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ASPHALT MANUFACTURE

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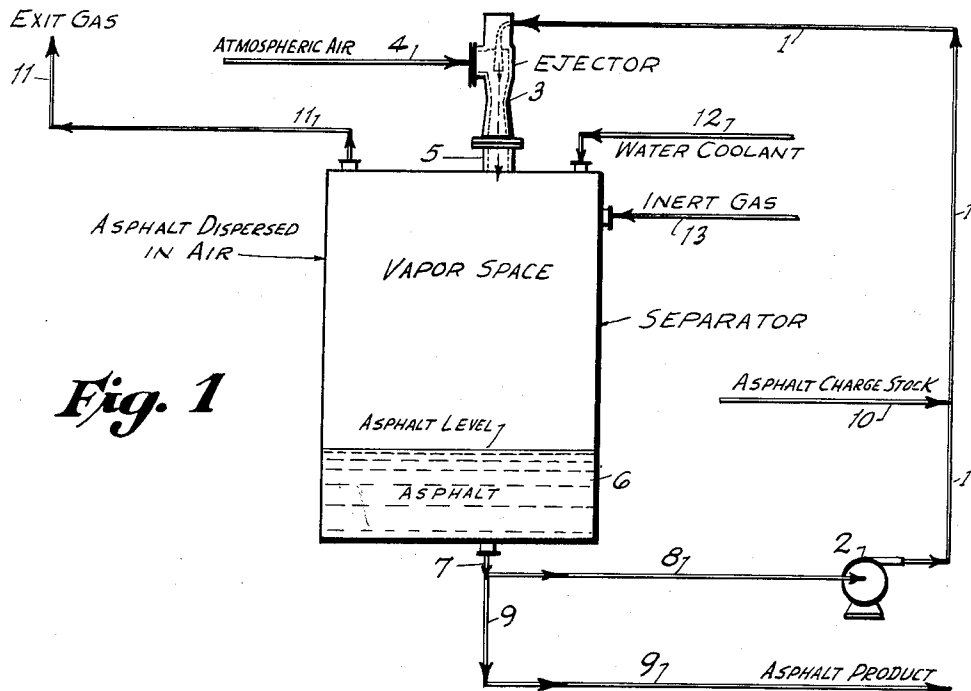


Fig. 1

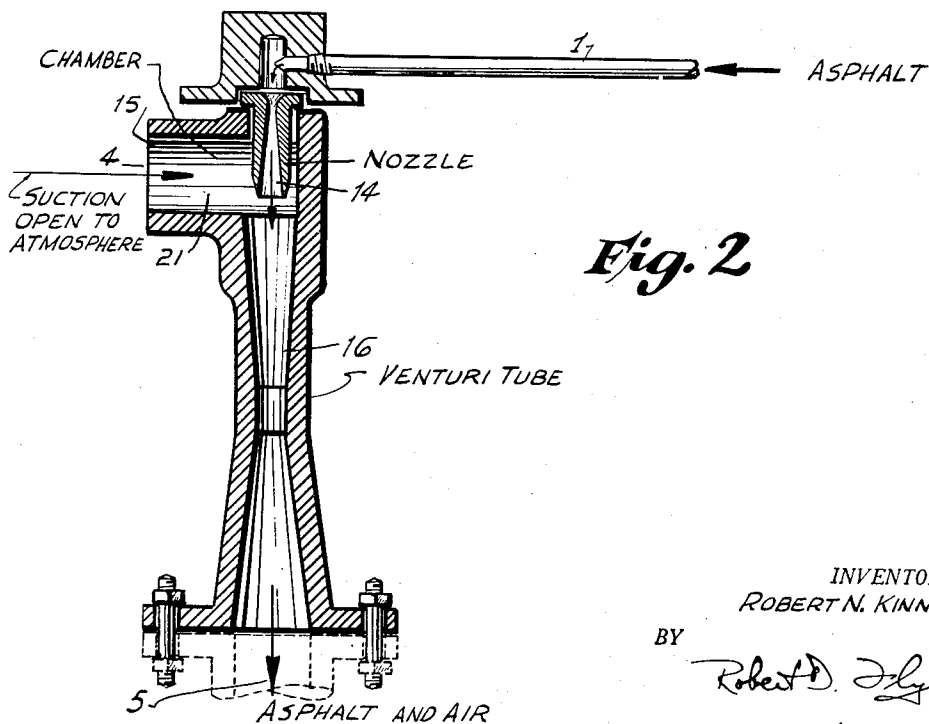


Fig. 2

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ASPHALT MANUFACTURE

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12 Claims. (Cl. 196—74)

This invention is concerned with a new process for manufacturing asphalt and is also concerned with a novel apparatus for accomplishing the process.

PRIOR PRACTICES

More specifically, the present invention marks a departure from prior and current practices in the art, in that much less power or energy and costly equipment are required for the production of a given quantity of asphalt. This is accomplished by a novel technique of dispersing an asphalt charge stock in an atmosphere of oxidizing gas, in contrast to prior and current practices of dispersing air through an asphalt charge stock. In the past, asphalt has been manufactured by air-oxidizing various petroleum fractions in externally and in internally heated stills, which have proven disadvantageous in several respects. The asphalt so produced has not been uniform in quality and this particularly applies to continuous operations. Also considerable product has been held up in the stills. In addition, many of the stills have been hazardous in that control of asphalt charge and air has been difficult, resulting in explosive mixtures. As the art developed, a number of variations were resorted to, with vertical towers, horizontal stills and tube stills fitted with mechanical agitators of different types being adopted in the industry. Typical of such variations are those shown in a series of domestic patents granted to E. W. Gard and B. G. Aldridge, among which are: 1,953,345; 1,953,346; 1,999,018; 2,170,496; 2,205,089; 2,205,090; 2,222,347; and 2,263,534. In general, all of the operations described in the foregoing series of patents have involved a system wherein air has been dispersed in an asphalt charge, with mechanical means being used to break up the asphalt charge and provide an intimate mixture of the same and air. The equipment used for intimately mixing the charge and air has been relatively expensive, in addition to the stills and air compressors required.

In an effort to overcome some of the disadvantageous features of the techniques referred to above, Aldridge developed a vertical still in which is positioned a vertical tube such that an annular space is provided between the tube and the walls of the still. As this technique is described in Patent No. 2,289,953, the oil charge circulates from the bottom to the top of the still, thence overflows back into the annular space and down to the bottom of the still. Air is introduced into a lower portion of the still through a plurality of ejectors which are mounted on a plate covering the lower end of the tube. The introduction of air through the ejectors is considered to create a jetting or gas-lifting effect through the cylinder. However, in essence, the system so described by Aldridge is fundamentally the same as those described in the foregoing series of patents, since air is again dispersed in the asphalt charge. In the ejector system, the ejector nozzles are submerged in an asphalt phase and air is bubbled into the asphalt phase, whereby the latter is broken up by the air and intimate mixing is realized. It will be obvious

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to those skilled in the art that considerable power is required to overcome the static discharge pressure head at the nozzles. Another feature of this Aldridge system is the maintenance of a relatively high ratio of oil to air and relatively high flow rate. The patentee recommends a circulation ratio of 10-50 gallons per minute per cubic foot of air per minute; and states that with lower circulation ratios of four to five gallons per cubic foot of air, no more than about twenty per cent of the oxygen in the air has been utilized.

OBJECTS

It is an object of this invention, therefore, to provide a process or technique for manufacturing asphalt with a minimum of equipment, particularly eliminating the use of an air compressor, mechanical agitators and a relatively large still. It is also an object of this invention to reduce the power or energy requirements in rapid asphalt manufacturing procedures. Another object is to provide a means for efficiently dispersing an asphalt charge into air. Still another object of the invention is to effect a better utilization of the oxygen in the air charge (than has been possible heretofore) while maintaining a relatively low circulation ratio of asphalt charge to air. Another object is to prevent the deterioration of plastic and other desirable properties of asphalt during processing at high temperatures; this is accomplished by maintaining a low residence time in the processing equipment. And another object is to provide new apparatus for manufacturing asphalt. Other objects of the invention will be apparent from the following description.

INVENTION

It has now been found that the foregoing objects are realized by circulating an asphalt charge through an ejector into which air is inducted simultaneously by the flow of the asphalt charge, and discharging the reaction product of said asphalt charge and air into the vapor space of a separator. In a continuous operation, a portion of the reaction product is withdrawn and the balance is recirculated back to the ejector. In a batch operation, the reaction product is circulated from the separator to the ejector until a product having the desired characteristics has been formed.

As illustrated in Figure 1, a suitable asphalt charge stock in line 1 is pumped, by means of circulating pump 2, to ejector 3 into which air is drawn from the atmosphere through ejector opening 4. Asphalt charge and air are intimately mixed, one with the other, in ejector 3 with the formation of some intermediate asphalt product, or "semi-blown" product. Asphalt charge, air and the intermediate product are discharged through discharge 5 into the vapor space in separator 6. The circulation ratio of asphalt charge to air, and the vapor space and the asphalt level in separator 6, are so controlled, as explained below, that the vapor space contains asphalt dispersed in air as opposed to prior operations involving air dispersed in asphalt. Asphalt product is withdrawn from separator 6 through line 7, and is recycled from line 7 through line 8 and pump 2 to line 1, until a finished product of desired characteristics has been formed. When the latter product has been formed, a portion thereof is withdrawn from the system through line 9, the balance is circulated as indicated, and additional charge is added through line 10. As the product is continuously withdrawn through line 9, the additional charge stock is continuously added through line 10 such that the asphalt level is maintained in separator 6. Spent gases, principally nitrogen and water vapor, are removed from the separator 6 through line 11. Water can be introduced, preferably sprayed, into separator 6 through line 12, as a coolant to aid in controlling the temperature within the

separator. As will be made clear hereinafter from a discussion of operating temperatures, water is vaporized in separator 6 and is removed therefrom through line 11 as part of the exit gases.

As a safety measure, in order to prevent any possibility of an explosive mixture forming in the vapor space of the separator 6, an inert gas or stream acting as a diluent can be introduced through line 13. This inert gas or diluent is removed with spent gases through line 11. The inert gas can be nitrogen, carbon dioxide or the like.

Figure 2 illustrates a typical ejector providing a Venturi effect. As shown, ejector 3 comprises inlet line 1 through which the asphalt charge passes to Venturi nozzle 14 and thence to chamber 15. Ejector 3 is constructed with orifice 4 open to the atmosphere and through which air is inducted by the flow of asphalt charge. Chamber 21 is joined with Venturi tube 16 which, in turn, is joined with discharge 5.

In further detail with reference to Figure 1, a Kuwait (Near East) flux having a softening point of about 85° F. is brought into line 1, preferably through a heat exchanger (not shown) at a temperature of about 300–350° F., and is pumped by pump 2 to ejector 3 at a rate of about three gallons per minute. Air is sucked into the ejector 3 through orifice 4 at a rate of about one cubic foot per minute. The flux and air are in intimate contact in the ejector, with the result that the softening point of the charge increases to about 145° F. in one hour. Asphalt resulting from oxidation of the flux, unreacted flux and air are discharged from line 3 through 5 into vapor space in the separator 6, such that asphalt particles are dispersed in air.

In order to provide suitable mixing of the flux and air in the ejector 3, it is most advantageous to have a Venturi ejector whereby added velocity is given to the air so that an auxiliary air compressor is not required. Vapor space of the separator 6 comprises about 50 per cent by volume.

As indicated above, the flux in line 1 is generally at 300–350° F. so that it is readily pumpable. Oxidation of the flux is exothermic with the result that the temperature of the materials in the ejector and in the air space rises rapidly to 450–500° F., and generally would rise even above 600° F. if not controlled. It is advisable to maintain the temperature within the range of 350 to 550° F. since the products obtained under such conditions possess desirable characteristics. The temperature is readily controlled by introducing a coolant such as water into separator 6 through line 12. It will be understood that one or more lines such as 12 can be used, that a spray or battery of sprays can be used to bring the coolant into 6, and that meters and coolers can be included in line 12; all are well-known expedients in the art. One advantage realized by using a coolant such as water is that it reduces the chance of an explosion occurring by virtue of an explosive mixture being formed.

Gases in separator 6 are taken through line 11. The gases are principally nitrogen, water vapor formed in the oxidation reaction and steam from the added coolant, water. Generally, the oxygen content of the exit gases will be within the range of ten to eighteen per cent, when the circulation ratio of asphalt to air is from 1.6 to 5.6 gallons per minute of flux to one cubic foot of air per minute and when the temperature is from about 350° F. to about 550° F. Thus, the utilization of oxygen in the air is from about fifteen to about forty-five per cent under such conditions. Optimum operation, however, involves a circulation ratio of about three gallons of flux per minute per cubic foot of air per minute, and a temperature of about 480° F., such that about 40 per cent of the air is utilized. With such conditions as these, it has been noted that the softening point of the asphalt is raised about 56–60 points per hour.

The asphalt level in separator 6 generally comprises about fifty per cent of this vessel, allowing for a vapor space of about fifty per cent, as mentioned above. Asphalt is withdrawn from the separator 6 through line 7, by pump 8, at the same rate as flux is charged through line 1. This allows for a residence time of about thirty minutes for the asphalt in separator 6 when a product of 115° F. softening point is formed from an 85° F. softening point flux. Asphalt product taken from the system through line 9 is stored in a tank (not shown) where it is cooled.

As indicated above in connection with the system illustrated by Figure 1, a continuous operation is contemplated herein. So also is a batch-type operation. In the latter, the operating conditions are the same as explained above, with the exception that there is no continuous addition of asphalt charge stock and no continuous removal of asphalt product. Rather, the charge is recirculated until a product of the desired characteristics is formed in the system, whereupon the product is withdrawn through lines 7 and 9.

While air is most generally used as the source of oxygen, in view of its low cost and availability, oxygen alone can be used. Also, other oxidizing gases such as chlorine and other halogens, SO₃, etc. may be used.

It is also contemplated herein that catalysts or modifying materials can be used in the preparation of asphalts. For example, phosphoric acid can be added to the asphalt charge stock, either to line 1 or line 10 (not shown), in which event the operating temperature will be as described in my copending application Serial No. 277,631, filed March 20, 1952.

The operating technique and apparatus of this invention are also useful for contacting oxidizing gases with other oils such as animal, marine, mineral and vegetable oils. By way of illustration, rapeseed oil can be effectively air-blown to a bodied oil useful in compounded lubricants.

The asphalt charge stocks suitable for use herein can be of varied character. Broadly, any petroleum residuum or flux, remaining following separation therefrom of vaporizable hydrocarbons through lubricating oil fractions, or any relatively high molecular weight extract obtained by petroleum refining, can be used. For example, residua from Pennsylvania, Mid-Continent, California, Middle-East, Near East, Venezuela, etc. crudes can be used. Or in other words, residua from paraffinic, naphthenic, aromatic, high sulfur, etc. stocks are suitable. It will be recognized, of course, that differences in charge stocks are reflected in differences in the character of the final products contemplated herein, and such differences are indicated below. Typical advantageous charge stocks are a Casper flux having an 85–90° F. softening point, which is representative of a Mid-Continent charge; Lagunillas fluxes having softening points of 70° F. and 120° F., such materials typifying Venezuelan residua charges; a 27% Kuwait residuum having an 85° F. softening point and a 24% Kuwait residuum having a 90° F. softening point, such typifying Near-East charges; a tar having a 95° F. softening point and obtained by a Duo-Sol treat of a heavy lubricating oil, and a tar having a 125° F. softening point and obtained by a Duo-Sol treat of a heavy lubricating oil.

EXAMPLES

The following examples are provided in order to illustrate the present invention and in order to point out advantages of the same over prior procedures. The charge stock shown in Examples 1 and 2 is a Kuwait flux having a softening point of 85° F.

Example 1

This example reveals the marked advantage of the present invention in being characterized by only a small hold-up of product in the ejector system as opposed to

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conventional blowing stills and towers, in continuous operation.

CONTINUOUS OPERATIONS

	Plant Blowing Stills	Plant Towers	Ejector
Product, bbl./day	2,500	2,500	2,500
Charging Volume, Hold-up, bbls.	1,120	1,100	49.5
Air Input, c. f. m./bbl. of Hold-up	1.67	0.79	16.0
Blowing Temperature, °F.	480	480	480
Charging Stock, SP, °F.	85	85	85
Product:			
SP, °F.	115	115	115
Pen., 77	100	100	100
Ductility	100+	100+	100+
Exit Gas, percent O ₂	12.1	1.9	0.0

Example 2

The great advantage in a much shorter blowing time in batch operations is revealed in the following tabulation.

BATCH OPERATIONS

	Plant Blowing Stills	Plant Towers	Ejector
Charging Volume, Hold-up, bbls.	300	300	300
Air Input, c. f. m./bbl. of Hold-up	1.67	1.67	16.0
Blowing Temperature, °F.	480	480	480
Blowing Time, Hrs.	10.1	5	0.5
Charging Stock, SP, °F.	85	85	85
Product:			
SP, °F.	115	115	115
Pen., 77	100	100	100
Ductility	100+	100+	100+
Exit Gas, percent O ₂	11.5	2.0	0.0

Example 3

This example illustrates the substantially lower power requirements of the present invention, when compared with prior procedures such as that shown in the aforesaid Patent 2,289,953.

	2,289,953	Ejector
Gallons/cubic foot of air, Maximum	50	5.6
Gallons/cubic foot of air, Minimum	10	1.6
Gallons/cubic foot of air, Preferred	30	3.0
Oxygen Used:		
Percent at Maximum liquid flow rate	80	45
Percent at Minimum liquid flow rate	30	16
Percent at Preferred liquid flow rate	70	40
Gallons/cubic foot of Oxygen Consumed:		
Max. flow	300	60
Min. flow	160	48
Prf. flow	205	36
HP/cubic foot of Oxygen Consumed Liquid at 20 p. s. i. g.:		
at Max. flow	3.5	0.70
at Min. flow	1.85	0.56
at Prf. flow	2.4	0.42

In this example it is assumed that the liquid is pumped against a head of 20 p. s. i. g.

I claim:

1. The process for manufacturing asphalt which comprises: passing an asphalt charge stock through an ejector into which air is inducted simultaneously by the flow of the said charge stock, whereby said charge stock is dispersed in air, the ratio of said asphalt charge to air being from about 1.6 to about 5.6 gallons per minute per 1 cubic foot of air per minute, and the temperature being maintained between about 300 and about 550° F.; and

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discharging the reaction product of said asphalt charge stock and air directly into a vapor space of a separator.

2. The process as defined by claim 1 wherein the operating temperature in the ejector and in the air space is between about 350° F. and about 550° F.

3. The process as defined by claim 1 wherein the operating temperature is about 480° F. and the ratio of said asphalt charge to air is about three gallons of asphalt charge per minute per cubic foot of air per minute.

4. The process as defined by claim 1 wherein a coolant is introduced at an upper portion of said separator, whereby the temperature therein is controlled.

5. The process as defined by claim 1 wherein water is introduced at an upper portion of said separator, whereby the temperature therein is controlled.

6. The continuous process for manufacturing asphalt which comprises: circulating an asphalt charge stock through an ejector into which air is inducted simultaneously by the flow of said charge stock, whereby said charge stock is dispersed in air, the circulating ratio of said asphalt charge to air being from about 1.6 to 5.6 gallons per minute per one cubic foot of air per minute, and the temperature being maintained between about 300 and about 550° F.; discharging the reaction product of said asphalt charge stock and air directly into the vapor space of a separator; collecting asphalt in said separator below said air space; and withdrawing a portion of asphalt and recirculating the remainder to said ejector.

7. The process as defined by claim 6 wherein the operating temperature is between about 350° F. and about 550° F.

8. The process as defined by claim 6 wherein the operating temperature is about 480° F. and the circulating ratio of said asphalt charge to air is about three gallons of asphalt charge per minute per cubic foot of air per minute.

9. The process as defined by claim 6 wherein the circulating ratio of said asphalt charge to air is about three gallons of asphalt charge per minute per cubic foot of air per minute.

10. The process as defined by claim 6 wherein a coolant is introduced at an upper portion of said separator, whereby the temperature therein is controlled.

11. The process which comprises: passing an asphalt charge stock through an injector into which an oxidizing gas is inducted by the flow of the said asphalt charge stock, whereby said asphalt charge stock is dispersed in said gas, and the temperature being maintained between about 300 and about 550° F.; and discharging the reaction product of said asphalt charge stock gas directly into a vapor space of a separator.

12. The process as defined by claim 11 wherein water is introduced at an upper portion of said separator, whereby the temperature therein is controlled.

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