

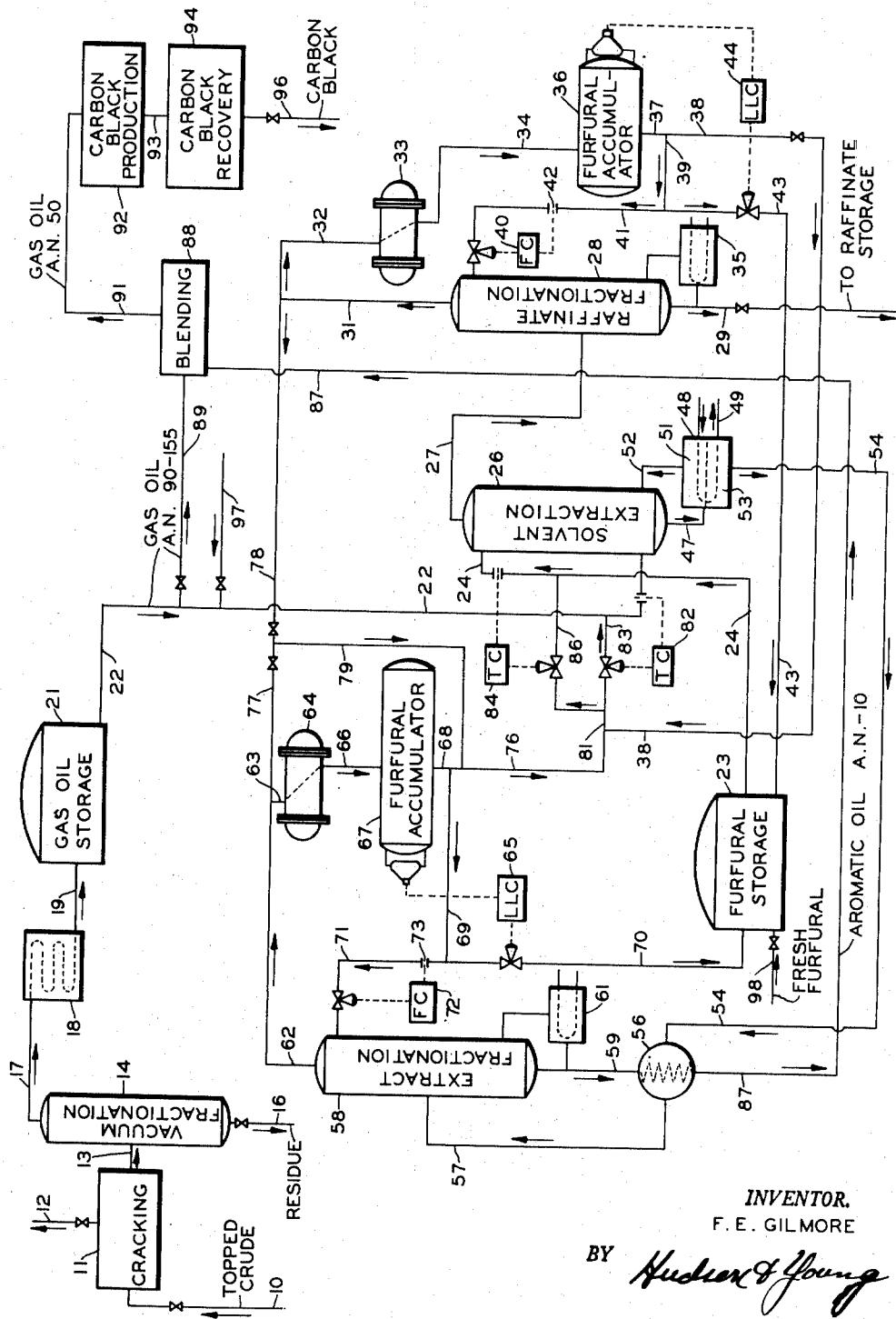
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FURFURAL EXTRACTION PROCESS

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FURFURAL EXTRACTION PROCESS

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This invention relates to solvent refining of hydrocarbon oils. In one embodiment this invention relates to the preparation of low aniline number oils. In another embodiment this invention relates to the regulation and control of temperatures and to the conservation of heat in the solvent refining of oils. In still another embodiment this invention relates to the use of smaller size equipment than employed heretofore in the countercurrent type solvent extraction of a hydrocarbon oil.

Solvent extraction refers to the separation of components of a mixture, usually a liquid solution, by treatment with an immiscible solvent in which one or more of the components of the mixture are more soluble than another. Solvent extraction is widely applied in the separation of compounds differing in chemical type, which are difficult to separate by distillation because their volatilities do not differ greatly. Solvent extraction involves the three steps of first, bringing solvent and mixture into intimate contact; second, separation of resulting phases; and third, separation and recovery of solvent and solute from each phase, usually by distillation. Contacting may be accomplished in any of several types of equipment used in the art, such as agitated vessels containing the liquids, plate columns, impinging jets of the two liquid streams, vessels with stirring means, packed towers, or the like. After separation of the phases, the solvent is usually recovered by distillation of the solvent-rich layer, termed the "extract," and of the solvent-lean layer, termed the "raffinate."

In conventional solvent extraction processes of the type above discussed, it has been common practice to bring the solvent and oil streams to their requisite extraction temperatures prior to their introduction into the zone of extraction, by heating them in indirect heat exchange relation with a selected hot stream, such as for example, a waste heat exchange, or by simply passing the solvent and/or feed stream to be heated, through a heating coil disposed in a steam heater or a direct fired heater, or the like.

My invention is concerned with the solvent refining of oils, wherein conventional means for heating solvent and oil feed streams to be introduced into the solvent extraction zone are unnecessary and wherein, when countercurrent flow is employed, a smaller volume of countercurrent flow is required than heretofore.

It is well known in the art that furfural polymerizes rather readily when subjected to heat and that this occurs in contact with metallic

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surfaces through which heat is transmitted or conducted into the furfural. According to the concept of this invention, as evident from this disclosure, furfural is never heated in contact with a metallic surface when said furfural is by itself. Thus, as evident from this disclosure, whenever heat is transmitted or conducted into the furfural through metallic surfaces, the furfural is, in a sense, diluted with a hydrocarbon oil or a fraction thereof. Thus, the steps of this invention inherently result in that polymerization of furfural is avoided to an extent far greater than has been or is now possible employing processes now known to the art.

15 It is an object of my invention to provide an improved process for the solvent refining of oils.

Another object is to provide for an improved and efficient utilization of heat in a process for the solvent refining of hydrocarbon oils.

20 Another object is to provide for reducing the volume of countercurrent flow, in a countercurrent flow type solvent extraction process for separating aromatic and paraffin hydrocarbons present in a hydrocarbon oil.

25 It is still another object to provide a solvent extraction process for the separation of aromatic and paraffinic hydrocarbons in a gasoil, employing furfural as a solvent, wherein the oil and furfural feed streams are heated in a novel and efficient manner.

30 It is yet another object to provide for the use of equipment of smaller size than has been possible heretofore, in a countercurrent type solvent extraction process.

35 Other objects will be apparent to one skilled in the art from the accompanying discussion and disclosure.

40 In accordance with my invention I have provided a solvent extraction process wherein hot solvent, recovered as an overhead distillate from the extract, is recycled to a cooler stream of solvent and/or oil entering the solvent extraction zone, in a novel and inexpensive heat transfer step, to supply heat in any desired amount to the extraction zone. My invention provides for the elimination in part or in whole, as desired, of relatively expensive conventional methods for heating such feed streams indirectly. As will be discussed more fully hereafter, conventional feed heaters, such as steam heaters, heat exchangers, direct fired heaters, and the like, are unnecessary, and heat that is otherwise lost after the recovered solvent is returned to storage, during conventional operation, is instead utilized in the zone of solvent extraction. Economically, a substantial savings

is effected by conserving the heat present in these recovered solvent streams, thereby eliminating the cost of fuel, or steam, used for heating these solvent extraction feed streams as in ordinary methods.

My invention provides still other advantages with respect to countercurrent flow type solvent extraction methods when recycling hot solvent directly to the oil feed stream, for the reason that certain constituents of the oil selectively soluble in the solvent, are dissolved in the solvent upon initial contact therewith, and, solvent phase therefrom can be immediately removed from the extraction zone without forming any part of the countercurrent flow system. Accordingly, equipment requirements are less when recycling solvent to a fresh oil feed stream, in a countercurrent flow type solvent extraction system, in accordance with my invention, than when employing conventional countercurrent solvent extraction methods.

My invention provides for controlling the recycle of hot solvent, so that the required proportions of recycled hot solvent in the specific feed stream are regulated as desired, and a constant predetermined temperature level can be maintained in the solvent extraction zone.

With reference to the attached schematic drawing, my invention is further illustrated with respect to the use of furfural as a solvent in a countercurrent flow type solvent extraction process for producing low aniline number stocks from relatively high aniline number gas oils. The utility of my invention is particularly illustrated as applied to the manufacture of oil stocks especially suitable for conversion to carbon black. The figure is a diagrammatic illustration of one form of apparatus in which the process of my invention can be practiced. It is to be understood that this flow diagram is diagrammatic only and may be altered in many respects by those skilled in the art and still remain within the intended scope of my invention.

Referring to the drawing, a topped crude oil (from a crude oil topping or reducing operation not shown), from line 10, is passed into cracking and gasoline recovery zone 11 wherein it is cracked at a temperature within the range of 850 to 900° F. Gasoline, i. e. cracking product boiling at a temperature not higher than 400° F. is withdrawn from zone 11 through line 12. Residue from the topped crude cracking in zone 11, i. e. cracking effluent boiling above 400° F. 11, i. e. cracking effluent containing gas oil and heavy residual components, is withdrawn from zone 11 and passed through line 13 into vacuum fractionation zone 14 operated at a temperature in a range of about 650 to 825° F. and at a pressure as low as about 10 mm. of Hg. Residual product, i. e. pitch having a softening point of about 200 to 300° F. is withdrawn from zone 14 through line 16. Gas oil is taken overhead from zone 14 through line 17, condenser 18, and passed through line 19 into gas oil storage 21. Gas oil in storage zone 21 has an aniline number generally within the range of from 90-155.

The aniline number indicates the aromaticity of an oil, and is determined by admixing an equal quantity of aniline with the oil to be tested and then determining the minimum solution temperature. That temperature expressed in degrees Fahrenheit is called the aniline number, or aniline point. A high aniline number indicates an oil having a low content of aromatic hydrocarbons, and vice versa.

Gas oil is withdrawn from storage zone 21 at a temperature generally atmospheric, e. g. about 50-120° F., through line 22, heated in a manner described hereafter, and passed from line 22 into a lower portion of countercurrent flow type solvent extraction zone 26. Furfural is withdrawn from furfural storage 23 at a temperature generally atmospheric, e. g. 50-120° F., through line 24, heated in a manner described hereafter, and passed from line 24 into an upper portion of zone 26. Furfural is passed downwardly in zone 26 in countercurrent flow relation with gas oil, the countercurrent flow system being generally maintained at a temperature within the limits of 100-180° F. and at a pressure within the limits of from 0 to 80 p. s. i. g., although temperature and pressure conditions outside these ranges can be employed if desired. The ratio of the volume of furfural introduced from line 24 into zone 26, to the volume of gas oil introduced into zone 26 from line 22 is generally within the limits of 0.5:1 to 1:1. It is often preferably to employ a temperature in the range of 140-150° F. when furfural-extracting aromatic hydrocarbons from a high aniline number gas oil and to introduce the furfural stream into the extraction zone at a temperature higher than that of the incoming gas oil stream.

Solvent-rich phase, i. e. extract, is withdrawn from the lower portion of extraction zone 26 through line 47, passed through bottoms-cooler 48, and cooled in indirect heat exchange with cooling water passed through coil 49. The bottoms from zone 26 is cooled to a specific temperature in zone 48, dependent on the desired aniline point of the aromatic product finally recovered. In the recovery of a -10 aniline point oil as desired herein for use in the preparation of a feed stock for carbon black manufacture, the bottom product from zone 26, must be cooled in zone 48 to a temperature of about 110-112° F. Upon such cooling in zone 48, a high aniline point layer 51 is formed and is returned through line 52 to the lower portion of zone 26 as reflux. Bottom layer 53 in zone 48, rich in furfural and a hydrocarbon oil having an aniline number of about -10, is withdrawn from zone 48 through line 54 and passed through heat exchange zone 55 in heat exchange with hotter furfural-free extract discussed hereafter, and through line 57 into extract fractionation zone 58 wherein furfural and low aniline point oil present in the stream from line 57, are separated. Solvent and oil in line 57 is heated in zone 56 in indirect heat exchange with solvent-free extract withdrawn from zone 58 through line 59. A conventional reboiler system 61 is employed as a source of heat for fractionation in zone 58. The fractionation of extract phase in zone 58, is conducted at a pressure generally within the range of from atmospheric to 50 p. s. i. g. Furfural vapors are withdrawn from fractionation zone 58 as overhead fractionation product at a temperature generally within the limits of 325-430° F. through line 62 and passed through line 63, condenser 64, and as condensate through line 66 into furfural accumulator 67. The temperature of condensate passed into zone 67 is within the limits of from 200 to 320° F., the specific temperature being dependent upon the amount of cooling effected in zone 64. Hot furfural is withdrawn from zone 67 through line 68 at a temperature within the 200-320° F. range, and passed in part through lines 69 and 71, into zone 58 as reflux for fractionation therein. Control of the rate of

flow of furfural as reflux into zone 58, is maintained by flow controller 72 of conventional design for regulating liquid flow in response to pressure drop across an orifice, in this case, orifice 73 in line 71. Another portion of hot furfural in line 68, is passed through lines 76 and 81 into oil and solvent lines 22 and 24 at a controlled rate as discussed hereafter. Furfural in line 68, not passed through lines 71 or 76, is passed through line 70 to furfural storage 23. Control of flow through line 70, is regulated by controller 65 of conventional design for controlling flow in response to level of a liquid, in this case the level of liquid furfural in zone 67.

When desired, uncondensed furfural vapor from line 62 is passed into line 77 and can then be passed through line 79 into oil and solvent streams 22 and 24 discussed hereafter.

Hot liquid furfural from line 76 is introduced into line 81 and into lines 22 and 24. The proportion of hot furfural introduced from line 81 into each feed stream, i. e. into lines 22 and 24, is that volume required to transfer heat to the cooler feed stream to form a resulting feed stream admixture at a predetermined temperature in the 100-180° F. range, so that upon introducing each feed stream admixture into zone 26, there are no further heat requirements for solvent extraction therein. This can be done by means of temperature controller 82 in line 83 delivering hot furfural from line 81 into line 22, and temperature controller 84 in line 86, delivering hot furfural from line 81 into line 24; temperature controllers 82 and 84 being of conventional design. Temperature controller 84 regulates the flow of hot furfural through line 86 in response to the temperature of furfural in line 24 to permit the requisite flow of hot furfural from line 81 into line 24 for maintaining a resulting furfural stream admixture at a predetermined temperature level, as discussed above.

Flow of hot furfural through line 83 is regulated by means of temperature controller 82 operated in response to the temperature of oil in line 22; the quantity of hot furfural passed through line 83 being regulated to maintain a resulting furfural-oil stream admixture at a predetermined temperature level, as discussed above.

Similarly, hot furfural vapors can be passed from line 79 through lines 88 and 93 to form resulting feed stream admixtures at desired temperature levels.

A highly aromatic oil, having an aniline number dependent on the specific conditions employed in zone 26, in this case -10, is withdrawn from zone 58 through line 59 and heat exchanger 56.

Raffinate, i. e. a solvent-lean, aromatic-poor, oil phase, is withdrawn overhead from zone 26 through line 27 and passed to raffinate fractionation zone 28. Raffinate entering zone 28 from line 27 contains approximately 20 per cent furfural, and 80 per cent highly paraffinic oil, having an aniline number often as high as about 180. Raffinate is fractionated in zone 28 at a pressure usually within the range of from atmospheric to 20 p. s. i. g., or higher, if desired. Solvent-free raffinate is withdrawn as fractionation bottoms product from zone 28 through line 29 and passed to storage. Furfural is removed from zone 28 as vaporous overhead fractionation product at an overhead temperature of from about 325-430° F. through line 31, and is passed through line 32, condenser 33, and as condensate, through line 34 into furfural accumulator 36. Condensed furfural is passed into ac-

cumulator 36 at a temperature generally within the range of 200 to 320° F. dependent upon the extent of cooling in zone 33. Hot liquid furfural, i. e. at about 200-320° F., is withdrawn from zone 36 through line 37. A selected portion of hot furfural in line 37 is recycled through line 38 to the cooler oil and furfural feed streams in lines 22 and 24 as discussed more fully hereinafter. Another portion of hot furfural in line 37 is passed through lines 39 and 41 into zone 28 as reflux for the fractionation of raffinate therein. Control of furfural reflux into zone 28 is maintained by flow controller 40, of conventional design for regulating liquid flow in response to pressure drop across an orifice, in this case orifice 42. Furfural from line 37 not passed through lines 41 or 38 is passed through line 43 to furfural storage 23. Control of flow through line 43 is regulated by controller 44 of conventional design for controlling flow in response to a liquid level, in this case the liquid level of furfural in zone 36. Reboiler 35 associated with fractionation zone 28, is of conventional design, and provides the heat necessary in zone 28.

Hot furfural from line 38, can be introduced into line 81, together with hot furfural from line 16, and through lines 83 and 86 into lines 22 and 24 in the desired proportions, by means of flow controllers 82 and 84, as already discussed. Similarly, when desired, hot vapor from line 31 can be passed through line 78 when desired, and then through line 79 into line 81 and lines 22 and 24, together with vapor from line 77.

As disclosed in the copending application of E. V. Mathy, Serial No. 134,403, filed December 22, 1949, a gas oil having an aniline number of about 50 is particularly well suited for conversion to carbon black, and, in the preparation of such an oil as feed stock for a carbon black manufacturing step, a high aniline point oil such as a 120-160 aniline point gas oil is first extracted to separate a highly aromatic fraction therefrom having an aniline point of about -75 and +20° F., which is then reblended with an amount of the original gas oil, to provide a resulting blend having an aniline point of about 50. Higher yields of 50 aniline point oil can be obtained in this manner, than when separating a 50 aniline point oil from the original 120-160 aniline point gas oil in a single solvent extraction step.

In accordance with the teachings in the copending application above referred to, the highly aromatic oil withdrawn from zone 58 through line 59 has especial utility in the preparation of a feed stock for conversion to carbon black by blending it back with an amount of the original gas oil from storage 21 to provide a resulting blend having the preferred 50 aniline point. Accordingly, in the preparation of such a feed stock, the -10 aniline point oil from heat exchanger 56 is passed through line 87 into blending zone 88 along with gas oil from storage 21 passed through line 89. A gas oil having an aniline number of about 50 is withdrawn from zone 88 through line 91 and passed to carbon black production zone 92. Prior to conversion in zone 92 the gas oil from line 91 is preheated and vaporized. In zone 92 the oil blend from line 91 is continuously introduced into a cylindrically disposed carbon black furnace at about the center of the inlet wall. The gas oil vapors are passed through the cylindrical furnace in a direction parallel to the longitudinal axis thereof at a rate in the order of 50 (D³) gallons per hour where D is the diameter of the cylindrical chamber in feet. Air

or an air-gas mixture is introduced into the furnace near its inlet wall through a tangential port in the side wall, said port being directed tangentially with respect to the longitudinal axis of the furnace. The air or air-gas mixture is introduced at a rate of about 400 cubic feet per gallon of oil and at a velocity in the tangential port preferably in an excess of 56 feet per second. The combustible mixture is burned to maintain the temperature in the furnace at 2100 to 10 2400° F. and to decompose the unburned oil to carbon black. The effluent from the furnace is quickly quenched, generally with a water spray and is then cooled further to about 450° F. Effluent is withdrawn from carbon black production zone 92 through line 93 to carbon black recovery zone 94 which may be any suitable means for recovering the carbon black such as an electrical precipitator. Finished carbon black is withdrawn from zone 94 through line 96. 15 20

It is to be understood that various pumps, valves, and the like known to those skilled in the art have not been specifically illustrated herein in the discussion of the drawing and that such modifications of the present invention may be practiced without departing from its scope. However, for the purpose of clarity, certain specific valves, flow controllers, temperature controllers and liquid level controllers have been illustrated in order to facilitate a clear illustration of one manner in which a specific embodiment of my invention can be practiced. 25

As illustrated in the figure and discussed above, temperature controllers of conventional design can be employed in proportionating hot recycled furfural with a stream of cold solvent or a stream of cold oil, to form a resulting feed stream admixture at a predetermined temperature level for introduction into the solvent extraction zone. It is to be understood however, that any suitable means for proportionating the hot recycled furfural stream with a cold oil or cold furfural feed stream, can be employed. In the following tables are listed data exemplary of proportions of hot recycled furfural to be added to cold oil and cold furfural feed streams to produce resulting stream admixtures that can be utilized in the extraction zone in accordance with my invention. 30 35

In Table I below, are listed volume ratios of hot recycled furfural to cold furfural (each at a specified temperature) required for producing a resulting furfural stream admixture at a temperature of from 100 to 180° F., suitable for utilization in a gas oil-furfural solvent extraction zone, in accordance with my invention. 40 45

Table I

Temp. Cold Furfural, °F.	Temp. Hot Furfural °F.	Vol. Ratio, Hot Furfural To Cold Furfural	Temp. of Resulting Furfural Admixture, °F.
50	200	0.32:1	100
50	200	1.3:1	150
50	200	3.5:1	180
60	300	0.47:1	150
50	320	0.145:1	100
50	320	0.42:1	150
50	320	0.68:1	180
100	200	0.8:1	150
100	300	0.28:1	150
120	200	0.68:1	150
120	200	2.6:1	180
120	300	0.24:1	150
120	320	0.21:1	150
120	320	0.44:1	180

In Table II below are listed volume ratios of hot recycled furfural to cold gas oil (each at a specified temperature) required for producing a resulting furfural-gas oil stream admixture at a temperature of from 100 to 180° F., suitable for utilization in a gas oil-furfural solvent extraction zone, in accordance with my invention. 5

Table II

Temp. Cold Oil, °F.	Temp. Hot Furfural, °F.	Vol. Ratio, Hot Furfural To Cold Gas Oil	Temp. of Resulting Furfural Gas Oil Admixture, °F.
50	200	0.42:1	100
50	200	0.95:1	140
50	200	0.6:1	180
50	300	0.40:1	140
50	320	0.19:1	100
50	320	0.37:1	140
50	320	0.80:1	180
100	200	0.43:1	140
100	300	0.19:1	140
120	200	0.22:1	140
120	200	2.9:1	180
120	300	0.097:1	140
120	320	0.087:1	140
120	320	0.40:1	180

In the practice of my invention, it is generally preferred that the boiling range of the oil to be extracted, be higher than the boiling point of the solvent, under the conditions of extract fractionation. In some instances an amount of oil can be tolerated in the recycle solvent streams, but it is generally preferred that solvent substantially free of oil, be recovered and recycled from the extract and raffinate. 30 35

It may be desired in some instances to supply heat by means of my invention to a furfural feed stream alone, or an oil feed stream alone to heat same to the requisite temperature within the 100-180° F. range, and then to employ conventional methods for heating the other stream, or otherwise furnishing the remainder of the required heat to the extraction zone; and it is to be understood that such operation is within the scope of my invention. 40 45

My invention can be applied to oils having aniline points within a broad range, generally those oils ordinarily suitable for treatment by conventional solvent extraction processes. 50

As illustrated in the figure, any selected oil feed stock can be employed, in the practice of my invention by introduction of same into line 22, through line 97, at a point downstream from storage 21. Similarly, fresh or make-up furfural can be introduced into the system through line 98 into storage 23. 55

Advantages of this invention are illustrated by the following examples. The reactants and their proportions, and other specific ingredients are presented as being typical and should not be construed to limit the invention unduly. 60

EXAMPLE

A 90-155 aniline point gas oil is contacted in countercurrent flow relation with furfural in a 65 solvent extraction step to recover low aniline point constituents therefrom.

Furfural is introduced into a top portion of a vertically disposed extraction tower at 150° F., and gas oil is introduced into a lower portion of the extraction zone at 140° F., and these two streams are contacted countercurrently therein under a pressure of 70 p. s. i. g. Furfural is introduced into the top of the extraction tower in a volume ratio to gas oil introduced into the 70 75 lower portion of the tower of 0.52:1.

Furfural to be utilized in the extraction tower is withdrawn at 100° F. from furfural storage and admixed with a hot liquid furfural stream recycled at 300° F., and described hereafter, in a volume ratio of hot furfural to storage furfural of 0.28:1 to form a resulting furfural stream admixture at a temperature of 150° F., which admixture is that furfural stream introduced into the top of the extraction tower.

Gas oil to be utilized in the extraction tower is withdrawn at 100° F. from gas-oil storage and admixed with a hot liquid furfural stream recycled at 300° F., and described hereafter, in a volume ratio of hot furfural to gas oil of 0.19:1, to form a resulting furfural-gas oil stream admixture, which is that gas oil stream introduced into the lower portion of the extraction tower.

Raffinate is withdrawn from the top of the extraction tower and passed to a raffinate fractionation tower and therein fractionated to produce vaporous furfural at 430° F. as an overhead fractionation product, and furfural-free raffinate as kettle product at 558° F. Furfural overhead vapors thus recovered are cooled and condensed, and returned in part as reflux to the raffinate fractionator and in remaining part to furfural storage. Kettle product is withdrawn from the raffinate fractionator and passed to storage.

Extract is withdrawn from the bottom of the extraction tower and passed to an extract fractionation tower and therein fractionated to produce vaporous furfural at 330° F. as an overhead fractionation product, and furfural-free extract, as kettle product at 558° F. Kettle product is withdrawn from the extract fractionator and passed to storage. Vaporous furfural overhead product is withdrawn from the extract fractionator and cooled to form furfural condensate at 300° F. A portion of the 300° F. condensate thus formed, is that hot liquid furfural recycled to the furfural stream withdrawn from storage, to form the furfural stream admixture at 150° F., as above described. Another portion of the 300° F. condensate is that hot liquid furfural recycled to the gas-oil stream withdrawn from gas oil storage, to form the furfural-gas oil stream admixture at 140° F., above described.

Remaining furfural condensate recovered from the extract fractionation tower is passed to furfural storage, except for that amount returned to the extract fractionator as reflux.

As will be evident to those skilled in the art, various modifications of this invention can be made, or followed in the light of the foregoing disclosure and discussion, without departing from the spirit or scope of the disclosure or from the scope of the claims.

I claim:

1. A solvent extraction process wherein furfural is utilized in the separation and recovery of aromatic and paraffin hydrocarbons from a 90-155 aniline point gas oil, comprising admixing a cold stream of furfural existing at a temperature within the limits of 50-120° F. with a hot recycled liquid furfural stream existing at a temperature within the limits of 200 to 320° F. and recovered as described hereafter, in a volume ratio of hot furfural to cold furfural within the limits of 0.21:1 to 3.5:1 to form a resulting mixed furfural stream at a temperature within the limits of 100 to 180° F.; admixing a cold stream of said gas oil existing at a temperature within the limits of 50 to 120° F. with a stream of hot recycled liquid furfural existing at a temperature within the limits of 200 to 320° F. and recovered

as described hereafter, in a volume ratio of the said hot furfural to cold gas oil within the limits of 0.19:1 to 2.9:1 to transfer heat in a predetermined amount from said hot furfural to said cold gas oil to form a resulting furfural-gas oil stream at a temperature within the limits of 100 to 180° F. and cooler than said mixed furfural stream; introducing said mixed furfural stream into countercurrent flow relation with said furfural-gas oil stream at a pressure within the limits of 0 to 80 p. s. i. g.; recovering raffinate from said countercurrent flow and passing same to a raffinate distillation zone and therein distilling said raffinate at a distillation pressure of from atmospheric to 20 p. s. i. g. to produce furfural as a vaporous overhead distillation product at a temperature within the limits of 325 to 430° F.; recovering furfural-free raffinate as a raffinate-distillation kettle product; recovering said furfural overhead distillation product and condensing same at a temperature within the limits of 200 to 320° F., whereby a first hot furfural condensate is formed at a temperature in said 200-320° F. range; passing a portion of said first hot condensate to said raffinate distillation as a liquid reflux; passing extract from said countercurrent flow to an extract distillation zone and therein distilling said extract at a distillation pressure of from atmospheric to 50 p. s. i. g. to produce furfural as a vaporous overhead distillation product at an overhead temperature of from 325 to 430° F., and a solvent-free extract as a distillation kettle-product; recovering said extract kettle-product, recovering the last said furfural overhead distillation product and condensing same to a temperature within the limits of 200 to 320° F., whereby a second hot furfural condensate is formed at a temperature in said 200 to 320° F. range; passing a portion of said second hot condensate to said extract distillation as a liquid reflux; recycling hot liquid furfural from at least one of said first and second condensates to said zone of countercurrent flow in admixture with said cold furfural as above described; and recycling hot liquid furfural from at least one of said first and second condensates to said zone of countercurrent flow in admixture with said cold gas oil as above described.

2. The process of claim 1 wherein said mixed furfural stream and said furfural-gas oil stream is each formed at a temperature within the limits of 140 to 150° F.

3. A solvent extraction process wherein furfural is utilized in the separation and recovery of aromatic and paraffin hydrocarbons from a 90-155 aniline point gas oil, comprising admixing a cold stream of liquid furfural existing at a temperature within the limits of 50 to 120° F. with a hot recycled liquid furfural stream existing at a temperature within the limits of 200 to 320° F., and described hereafter, in a volume ratio of hot furfural to cold furfural within the limits of 0.2:1 to 3.5:1 to form a resulting furfural stream at a temperature within the limits of 100 to 180° F.; introducing a stream of said gas oil at a temperature within the limits of 100-180° F., and cooler than said resulting furfural stream into countercurrent flow relation with said furfural stream, recovering raffinate from the zone of said countercurrent flow and separating furfural and furfural-free raffinate therefrom; recovering furfural and furfural-free raffinate thus separated; passing extract from the zone of said countercurrent contacting to an extract distillation zone and therein distilling

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extract at a pressure of from atmospheric to 50 p. s. i. g. to produce furfural as a vaporous overhead distillation product at a temperature of from 325 to 430° F., and a solvent-free extract as a distillation kettle-product; recovering said extract kettle-product; recovering said furfural overhead distillation product and condensing same at a temperature within the limits of 200 to 320° F., whereby a hot furfural condensate is formed at a temperature in said 200-320° F. range; dividing said condensate into two portions having the same temperature; returning one portion to said distillation as reflux; and mixing a second portion of said condensate with said cold furfural as the first said hot recycled liquid furfural.

4. In a process for the furfural extraction of aromatic hydrocarbons from a gas oil by countercurrently contacting a feed stream of liquid furfural and a liquid feed stream of such a gas oil at a temperature within the range of 100-180° F., the improvement comprising recovering a furfural-containing phase from said furfural extraction and distilling said phase to produce furfural as vaporous overhead distillation product at a temperature within the range of 325-430° F., cooling said overhead distillation product to form a condensate at a temperature within the range of 200-320° F., returning condensate formed as described with at least one of said liquid feed streams initially at a temperature within the range of 50-120° F. in a requisite amount for transfer of heat from said condensate to said feed stream to heat same to a temperature within the range of 100-180° F., and introducing the resulting feed stream furfural admixture into the zone of said extraction.

5. The process of claim 4 wherein said furfural-containing phase is an extract phase.

6. The process of claim 4 wherein said furfural-containing phase is a raffinate phase.

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7. In a solvent extraction process wherein furfural is contacted in countercurrent flow relation with a gas oil to extract aromatic hydrocarbons therefrom at a temperature within the range of 100-180° F., the improvement of introducing heat into the extraction zone and concomitantly reducing the total volume of countercurrent flowing liquids, comprising recovering a furfural-containing phase from the zone of said countercurrent flow, recovering liquid furfural from said phase at a temperature within the range of 200-320° F., and recycling same to said zone of countercurrent flow in admixture with a stream of said gas oil initially at a temperature within the range of 50-120° F. in a requisite proportion to transfer heat to said gas oil to provide a resulting furfural-gas oil admixture at a temperature within the range of 100-180° F., whereby furfural in admixture with said gas oil feed heats said oil at a temperature within the range of 100-180° F. requisite for introducing same into the zone of said extraction and selectively dissolves aromatic hydrocarbons therefrom and forms an aromatics-rich furfural phase, and recovering said aromatics-rich furfural phase without introducing same into said countercurrent flow, whereby the volume of countercurrently flowing liquids is reduced in an amount equal at least to the volume of said selectively dissolved aromatic hydrocarbons.

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