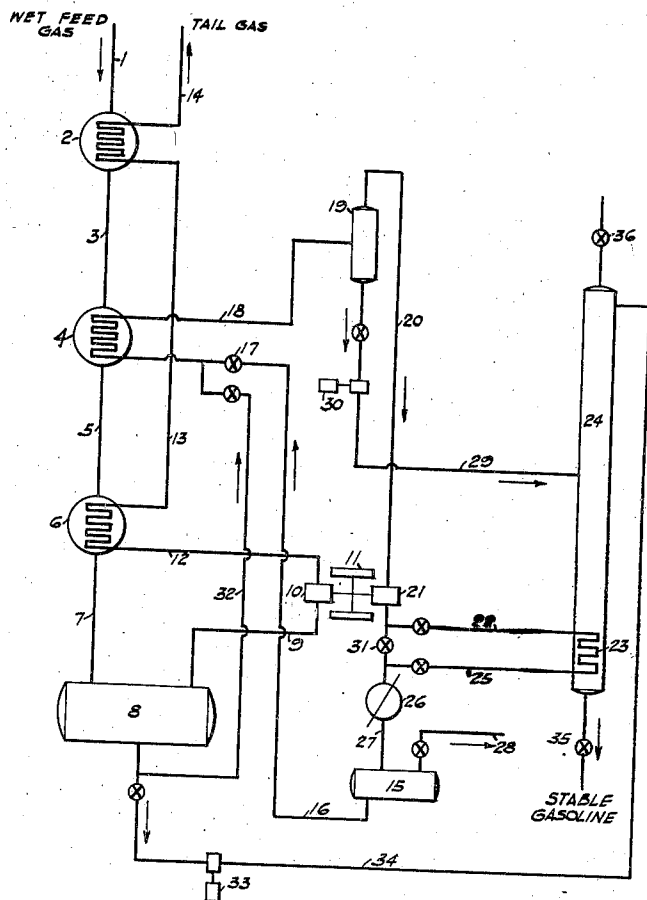


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SEPARATION OF HYDROCARBONS

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SEPARATION OF HYDROCARBONS

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This invention relates to the recovery of liquefiable components from hydrocarbon gas and more particularly to an improved method wherein the pressure energy of the gas is utilized to furnish low temperature refrigeration required in the process and the liquid condensate formed furnishes the refrigerant used in one part of the process.

In a copending application, Serial Number 103,121 filed September 29, 1936, a novel method for the recovery of valuable liquid components of hydrocarbon gas has been disclosed. The method disclosed therein comprises the steps of expanding gas, from which the liquefiable components have been stripped, through an engine, thereby performing work and cooling the gas to a low temperature according to well known thermodynamic principles. The cold dry gas then serves as the cooling medium in heat exchangers for chilling the incoming wet feed gas under substantial pressure and condensing therefrom its liquefiable components. The unliquefied residual gas then serves as the gas which is expanded and chilled in the engine. The power generated by the expanding gas in the engine is converted into heat and is utilized to stabilize the condensate recovered.

In the practice of the method disclosed in the copending application it sometimes occurs that there is insufficient cooling capacity in the cold expanded gas to secure the desired result. Also it sometimes happens that the power developed by the engine is more than can be economically used in the form of heat for the stabilization of the condensate. It is not, however, feasible in the latter case to reduce the engine power since then the available refrigeration would be reduced.

It is an object of this invention to utilize pressure energy in or added to hydrocarbon vapors undergoing treatment for the recovery of liquid hydrocarbons therefrom, as the operating energy in mechanical refrigeration that produces refrigeration by expansion of vapor or evaporation of liquid, the refrigerant being hydrocarbon withdrawn from the vapors undergoing treatment.

It is a feature of this invention that, in a procedure for the recovery of liquid hydrocarbons from a mixture of hydrocarbon vapors which involves expansion of hydrocarbon vapors, the energy derived from the expansion is utilized to operate a mechanical refrigerating system that provides refrigeration useful in the recovery procedure and utilizes as the refrigerant therein hydrocarbons withdrawn from the vapors undergoing treatment. Further features of this invention

are that the vapor mixture is cooled prior to its expansion and hydrocarbons are thereby condensed therefrom which are, at least in part, utilized as the refrigerant; that the hydrocarbon vapors expanded are the uncondensed vapors of that cooling operation; that the cold expanded vapors are utilized for heat absorption in that cooling operation; that the cold condensate may be utilized for the absorption of heat in the cooling operation; that the vapors evolved from the condensate by that heat absorption are used as the refrigerant; that the energy of the expansion is utilized to compress the refrigerant; that heat may be absorbed from the compressed refrigerant in the condensate; that a part of such heat absorption in condensate may be an absorption in condensate previously utilized in the cooling of the incoming vapors; that such heat absorption from compressed refrigerant may be also effected by another portion of condensate; that heat in the compressed refrigerant is absorbed in the condensate in the stabilization of the latter; that the cooled compressed refrigerant is utilized in cooling the incoming vapors prior to the expansion thereof; that the compressed refrigerant may be mixed with the cold condensate passing into heat exchange relation with the incoming vapors; that there may be a continuous supply and withdrawal of hydrocarbons to and from the refrigerant to make up for losses or to provide for automatic adjustment of the character thereof in accordance with variations in the quality of the vapors undergoing treatment; that the vapor-pressure characteristics of the refrigerant are adjusted automatically, continuously or intermittently, to meet the temperature conditions of the system within the pressure limitations thereof to the end that substantially all of the refrigerant may be condensed at the temperature of the cooling water available under the compressor pressure available and substantially all of the refrigerant may be vaporized under the heat-exchange conditions under which the refrigerant is utilized to cool incoming vapor to be treated, i. e., under the suction conditions of the refrigerant compressor; that unvaporized refrigerant may be continuously removed from the refrigerating system as by being passed to the condensate undergoing stabilization treatment and uncondensed refrigerant may be continuously removed from the refrigerating system as by venting; and that fractionation of the refrigerant, at both its high-boiling and low-boiling ends may be continuously and automatically maintained to the end that said pressure and temperature

requirements are met in the treatment of vapors of varying quality from a single field or from different fields. Thus, apparatus for the practice of this invention being transportable, the apparatus may be readily moved into any field and it will automatically select and maintain a refrigerant correctly suited to the pressure and temperature conditions available in the apparatus and field.

This invention resides in the separate or joint use of the several features thereof herein described and is not limited to the simultaneous use of all or of any particular number of such features.

The operation of the invention will be fully understood from the following description taken in connection with the accompanying drawing, the single figure of which represents diagrammatically apparatus for the practice of a preferred embodiment of the invention.

Referring to the drawing, wet hydrocarbon gas under substantial pressure enters the system through pipe 1 and passes through heat exchanger 2 in which it is partially cooled by indirect heat exchange with cold dry gas. From exchanger 2 the feed gas passes through pipe 3 to heat exchanger 4 in which it is further cooled by indirect contact with a vaporizing refrigerant as will be more fully described. The feed then passes through pipe 5 to exchanger 6 in which it is still further chilled by heat exchange with cold dry gas. The cooling suffered by the feed gas results in the condensation of practically all of the desired higher boiling constituents of the gas, along with a certain quantity of lower boiling material, not desired, forming a "wild" condensate. The unliquefied gas and the condensate pass through pipe 7 to separator 8 in which gas and condensate are separated.

The unliquefied dry gas passes from separator 8 through pipe 9 to the inlet of power cylinder 10 of engine 11. The gas expands polytropically in engine 11, its energy being converted into work, and the gas itself being cooled by the expansion according to well known thermodynamic principles. The cooled expanded gas exhausts from the engine into pipe 12 through which it passes to heat exchanger 6 in which the gas chills the wet feed gas as already described and is itself warmed. The partially warmed dry gas then passes through pipe 13 to exchanger 2 in which it imparts cooling to the feed gas and is in turn further warmed. The dry gas, now warmed to a point such that it is no longer available as a cooling medium for feed gas, passes through pipe 14 to any desired disposal system.

The auxiliary refrigerating system, mentioned above, operates in the following manner. Volatile hydrocarbon liquid serving as the refrigerant and maintained under a relatively high pressure is drawn from accumulator 15 through pipe 16 to heat exchanger 4. The pressure on the liquid is released by throttle valve or orifice 17 located in pipe 16. Due to the volatility of the liquid it vaporizes on release of pressure and is thus cooled to its boiling point under the reduced pressure and on passing through heat exchanger 4 absorbs heat from the feed gas passing therethrough thereby cooling the feed gas and vaporizing still more of the liquid in the usual manner of operation of this type of refrigerant. The vaporized refrigerant along with any unvaporized portion passes from exchanger 4 through pipe 18 to separator 19 where vapor and liquid are separated. The vapor passes from separator 19 through pipe

20 to the compressor end 21 of engine 11 which is driven by the expanding dry gas as already described. The vapor is compressed to a relatively high pressure slightly greater than that existing in accumulator drum 15 to allow for frictional losses. The vapor, on being compressed, is heated as usual when gases are compressed and discharges from compressor 21 into pipe 22 through which it passes to reboiler coil 23 located so as to furnish the required heat for condensate stabilizer 24. The hot compressed vapor in passing through coil 23 is cooled and may be partially condensed therein and passes through pipe 25 to condenser 26 in which it is further cooled and condensed by any suitable cooling medium, such as water or air. The cooled refrigerant passes through pipe 27 to accumulator 15. Any uncondensed lighter portion is vented through valve controlled pipe 28 to any suitable disposal system. This uncondensed portion may be returned to the feed gas or it may be mixed with tail gas or otherwise handled as desired. Any unvaporized refrigerant collected in separator 19 may be withdrawn by pump 30 and discharged through pipe 29 to stabilizer 24 as shown or may be otherwise disposed of according to its physical characteristics. The amount of heat delivered to coil 23 is regulated by by-passing controlled amounts of the hot compressed vapor around coil 23 by means of valve controlled by-pass pipe 31.

The refrigerant used in this auxiliary system is derived directly from the condensate formed and is secured in the following manner. When a plant operating in accordance with the invention is starting up for the first time, no refrigerant is available for the auxiliary system. However, enough refrigeration is available from the cold expanded dry gas in exchangers 2 and 6 that a certain amount of condensate is formed and collected in separator 8 even though exchanger 4 is idle. This condensate, or a portion of it, is drawn through pipe 32 and released into the refrigerant coil of exchanger 4. The release in pressure and the fact that the feed gas passing through exchanger 4 is warmer than the condensate from separator 8 both cause vaporization of the condensate flashed into the coil of exchanger 4, resulting in some refrigerating effect. The partially vaporized material passes to separator 19 wherein the heavier, less volatile portion is eliminated from the system as a liquid through pipe 29. The vaporized portion is compressed by compressor 21 and a portion is condensed by condenser 26 and is collected in accumulator 15. The lighter highly volatile portion which does not condense under the temperature and pressure conditions imposed is eliminated through pipe 28. The liquefied portion is flashed through pipe 16 into exchanger 4 as in normal operation. Condensate from separator 8 is fed into the system until such a time that sufficient refrigerant has been accumulated. The system thus fractionates from the condensate an intermediate portion suited to the conditions. Components of too high boiling range to vaporize in exchanger 4 are eliminated at separator 19 and components of too low boiling range to condense under the conditions in accumulator 15 are rejected there as gas. Thereafter small amounts of condensate from separator 8 are introduced into the system from time to time to make up for unavoidable losses of refrigerant in operation and these added amounts are likewise fractionated by the system as they are added.

The cold "wild" condensate collected in separator 19

rator 8 is withdrawn by pump 33 and charged through pipe 34 to stabilizer 24 as shown. Stabilizer 24 operates in the usual manner for such equipment, its purpose being to rectify the wild condensate, removing from it its undesirable low boiling components and producing a stabilized product which is withdrawn through pipe 35 and sent to storage for final disposition. The removed light material passes from the stabilizer as a vapor through pipe 36. Under certain conditions stabilizer 24 may operate at a lower pressure than that in separator 8, in which case the condensate may be charged to the stabilizer without the use of pump 33.

In accordance with the invention, wet feed gas containing from as little as a third of a gallon to several gallons of recoverable motor fuel per thousand cubic feet of gas is introduced into the system in pipe 1 at substantial pressure. This pressure may be as low as fifty pounds per square inch gauge or lower or it may be considerably higher, for example it may be as high as two or three hundred pounds per square inch. In passing through heat exchangers 2, 4, and 6 the feed gas is cooled to from -10 degrees Fahrenheit to as low as -100 degrees Fahrenheit depending on the characteristics of the gas and the pressure under which it is being cooled. Lean gas requires a low temperature to recover the desired components and a given recovery requires a lower temperature at low pressure than that required for higher pressures. Due to the fact that in order to recover a large proportion of the higher boiling components, a certain amount of the lower boiling components must also be condensed the volume of wild condensate collected in drum 8 is greater than that of the desired components, the excess varying from as little as 25% to over 100%.

The dry gas, in expanding through the engine, is cooled by an amount depending on the ratio of expansion of the gas in the engine. This cooling, in terms of the absolute temperature of the gas at the engine inlet, may vary from about 12% for a 2:1 expansion ratio to about 50% for a 10:1 expansion ratio. The cold expanded dry gas in cooling the feed gas in exchangers 2 and 6 is itself warmed to a temperature approaching that of the entering feed.

The refrigerant used in the auxiliary refrigerating system may vary widely in characteristics depending on the conditions under which it is produced. The temperature and pressure under which it is condensed in condenser 26 and the temperature and pressure existing in separator 19 determine its characteristics. For example, it may be condensed in condenser 26 at a temperature around 100 degrees Fahrenheit and a pressure of 200 pounds per square inch and may be present in separator 19 as a saturated vapor at about -40 degrees Fahrenheit and atmospheric pressure in which case it would correspond to propane. With other temperatures and pressures the refrigerant may consist of ethane, propane, or butane, or a mixture of these materials and may also contain appreciable amounts of methane and also the higher boiling hydrocarbons such as pentane and hexane. The temperature to which the refrigerant vapor is heated on being compressed is a function of the compression ratio used and of the temperature at its inlet to the compressor. Depending on the compression ratio, the absolute temperature of the compressed vapor may be 50%, or over, higher than that at the compressor intake.

This arrangement whereby part of the refrigerating load is carried by work generated in the engine permits the generation of more refrigeration than would be possible where only the expanded dry gas from the power end of the engine is used. Under certain conditions where the maximum total available refrigeration from the system as a whole is greater than that required to secure the desired recovery, the power development of the engine may be reduced until the total refrigeration is equal to that required, thus reducing the cost of the engine.

As an example of a specific operation in accordance with this invention, fifteen million cubic feet per day of natural gas containing about one gallon of so-called 26 pound Reid vapor pressure gasoline per 1,000 cubic feet is supplied to a plant at 50 pounds gauge pressure and 80 degrees Fahrenheit. It is cooled in the exchangers to about -80 degrees Fahrenheit, the pressure having dropped to 45 pounds gauge due to frictional losses. About 16 percent by weight of "wild" condensate is collected in separator 8. The dry gas at 45 pounds gauge and -80 degrees Fahrenheit expands in the engine to about 13 pounds gauge and -125 degrees Fahrenheit, the indicated power development of the engine being about 340 horse power. The expanded gas, in passing through exchangers 2 and 6 is warmed to about 60 degrees Fahrenheit and exhausts to the tail gas pipe 14 at that temperature. The feed gas is cooled a total of about 110 degrees in exchangers 2 and 6. Fifty degrees additional cooling is secured in exchanger 4 from the auxiliary refrigerating system. Liquid refrigerant is held at 200 pounds pressure and 100 degrees Fahrenheit in accumulator 15. It is flashed to atmospheric pressure in exchanger 4, being cooled thereby to about -40 degrees Fahrenheit. In passing through exchanger 4 the vapor is heated to about 0 degrees Fahrenheit and passes through separator 19 at that temperature. On being compressed by compressor 21 to 200 pounds pressure the vapor is heated to about 160 degrees Fahrenheit and passes to reboiler coil 23 at that temperature where it is cooled to about 100 degrees Fahrenheit and partially condensed, the remaining condensation being carried out in condenser 26. The indicated power requirement of the compressor is about 270 horse power, showing an overall engine efficiency from power cylinder to compressor cylinder of about 80 percent.

The wild condensate at -80 degrees Fahrenheit is charged to stabilizer 24 which operates at atmospheric pressure. The temperature of the product in the reboiler zone is about 70 degrees Fahrenheit and is withdrawn from the stabilizer at that temperature and pumped to storage. This product is so-called 26 pound Reid vapor pressure gasoline and represents a recovery of about 11.5 percent by weight from the feed gas or about 1 gallon per thousand cubic feet. The vapor from the top of the stabilizer leaves through pipe 36 at a temperature of about 0 degrees Fahrenheit and is largely composed of ethane, propane, and butane, with a small amount of methane and a negligible quantity of pentane.

It will be noted that the exhaust from the engine is held at a relatively high pressure, i. e., 13 pounds gauge. If the full expansion of gas to atmospheric pressure were permitted the power development of the engine would be almost doubled. In addition the refrigeration available from the expanded gas would be greater,

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thus reducing or eliminating that required from the auxiliary system, the power requirement of which would proportionately fall. Under these conditions a more costly engine would be required and there would be an excess of power developed for which some means of dissipation would be required.

While the operation of this invention has been described in connection with the recovery of higher boiling components from natural gas it may equally well be used in connection with gas encountered in the refining of petroleum, such as still gas, gas produced in the cracking or polymerization of petroleum hydrocarbons, and the gas produced in the distillation of coal, shale and other bitumens, or any other gas containing such liquefiable components.

The examples herein recited are given solely by way of explanation and clarification and the scope of this invention is limited only by the appended claims.

I claim:

1. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising compressing by the pressure energy of a portion of the mixture a volatile hydrocarbon refrigerant comprising hydrocarbons of the mixture, cooling the compressed refrigerant and then passing the refrigerant in heat exchange relation with the mixture prior to utilization of the pressure energy thereof in the compression step.

2. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising cooling the mixture and condensing a portion thereof, compressing by the pressure energy of a portion of the mixture a volatile refrigerant comprising hydrocarbons of said mixture, cooling the compressed refrigerant, and passing the cooled compressed refrigerant in heat exchange relation with the vapor mixture in said first mentioned cooling step.

3. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising cooling the mixture and condensing a portion thereof, compressing by the pressure energy of a portion of the mixture a volatile refrigerant comprising hydrocarbons of said mixture, cooling the compressed refrigerant by heat exchange with said condensate and passing the cooled compressed refrigerant in heat exchange relation with the vapor mixture in said first mentioned cooling step.

4. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising cooling the mixture and condensing a portion thereof, compressing by the pressure energy of a portion of the mixture a volatile refrigerant comprising hydrocarbons of said mixture, cooling the compressed refrigerant, passing the cooled compressed refrigerant in heat exchange relation with the vapor mixture in said first mentioned cooling step, separating from the refrigerant hydrocarbons thereof remaining in liquid form after said heat exchange step, and then passing the refrigerant hydrocarbons in vapor form to said compression step.

5. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising cooling the mixture and condensing a portion thereof, compressing by the pressure energy of a

portion of the mixture a volatile refrigerant comprising hydrocarbons of said mixture, cooling the compressed refrigerant, separating uncondensed hydrocarbons from the cooled compressed refrigerant, and passing to said first mentioned cooling step the remaining refrigerant hydrocarbons.

6. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising subjecting a continuous stream of the vapor mixture to cooling and thereby condensing a portion thereof and cyclically subjecting a refrigerant comprising hydrocarbons of said mixture to compression and then to cooling and then to heat interchange with said stream of vapor mixture in said first named cooling step and maintaining substantial uniformity of composition of said refrigerant during the cyclic operations thereon.

7. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising subjecting a continuous stream of the vapor mixture to cooling and thereby condensing a portion thereof, cyclically subjecting a refrigerant comprising hydrocarbons of said mixture to compression and then to cooling and then to heat interchange with said stream of vapor mixture in said first named cooling step and passing a portion of said condensate to said refrigerant and fractionating said portion of said condensate to the constituency of said refrigerant.

8. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising subjecting a continuous stream of the vapor mixture to cooling and thereby condensing a portion thereof, cyclically subjecting a refrigerant comprising hydrocarbons of said mixture to compression and then to cooling and then to heat interchange with said stream of vapor mixture in said first named cooling step, passing a portion of said condensate to said refrigerant, and removing from said refrigerant liquid hydrocarbons thereof passing from said heat interchange.

9. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising subjecting a continuous stream of the vapor mixture to cooling and thereby condensing a portion thereof, cyclically subjecting a refrigerant comprising hydrocarbons of said mixture to compression and then to cooling and then to heat interchange with said stream of vapor mixture in said first named cooling step, passing a portion of said condensate to said refrigerant, and removing from said refrigerant hydrocarbons remaining in vapor form after the cooling of the compressed refrigerant.

10. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising cooling the mixture and condensing a portion thereof, compressing by the pressure energy of a portion of the mixture a volatile refrigerant comprising hydrocarbons of said mixture, passing a portion of said condensate to a stabilizing zone, passing said compressed refrigerant in heat exchange relation with said condensate in said zone and thereby cooling the compressed refrigerant, and passing the cooled compressed refrigerant in heat exchange relation with the vapor mixture in said first mentioned cooling step.

11. In the recovery of liquid hydrocarbons from

a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising cooling the mixture and condensing a portion thereof, compressing by the pressure energy of a portion of the mixture a volatile refrigerant comprising hydrocarbons of said mixture, cooling the compressed refrigerant, passing the cooled compressed refrigerant in heat exchange relation with the vapor mixture in said first mentioned cooling step, passing the condensate to a stabilizing zone, and separating from the refrigerant and passing to said zone hydrocarbons remaining in liquid form after said heat exchange.

12. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising cooling the mixture and condensing a portion thereof, compressing by the pressure energy of a portion of the mixture a volatile refrigerant comprising hydrocarbons of said mixture, cooling the compressed refrigerant, passing the cooled compressed refrigerant in heat exchange relation with the vapor mixture in said first mentioned cooling step and adding a portion of said condensate to the refrigerant passing to said heat exchange.

13. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising cooling the mixture and condensing a portion thereof, expanding the residual vapors and reducing their temperature, utilizing said reduction of temperature in said cooling step, by the energy of said expansion compressing a volatile refrigerant comprising hydrocarbons of said mixture, cooling the compressed refrigerant, and passing the cooled compressed refrigerant in heat exchange relation to said mixture in said first mentioned cooling step.

14. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising cooling the mixture and condensing a portion thereof, expanding the residual vapors and reducing their temperature, utilizing said reduction of temperature in said cooling step, by the energy of said expansion compressing a volatile refrigerant comprising hydrocarbons of said condensate, passing a portion of said condensate to a stabilizing zone, passing the compressed refrigerant in heat exchange relation to said condensate in said zone to cool the refrigerant, and passing the cooled refrigerant in heat exchange relation to the mixture in said first mentioned cooling step.

15. In the recovery of liquid hydrocarbons from a mixture of the vapors thereof with vapors of more volatile hydrocarbons the steps comprising cooling the mixture and condensing a portion thereof, expanding the residual vapors and reducing their temperature, utilizing said reduction of temperature in said cooling step, by the energy of said expansion compressing a volatile refrigerant comprising hydrocarbons of said condensate, passing the compressed refrigerant in heat exchange with a portion of said condensate to cool the refrigerant, and passing the cooled refrigerant in heat exchange with the mixture in said first mentioned cooling step.

16. The method of recovering higher boiling liquefiable components from wet hydrocarbon gas which comprises cooling and partially liquefying wet hydrocarbon gas under substantial pressure, in a cooling step including indirect heat exchange with vaporizing hydrocarbon refrigerant, separating the cooled and partially liquefied gas into

a liquid portion and a dry gas portion, expanding the dry gas portion to perform work and to cool the dry gas, passing the cooled expanded dry gas in heat exchange relation with the wet gas in the first mentioned cooling step, expending said work in compressing the vaporized hydrocarbon refrigerant from said first mentioned cooling step, cooling and liquefying the compressed refrigerant vapor, and returning the liquefied refrigerant at reduced pressure to said first mentioned cooling step.

17. The method of recovering higher boiling liquefiable components from wet hydrocarbon gas which comprises cooling and partially liquefying wet hydrocarbon gas under substantial pressure by indirect heat exchange with cold dry gas, further cooling and partially liquefying said wet hydrocarbon gas by indirect heat exchange with vaporizing hydrocarbon refrigerant, separating the cooled and partially liquefied wet gas into a liquid portion and a dry gas portion, expanding the dry gas portion to perform work and to cool the gas, the cooled expanded dry gas being the cold dry gas in the first mentioned cooling step, expending said work in compressing the vaporized refrigerant from the second mentioned cooling step whereby the vaporized refrigerant is heated, passing the separated liquid portion of the wet gas to a stabilizing zone, passing the heated compressed refrigerant vapor in indirect heat exchange with liquid undergoing stabilization in the stabilizing zone to transfer heat from the compressed refrigerant vapor to the liquid undergoing stabilization, cooling and liquefying the compressed refrigerant vapor, and returning the liquefied refrigerant at reduced pressure to said second mentioned cooling step.

18. The method of recovering higher boiling liquefiable components from wet hydrocarbon gas which comprises cooling and partially liquefying wet hydrocarbon gas under substantial pressure by indirect heat exchange with cold dry gas, further cooling and partially liquefying said wet gas by indirect heat exchange with vaporizing hydrocarbon liquid refrigerant, separating the cooled wet gas into a liquid portion and a dry gas portion, passing a part of the liquid portion at reduced pressure to the second mentioned cooling step as a portion of the vaporizing hydrocarbon liquid refrigerant whereby a part of said liquid is vaporized, separating the vaporized portion of the refrigerant from the unvaporized portion thereof, compressing the vaporized portion of the refrigerant, cooling the compressed refrigerant vapor to liquefy a portion thereof, and returning the liquefied portion of the refrigerant to the second mentioned cooling step at reduced pressure as a part of the vaporizing hydrocarbon liquid refrigerant.

19. The method of recovering higher boiling components from wet hydrocarbon gas which comprises cooling and partially liquefying wet hydrocarbon gas under substantial pressure by indirect heat exchange with cold dry gas, further cooling and partially liquefying said wet gas by indirect heat exchange with vaporizing hydrocarbon refrigerant, separating the cooled wet gas into a liquid portion and a dry gas portion, expanding the dry gas portion to perform work and to cool the gas, the cooled expanded dry gas being the cold dry gas in the first mentioned cooling step, passing a part of the liquid portion of the wet gas at reduced pressure to the second mentioned cooling step as a portion of the vaporizing hydrocarbon refrigerant, separating the vaporized

portion of the refrigerant from the unvaporized portion, expending said work in compressing the vaporized portion of the refrigerant, cooling and partially liquefying the compressed refrigerant vapor and returning the liquefied portion at reduced pressure to the second mentioned cooling step as a portion of the vaporizing hydrocarbon refrigerant.

20. The method of recovering stable motor fuel from wet hydrocarbon gas which comprises cooling and partially liquefying wet hydrocarbon gas under substantial pressure by indirect heat exchange with cold dry gas, further cooling and partially liquefying said wet gas by indirect heat exchange with vaporizing hydrocarbon refrigerant, separating the cooled wet gas into a liquid portion and a dry portion, expanding the dry gas portion to perform work and to cool the gas, the cooled expanded gas being the cold dry gas in the first mentioned cooling step, passing a por-

tion of the liquid portion of the wet gas at reduced pressure to the second mentioned cooling step as a part of the vaporizing hydrocarbon refrigerant, separating the vaporized portion of the refrigerant from the unvaporized portion, expending said work in compressing the vaporized refrigerant whereby it is heated, passing the remaining portion of the liquid portion of the wet gas to a stabilizing zone, passing the heated compressed refrigerant vapor in indirect heat exchange with liquid undergoing stabilization in the stabilizer to transfer heat from the compressed refrigerant vapor to the stabilizer whereby the liquid portion of the wet gas is stabilized, cooling and partially condensing the compressed refrigerant vapor, and returning the condensed portion to the second mentioned cooling step at reduced pressure as a portion of the hydrocarbon refrigerant.

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