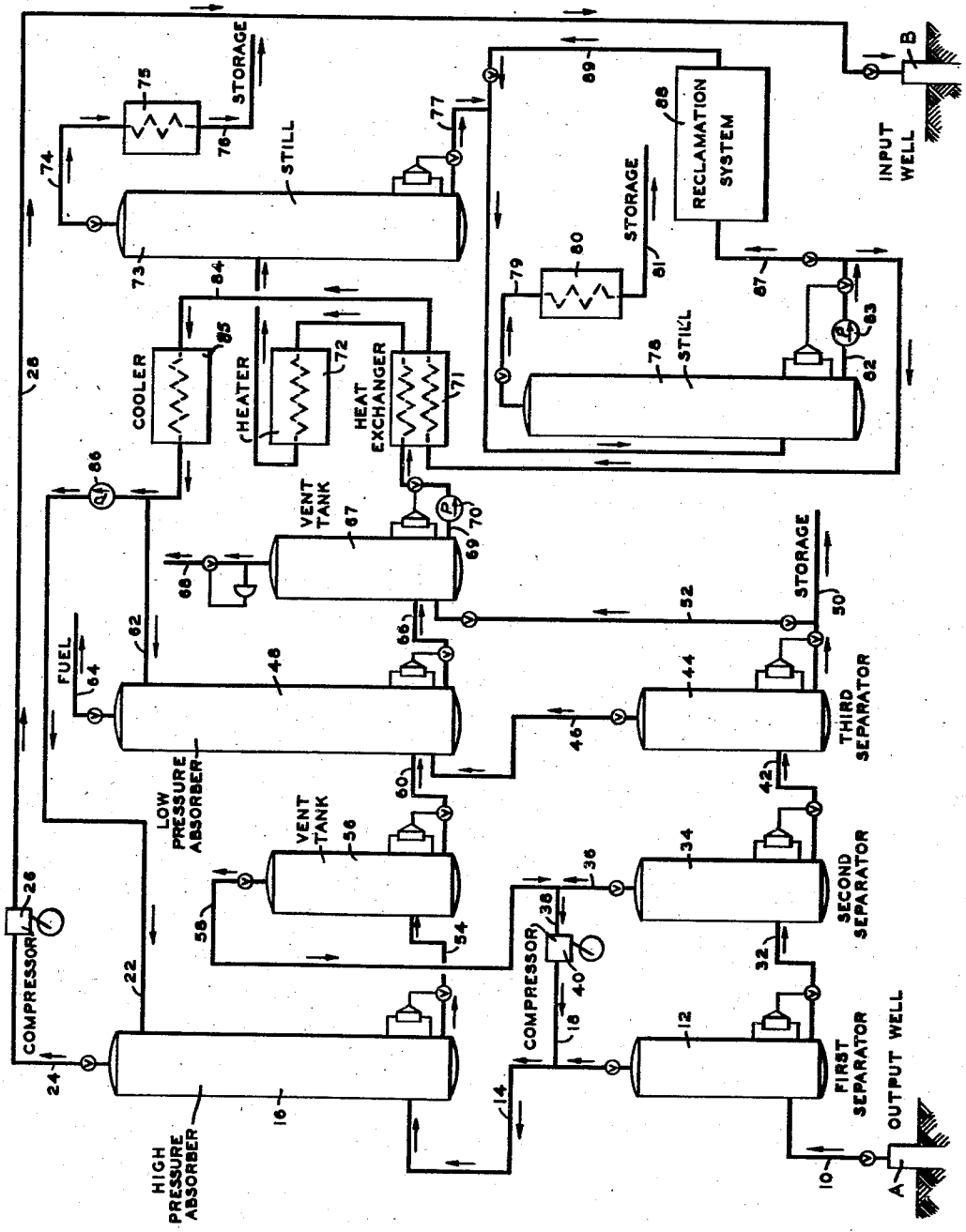
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DISTILLATE PRODUCTION

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FRANK S. WEST
INVENTOR

BY

HIS ATTORNEYS

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DISTILLATE PRODUCTION

Frank S. West, Houston, Tex., assignor to The Texas Company, New York, N. Y., a corporation of Delaware

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1 Claim. (Cl. 183—114.6)

This invention relates to a process for the production of desired liquefiable hydrocarbons from the fluids flowed from a well tapping a high pressure formation of the distillate type. More particularly the invention relates to a process for the production of a distillate field, wherein desired liquefiable hydrocarbons are recovered by a procedure involving absorption, and residual gases are returned to the same or a different formation for the purpose of maintaining pressures.

Various types of processes have been employed and proposed for the production of the so-called distillate or condensate fields. Because of the necessity for returning residual gases to a formation for maintaining pressures, these processes have been designed in one way or another to conserve energy so as to be able to return the gases at a minimum compression cost. Some of the processes have employed an absorption step and in these cases, particularly where the absorption is carried out at a relatively high pressure, the amount of oil which must be circulated in the processes has been recognized as being an important factor in the success of the processes.

It is known that the hydrocarbons in a distillate formation exist substantially as a homogeneous gas phase at high pressures and temperatures. The formation pressures may range from 3000 to 5000 pounds per square inch or higher. Also, so far as known, in the typical distillate formation the conditions of temperature and pressure are such as to be at or near the dew point for the composition of the fluid, or, stated in another way, the conditions are near the dew point curve of the two-phase boundary for the fluid on the pressure-temperature plane. Thus, any substantial reduction in pressure will cause condensation of liquid.

In many fields the rate of flow from the producing wells is such that when the reduction in pressure due to friction is added to that resulting from the static head of the fluid in the wells, a large reduction in pressure occurs from the formation to the well-head. This, with the consequent reduction in temperature may cause the condensation at the well-head of 50 per cent to 80 per cent or even more of the liquefiable hydrocarbons in the fluid.

The material actually produced, therefore, is a mixed fluid containing a gas phase and a liquid phase, the latter apparently being in the form of small droplets or a mist. The liquid condensed under these conditions is composed of a large proportion of normally liquid hydrocarbons but also contains a substantial proportion of light gases, including ethane and methane, which are not desired in the recovered liquid hydrocarbons. Incidentally, it will be understood that in producing a distillate field the liquefiable hydrocarbons that will be recovered will depend upon economic considerations. In some cases, the recovery process will be operated so as to recover only a part of the butanes together with the pentanes and heavier. In other cases, the propanes may have a ready market and the process will be designed and operated so as to recover a maximum amount of the propanes and heavier.

It is an object of the invention to provide an improved process for the production of distillate characterized in that an efficient recovery of desired liquefiable hydrocarbons is accomplished with a minimum expenditure of energy.

Other objects of the invention in part will be obvious and in part will appear hereinafter.

The present invention is particularly concerned with a process for the production of distillate wherein a substantial proportion of the liquefiable hydrocarbons are condensed because of a reduction in pressure and temperature such as occurs due to the flow of the fluid from the formation to the plant, the remaining gases are subjected to absorption to separate additional liquefiable hydrocarbons, and the residual gases are returned to a formation, preferably after compression, for the purpose of maintaining formation pressures. In this process the condensed liquid hydrocarbons are preferably separated from the remaining gases at a pressure substantially the same as that at which the absorption is carried out. These liquid hydrocarbons, therefore, contain a proportion of undesired light hydrocarbons; e. g., methane and ethane, and, where propane is not being recovered, this hydrocarbon is also regarded as an undesired light hydrocarbon.

It is necessary to reduce the pressure on the recovered condensed liquid hydrocarbons to prepare them for storage and also to separate the undesired light hydrocarbons. This reduction in pressure is accomplished in stages in which certain pressures are maintained depending upon the characteristics of the condensed liquid hydrocarbons and the liquefiable hydrocarbons which it is desired to recover. For example, where the condensed liquid hydrocarbons are separated at a pressure of about 2000 pounds per square inch the pressure on the liquids may be reduced in two stages, the pressure in the first stage being maintained at a point somewhere between about

400 and 1000 pounds per square inch and the next stage being maintained at a pressure below 100 pounds per square inch, for example, between about 40 and 80 pounds per square inch.

It has been proposed in processes of this general type to recover desired liquefiable hydrocarbons from the hydrocarbons vaporized in the pressure reduction steps at a relatively low pressure below 100 pounds per square inch. In this case the residual gases would be obtained at such a low pressure as not to be usable for return to the formation because of the high compression costs involved.

I have discovered in accordance with the present invention that by compressing the evolved hydrocarbons removed from the first pressure reduction stage or stages to the pressure maintained in the high pressure absorption step, and passing these evolved hydrocarbons, together with gases separated from the condensed liquid hydrocarbons in the separation stage, through the absorption stage important advantages with respect to the amount of oil required to be circulated for absorption and also the precentage recovery of desired liquid hydrocarbons are obtained. I have also discovered that important advantages are obtained by reducing the pressure on the enriched absorption oil leaving the absorption step to a pressure of the order maintained in the first stage of reduced pressure, and then also compressing the elvolved gases to the high absorption pressure and passing the gases at the high pressure into contact with an absorption oil. The invention also embodies other features and advantages which will be apparent as the description proceeds.

In order that the invention may be understood more fully reference should be had to the accompanying drawing which contains a flow sheet illustrating one manner of carrying out the process of the present invention. In order to simplify the description and also in order to illustrate a preferred application thereof, the invention will be described in connection with the treatment of a distillate fluid removed from a relatively high pressure formation, of the order of 4000 to 5000 pounds per square inch, wherein the absorption is carried out at a pressure above 1500 pounds per square inch, such as between 1500 and 2500 pounds per square inch, a pressure of about 2000 pounds per square inch being typical.

Referring to the drawing, a distillate fluid is removed from an output well A, which taps a distillate formation, and the fluid is passed through a valved line 10 leading to a first separator 12. As discussed above, distillate fluids normally are under such conditions of temperature and pressure in the formation that the reduction in pressure and temperature resulting from the flow of the fluid to the well head is sufficient to cause the condensation of a substantial proportion of the liquefiable hydrocarbons contained in the fluid. Thus, the material flowing in line 10 will consist of a gas phase containing droplets of condensed hydrocarbons.

In the first separator 12 the condensed hydrocarbons are substantially entirely removed from the remaining gases. To aid in this, the separator 12 may be provided with baffles or other means, not shown, adapted to accomplish this removal. The gases are removed from this separator through a valved line 14 leading to the lower portion of a high pressure absorber 16. To the gases flowing in line 14, additional gases are added from line 18, as will presently be described. In the absorber 16 the gases come in countercurrent contact with an absorption oil introduced through line 22 and substantially complete recovery of remaining desired liquefiable hydrocarbons is accomplished. The residual gases are removed through line 24 and are raised in pressure by means of compressor 26 to a high pressure for maintaining pressure in a formation. At the raised pressure, they are passed through line 28 leading to an input well B, through which they are passed to the desired formation.

The liquid collecting in the separator 12 is removed therefrom through valved line 32 which leads to a second separator 34. In this embodiment of the invention, the first separator may be maintained at about the pressure of the later absorption, for example, a pressure between 1500 and 2500 pounds per square inch or higher, depending upon the well-head pressure, the pressure of absorption, and the composition of the distillate fluid. The second separator is preferably maintained at some pressure below 1000 pounds. Under these conditions hydrocarbons are evolved and are removed through valved line 36. Although these hydrocarbons contain a substantial proportion of methane and ethane they also contain considerable amounts of recoverable liquefiable hydrocarbons. In accordance with the invention, these hydrocarbons are passed through line 38 leading to compressor 40 and the pressure on them is raised to the pressure maintained in absorber 16. At this pressure, the gases are passed through lines 18 and 14 and into the absorber where the liquefiable hydrocarbons are recovered. Also, the light gases contained in the hydrocarbons removed in the second separator become a part of the residual gases which are economically returned to the formation through input well B.

The liquid hydrocarbons are removed from the second separator 34 through line 42 leading to a third separator 44 which may be maintained at some relatively low pressure of the order of 40 to 80 pounds per square inch. The hydrocarbon vapors evolved in this separator are removed through valved line 46 leading to the bottom portion of a low pressure absorber 48. The liquid hydrocarbons in condition for storage are removed from separator 44 through valved line 50 and passed to storage. A small proportion of these hydrocarbons may be passed through line 52 and employed for a purpose that will be referred to later.

The enriched absorption oil is removed from the bottom portion of high pressure absorber 16 through valved line 54 leading to a vent tank 56 which is maintained at some pressure below 1000 pounds and preferably at about the same pressure as second separator 34. At this reduced pressure, hydrocarbon vapors are evolved in vent tank 56 and are removed through valved line 58. These hydrocarbons contain a proportion of liquefiable hydrocarbons and are preferably passed through line 38 with the hydrocarbon vapors from the second separator 34 and are compressed and introduced into the bottom of the absorber at absorption pressure.

The remaining liquid is removed from vent tank 56 through line 60 and introduced into the bottom portion of low pressure absorber 48. Since the pressure in the low pressure absorber may be about 40 to 80 pounds per square inch, additional hydrocarbons are evolved and are contacted with the absorption oil introduced into this absorber through line 62. Thus, in this low

pressure absorber liquefiable hydrocarbons are removed from the gases released from the condensed liquid in the third separator 44 and from the gases released from the enriched absorption oil entering the bottom of the low pressure absorber. The lean gases are removed from the low pressure absorber through valved line 64, the process preferably being carried out so that the amount of gases obtained at this point is not substantially greater than the amount required for plant fuel.

The enriched absorption oil is removed from the low pressure absorber through line 66 and is passed into a low pressure vent tank 67, which may be maintained at a very low pressure of the order of 10 to 15 pounds per square inch. Gases may be vented from this tank through a valved line 68 and also used for fuel. The portion of the liquid hydrocarbons which is passed through line 52 is preferably introduced into this vent tank and used as make-up for the absorption oil. The enriched absorption oil is pumped through valved line 69 provided with pump 70 and passes through heat exchanger 71 and heater 72, which serve to raise the temperature of the enriched absorption oil to a sufficiently high temperature for distillation. The heated oil is introduced into a still 73 which may be maintained at a pressure of the order of about 60 pounds per square inch. In this still light liquefiable hydrocarbons boiling, say, below 320° F. are vaporized and removed overhead through line 74. The vapors are then condensed in condenser 75 and passed to storage through line 76.

The oil is removed from this still through valved line 77 and is passed into a second, lower pressure still 78. In the latter still the remaining absorbed hydrocarbons are largely removed from the absorption oil, although a portion of the higher boiling compounds may remain therein. The vaporized hydrocarbons are removed overhead through line 79, condensed in condenser 80 and passed to storage through line 81. The lean oil is removed from the bottom of still 78 through line 82 and is pumped by means of pump 83 to heat exchanger 71 where the heat contained in the lean oil is employed for heating the enriched oil going to the stills, while the lean oil is partially cooled to absorption temperature. The lean oil is then passed through line 84 and is cooled in cooler 85 to the temperature desired for absorption; for example, to a temperature below 100° F. A portion of this oil passes through line 62 into the upper portion of the low pressure absorber as described above, while the remainder is raised to the pressure existing in the high pressure absorber by means of pump 86, and at this pressure is passed through line 22 leading into the high pressure absorber.

In order to avoid the accumulation of tarry materials and other impurities in the absorption oil, a portion of the oil may be removed periodically or continuously from the lean oil flowing in line 82 through line 87. This line leads to a reclamation system 88 where impurities are removed from the oil. The cleaned increment of oil is then returned to the process through line 89.

The process described above is particularly valuable in cases where the first separator and the high pressure absorber are maintained at pressures of about 1500 to 2500 pounds per square inch, especially 2000 to 2500 pounds per square inch or higher, and it is desirable to maintain a stage of reduced pressure on the condensed liquid of from 400 to 700 pounds per square inch. Under these conditions it has been found that a material reduction in the amount of absorption oil required to be circulated can be accomplished by compressing the evolved hydrocarbons in the pressure reduction stage and subjecting these to absorption in the high pressure absorber. Additional reduction in the amount of absorption oil required to be circulated is accomplished by also compressing the evolved hydrocarbons from the vent tank into which the enriched absorption oil leaving the high pressure absorber is passed. Other features of the invention, which are preferably combined with those described, are the introduction of the enriched absorption oil from the high pressure vent tank into the low pressure absorber, the absorption of the evolved hydrocarbons from the low pressure separator in the low pressure absorber, and the use of a portion of the condensed hydrocarbons as make-up for the absorption oil. In connection with the use of a portion of the hydrocarbons condensed due to the reduction in pressure as the absorption oil, it is pointed out that these hydrocarbons constitute the heavier liquefiable hydrocarbons contained in the distillate fluid and are higher boiling than the bulk of the liquefiable hydrocarbons present in the gas phase of the fluid.

The process described can be employed efficiently for the recovery of liquefiable hydrocarbons from a distillate fluid having the composition shown in the following table:

Component	Mole fraction
Methane	0.74656
Ethane	0.073737
Propane	0.046921
Isobutane	0.009764
n-Butane	0.019817
Isopentane	0.007244
n-Pentane	0.007564
Hexanes and heavier	0.081557
Carbon dioxide	0.006824

This fluid apparently exists as a homogeneous phase at a pressure of about 4700 pounds per square inch in the formation, and may be produced at a pressure of about 2200 pounds per square inch at the well-head. In the treatment of this fluid, the first separator and high pressure absorber may be maintained at about 2000 pounds per square inch, the second separator and the enriched oil vent tank at about 400 to 700 pounds per square inch, and the third separator and the low pressure absorber at about 40 to 80 pounds per square inch. Under these conditions, liquefiable hydrocarbons are recovered efficiently with a circulation of a minimum amount of absorption oil and return to the formation of a maximum amount of light hydrocarbons at low compression costs. Also, the liquid hydrocarbons removed from the third separator constitute an excellent absorption oil for use in the process.

It will be understood that the pressure on the liquid hydrocarbons separated from the well fluids at a high pressure may be reduced in more than two stages. In general, the hydrocarbons evolved in any stage at a pressure above 400 pounds per square inch, preferably not above 1000 pounds per square inch, and especially between 400 and 700 pounds per square inch, may be compressed and treated efficiently as described above.

Obviously many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claim.

I claim:

A process of recovering liquefiable hydrocarbons from distillate well fluids produced at a high wellhead pressure and temperature such that the fluids are composed of a liquid phase and a gas phase, which comprises separating said liquid phase and said gas phase at an elevated pressure of about 2000 pounds per square inch, reducing the pressure on said liquid phase in successive stages maintained at about 400 to 700 pounds per square inch and about 40 to 80 pounds per square inch to evolve hydrocarbon vapors comprising liquefiable hydrocarbons in each stage, and produce a liquid fraction, compressing the hydrocarbon vapors evolved in said stage at about 400 to 700 pounds per square inch to a pressure of about 2000 pounds per square inch, passing said compressed vapors and the gases constituting the gas phase into contact under absorption conditions with an absorption oil composed of hydrocarbons of said liquid fraction at a pressure of about 2000 pounds per square inch to absorb liquefiable hydrocarbons therefrom and produce an enriched absorption oil, reducing the pressure on the enriched absorption oil in successive stages maintained at about 400 to 700 pounds per square inch and about 40 to 80 pounds per square inch to evolve hydrocarbon vapors comprising liquefiable hydrocarbons in each stage, compressing the vapors evolved in the stage maintained at about 400 to 700 pounds per square inch to a pressure of about 2000 pounds per square inch, contacting the last-mentioned vapors with said absorption oil under absorption conditions to remove liquefiable hydrocarbons therefrom, contacting the vapors evolved from said liquid fraction and from said enriched absorption oil in said stages maintained at about 40 to 80 pounds per square inch with an absorption oil under absorption conditions at a pressure of about 40 to 80 pounds per square inch to absorb liquefiable hydrocarbons from said vapors and produce an enriched absorption oil, and recovering absorbed hydrocarbons from said enriched absorption oil.

FRANK S. WEST.