitrogen, wppm	0.34	0.06	0.52
Sulfur, wt%	3.84	2.20	4.99
CCR, wt%	15.86	0.99	25.68
Nickel/Vanadium, wppm	33.5/93.2	Trace/Trace	45.2/136.9
D2887, °C			
IBP	291	266	
5%	376	339	
30%	512	438	
50%	588	488	
70%	660	539	
90%		604	
95%		633	
FBP	750+	699	
Recovered, %	88.7	100.0	

[40]

[41]

Table 4

[42]

Properties of VR and Pitch-Mixed Asphalt: 61% Pitch

[43]

	VR (Asphalt)	Pitch-Mixed Asphalt	Conditions for High Quality Asphalt
Mixing Ratio, vol. %			
VR	100		
Pitch		82.3	
HCVGO		17.7	
Penetration at 25 °C, 0.1mm	70	64	60 ~ 80
Softening Point, °C	48.2	48.6	Min 47
Viscosity at 60 °C, Pa s	213	221	Min 180
Wax, wt%	1.87	1.49	Max 1.8
Ductility at 15 °C, cm	63	105	Min 100
Chemical Composition			
Saturate	4.5	2.3	
Aromatic	61.8	66.9	
Resin	13.7	14.1	
Asphaltene	20.0	16.8	

[44]

[45]

Example 2

[46]

A feedstock comprising the atmospheric residue and the vacuum residue having the properties shown in Table 1, mixed at a volume ratio of 18:11, was subjected to solvent deasphalting under the conditions shown in Table 5 below, thus obtaining deasphalted oil and pitch. The results are given in Table 6 below. The pitch thus obtained was mixed with the vacuum residue and then with the heart cut vacuum residue to control the penetration thereof, leading to asphalt. The properties of the

asphalt thus obtained are shown in Table 7 below.

[47] As is apparent from Table 7, the asphalt prepared using the pitch was confirmed to have ductility after a thin film oven test that was superior to that of asphalt produced from the vacuum residue under the same penetration conditions.

[48]

[49] Table 5

[50] Conditions of Solvent Deasphalting: 70% Pitch

[51]

Feed	AR/VR (18/11 vol.)
Solvent	Propane
Pitch Yield, wt%	70
Pressure, kg/cm ² g	45.7
Temp. of Asphaltene Separator, °C	88

[52]

[53] Table 6

[54] Feed of Solvent Deasphalting and Properties of Product: 70% Pitch

[55]

	Feed	DAO	Pitch
Specific Gravity, 15/4	0.9888	0.9089	1.0385
API Gravity	11.60	24.18	4.75
Nitrogen, wppm	0.34	0.07	0.48
Sulfur, wt%	3.84	2.03	4.70
CCR, wt%	15.86	0.29	23.13
Nickel/Vanadium, wppm	33.5/93.2	Trace/Trace	40.5/129.4
D2887, °C			
IBP	291	259	
5%	376	332	
30%	512	428	
50%	588	475	
70%	660	523	
90%		591	
95%		623	
FBP	750+	699	
Recovered, %	88.7	99.5	

[56]

[57] Table 7

[58] Properties of VR and Pitch-Mixed Asphalt: 70% Pitch

[59]

	VR (Asphalt)	Pitch-Mixed Asphalt	Conditions for High Quality Asphalt
Mixing Ratio, vol %			
VR	100	30.0	
Pitch		65.5	
HCVGO		4.5	
Penetration at 25 °C, 0.1mm	70	70	60~80
Softening Point, °C	48.2	48.0	Min 47
Viscosity at 60 °C, Pa s	213	194	Min 180
Wax, wt%	1.87	1.49	Max 1.8
Ductility at 15 °C, cm	63	145+	Min 100
Chemical composition			
Saturate	4.5	2.4	
Aromatic	61.8	62.6	
Resin	13.7	18.5	
Asphaltene	20.0	16.5	

Industrial Applicability

[60] As described hereinbefore, the present invention provides high quality asphalt containing pitch and a method of preparing the same. According to the present invention, the operation conditions of a solvent deasphalting process are appropriately controlled, such that aromatic and resin components contained in an atmospheric residue and a vacuum residue can be distributed to the pitch, and as well, a saturate can be removed. Thus, compared to conventional methods of preparing asphalt using only the vacuum residue, the wax content and ductility after a thin film oven test can be further improved.

[61] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

Claims

- [1] A high quality asphalt containing pitch, the pitch being obtained by subjecting a mixture comprising a first vacuum residue and a first petroleum distillate, which is lighter than the vacuum residue and has high amounts of aromatic and resin, to solvent deasphalting.
- [2] The asphalt according to claim 1, wherein a mixing ratio of the vacuum residue to the petroleum distillate is 10~90 wt%.
- [3] The asphalt according to claim 1, further comprising a second vacuum residue, a second petroleum distillate, or a mixture of the second vacuum residue and the second petroleum distillate.
- [4] The asphalt according to claim 1, wherein the first petroleum distillate comprises at least one selected from the group consisting of an atmospheric residue, a heart cut vacuum gas oil, and a slurry oil for fluid catalytic cracking.
- [5] The asphalt according to claim 3, wherein the second petroleum distillate comprises at least one selected from the group consisting of an atmospheric residue, a heart cut vacuum gas oil, and a slurry oil for fluid catalytic cracking.
- [6] The asphalt according to claim 1, wherein the pitch has penetration similar to (almost the same as) or lower than that of the vacuum residue.
- [7] A method of preparing high quality asphalt containing pitch, comprising conducting crude distillation and vacuum distillation to produce a vacuum residue for use in preparation of the asphalt, the method using the pitch obtained by subjecting a mixture of a first vacuum residue, produced through the vacuum distillation, and a first petroleum distillate, which is lighter than the vacuum residue and has high amounts of aromatic and resin, to solvent deasphalting.
- [8] The method according to claim 7, wherein a mixing ratio of the first vacuum residue to the first petroleum distillate is 10~90 wt%.
- [9] The method according to claim 7, wherein the solvent deasphalting requires a solvent selected from C3~C4 paraffin solvents and mixtures thereof, and a yield of the pitch is 10~90 vol%.
- [10] The method according to claim 7, wherein the solvent deasphalting is conducted at a pitch extraction temperature of 43~93°C in the presence of n-propane or 115~150°C in the presence of n-butane/iso-butane at a pitch extraction pressure of 30~46 kg/cm²g, and the pitch produced through the solvent deasphalting has penetration similar to (almost the same as) or lower than that of the vacuum residue used in the solvent deasphalting.
- [11] The method according to claim 7, further comprising mixing the pitch with a second vacuum residue, a second petroleum distillate, or a mixture of the second

vacuum residue and the second petroleum distillate.

[12] The method according to claim 7, wherein the first petroleum distillate comprises at least one selected from the group consisting of an atmospheric residue, a heart cut vacuum gas oil, and a slurry oil for fluid catalytic cracking.

[13] The method according to claim 11, wherein the second petroleum distillate comprises at least one selected from the group consisting of an atmospheric residue, a heart cut vacuum gas oil, and a slurry oil for fluid catalytic cracking.