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COMBINATION HIGH AND LOW PRESSURE
ABSORPTION PROCESSAlvin J. Miller, Bartlesville, Okla., assignor to
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4 Claims. (Cl. 196-8)

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This invention relates to the treatment of hydrocarbons. In one of its more specific aspects it relates to a method for the treatment of natural gas containing condensable hydrocarbons for the recovery of those condensable hydrocarbons. In a still more specific aspect, it relates to a process for the treatment of natural gases to increase the extraction of natural gasoline and LPG hydrocarbons and to increase the volume and/or the calorific value of a high pressure residue gas. In another aspect, it relates to a method for transferring selected constituents from a low pressure residue gas to a high pressure residue gas without compression.

The term "condensable hydrocarbons" as used throughout this specification and claims is intended to include such hydrocarbons as propane, the butanes, pentanes, hexanes and such higher boiling hydrocarbons occurring in natural gas. Aromatics and naphthenes also occur in some gases.

The term LPG as used throughout the specification and claims is a shortened form of "liquid petroleum gas or gases." Hydrocarbon gases ordinarily termed liquefied petroleum gases are such as propane, butane or mixtures of such other normally gaseous hydrocarbons as are marketed in a liquefied condition.

An object of this invention is to provide a process for the extraction of condensable hydrocarbons from hydrocarbon gas mixtures. Another object of this invention is to provide a process for the extraction of condensable hydrocarbons from hydrocarbon gas mixtures wherein the recovery of such hydrocarbons is greater than for conventional methods of hydrocarbon recovery. Still another object of my invention is to provide a process for the treatment of natural gases at different pressures wherein the total yield of natural gasoline and LPG hydrocarbons is increased and the volume of high pressure residue gas is also increased. A still further object of my invention is to provide a process for transferring selected hydrocarbon constituents from a low pressure residue gas to a high pressure residue gas without compression. A still further object of my invention is to provide a process whereby high pressure residue gas may be enriched so as to increase its calorific value. Still other objects and advantages of my invention will be apparent upon reading the following disclosure taken in conjunction with the drawing, which respectively, describes and illustrates the preferred embodiment of my invention.

In the drawing, the one figure represents dia-

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grammatically one form of apparatus in which the process of my invention may be carried out.

Referring now to the drawing, the apparatus consists essentially of a low pressure absorber vessel 8, a second low pressure absorber or saturator vessel 9, and a high pressure absorber vessel 10. These major pieces of equipment are connected by pipes for passage of liquids or vapors from one vessel to another and these vessels and pipes are equipped with such other auxiliary apparatus as valves, compressors, pumps, controllers and meters of various types, which auxiliary equipment is for the most part not shown in the drawing for purposes of simplicity. The installation and use of this auxiliary equipment is understood by those skilled in the art as necessary and useful for carrying out the process.

Broadly speaking, my process consists in saturating absorption oil with constituents from a low pressure residue gas and then using this enriched or saturated absorption oil for the extraction of condensable hydrocarbons from a natural gas under high pressure conditions. In this process, I find that I can obtain a greater yield of condensable hydrocarbons as a natural gasoline and also I obtain a larger volume of high pressure residue gas than if the same volumes of low pressure natural gas and of high pressure natural gas were treated independently and without the absorption oil to the high pressure absorber having been previously contacted with low pressure residue gas.

In practicing my invention one natural gas may be used. A portion of this gas is treated under low pressure absorption conditions while a second portion may be compressed and then treated under high pressure absorption conditions, or the process may be used in a field in which a high pressure gas and a low pressure gas are available. I will describe the operation of my process for the treatment of a raw natural gas from one source.

Referring now to the drawing, a raw wet natural gas from a source, not shown, enters my system through a line 1. A portion of this gas is passed at about 50 pounds pressure through line 2 into the lower portion of the absorber vessel 8. A lean absorption oil enters this vessel at a point near its top through a line 42. Enriched absorption oil leaves the bottom of the vessel through a line 22 and the oil flows on to a line 34. The residue gas from this low pressure absorber leaves the top of the absorber through a line 21 and is introduced into the bottom of the low pressure saturator vessel 9. A quantity of

lean oil enters the top of this vessel through a line 43 and rich absorption oil leaves the bottom of the vessel through a pipe 24. Residue gas from this vessel flows through an overhead gas line 23 for such disposal as desired. This saturator vessel 9 is for all practical purposes an absorber vessel and may be of similar size and of similar construction as absorber vessel 8.

An additional quantity of raw natural gas from line 1 is passed into a line 3 and is compressed by compressor 4 to a pressure of about 600 pounds per square inch absolute.

The low pressure absorption and saturator vessels are described as operating under gauge pressures while the high pressure absorber 10 is described as operating under absolute pressure. Hence, all pressures describing operating conditions in the low pressure portions of the system are gauge pressures and the pressures in the high pressure portion of my system are absolute pressures.

This compressed gas from line 3 passes into a separator vessel 5 in which any condensate formed by the compression is separated from the compressed gas. This condensate may be removed from the separator through a line 6 for such disposal as desired. The vapor phase from this separator passes through a line 7 into the lower portion of a high pressure absorber 10. The saturated absorption oil from saturator 9 is passed through pipe 24 and under the influence of a pump 25 is introduced into the top of the high pressure absorber as absorption oil. If desired, a cooler 29 may be used to cool the absorption oil prior to its introduction into the high pressure absorber. This cooling may be necessary or at least desirable since absorption is ordinarily accompanied by evolution of heat and accordingly the absorption oil leaving the bottom of saturator 9 will have a higher temperature than that conducive to good high pressure absorber operation. High pressure residue gas leaves the top of the high pressure absorber through a line 26 for such disposal as desired as, for example, it may flow directly into a utility pipe line or into a pressure storage vessel prior to pipe line use. The enriched high pressure absorption oil is removed from the absorber through a pipe 27 and is passed through a pressure reducing valve 32 into a flash tank 11. The amount of pressure reduction occurring through valve 32 is intended to be such that at least the major portion of the methane absorbed under the high pressure conditions in absorber 10 is flashed from the liquid and may be removed through a vapor line 28. The flash tank bottoms is passed through a line 31 into the line 34 and therein is combined with the rich absorption oil from the low pressure absorber 8. This combined absorption oil stream is then passed through line 34 and is heated somewhat in exchanger 33 and is further heated in heater 35 prior to passage through a line 36 into the top of a conventional stripper still 12. Steam may be added to or introduced into the bottom of this stripper still through a pipe 37 to assist in removing the absorbed hydrocarbons from the absorption oil. Steam and stripped hydrocarbons leave the still through the overhead vapor line 44. This overhead vaporous material is cooled in condenser 13 and the cooled material passed on through a line 45 into a make tank 14. In this make tank, condensed water settles to the bottom and may be withdrawn through a water drawoff line 46 while liquid hydrocarbons may be removed through a line 52 and passed

under influence of a pump 51 through a cooler 53 and on through a line 54 into a high pressure accumulator 15. Uncondensed vapors from the make tank 14 are removed through a line 47 and are compressed by a compressor 48 and added to the liquid hydrocarbons prior to cooling in cooler 53. An unstabilized natural gasoline product is then removed from the accumulator through a line 57 for such disposal as desired. The uncondensed gases may be removed from this accumulator through a line 56 for such disposal as desired.

The stripper still bottoms is removed from the still 12 through a line 38 and is passed through exchanger 33 in indirect heat exchange with the rich absorption oil flowing through line 34. This still bottoms flows on through line 38 and is further cooled in cooler 41 and the stream of cooled oil is then divided and a portion flows through pipe 42 into the low pressure absorber 8 as lean oil and the remaining portion flows through a line 43 into the low pressure saturator 9 as lean oil.

In actual operation of such a system, the flash tank vapors flowing through line 28 may be, if desired, compressed and added to the compressed gas flowing through line 7 prior to introduction of the latter gas into the high pressure absorber 10.

In a similar manner, the vented gases from the high pressure accumulator 15 may likewise be compressed and added to the high pressure gas in line 7. In this manner of operation, the methane content of the flash tank and accumulator vapors will ultimately find its way into the high pressure residue gas flowing through line 26 while some ethane and higher boiling hydrocarbons will ultimately find their way into the natural gasoline product flowing through line 57.

The low pressure absorber 8 may be operated under about 50 pounds per square inch gauge pressure while the saturator 9 may be operated at a slightly lower pressure as, for example, about 45 pounds. The temperature of the lean oil used in the absorber 8 and saturator 9 may enter these vessels at about atmospheric temperature. The high pressure absorber 10 may be operated at about 600 pounds per square inch absolute. This absorber may also be operated at about atmospheric temperature. It will be understood, however, that these absorbers and saturators need not be operated specifically at atmospheric temperature and under the pressures stated, but these pressures and temperatures may be varied somewhat as will be dictated by the pressures of the available natural gas or gases, and by the available temperature of the plant cooling water and by the desired minimum B. t. u. requirements of the high pressure residue gas.

The still 12 may be operated under such temperature and pressure and with such an amount of steam that all or substantially all of the absorbed hydrocarbons will be removed so that the lean absorption oil will be in optimum condition for extraction of desired hydrocarbons from the gases.

Hydrocarbon gases pumped into utility pipe lines frequent times are sold on minimum B. t. u. specifications and one particular advantage of my invention is that I am able to produce a high pressure residue gas suitable for utility pipe line purposes and having a high minimum B. t. u. content and at the same time I am able to extract larger quantities of gasoline that can be ob-

tained in conventional processes. In order to illustrate quantitatively these advantages, Tables I, II and III are given. In Table I are given results (1) without lean oil saturation and (2) with lean oil saturation for both the residue gas product and the gasoline product. The wet gas feed to the high pressure absorber in each case was 64,931,253 standard cubic feet, that is, without lean oil saturation and with lean oil saturation. Referring to the data, it will be noted that under the heading "Residue gas" the column headed "With lean oil saturation" shows that there are produced about 350,692 cubic feet more high pressure residue gas than when the lean oil to the high pressure absorber was not saturated with low pressure residue gas constituents. In addition, under the subheading "Gross heating value" it will be further noted that when lean oil saturation was used a higher yield of higher B. t. u. value residue gas was obtained. This B. t. u. value was 1127.1 per cubic foot. Without lean oil saturation, the smaller volume of high pressure residue gas had a heating value of 1113.3 B. t. u. per cubic foot. This difference in heating value is 13.8 B. t. u. per cubic foot but when it is considered that 350,692 more cubic feet of gas were produced having the higher B. t. u. value then the process of my invention has real value. Upon reference to the heading "Absorbed constituents" which are actually the constituents absorbed by the absorption oils and produced as gasoline, it will be seen that there is a considerably higher yield of gasoline with my process than in the conventional process. With lean oil saturation there is produced slightly over 369,000 gallons of gasoline in comparison to 339,000 gallons when the lean oil to the high pressure absorber was not previously treated as herein disclosed. This difference is 30,000 gallons of gasoline for each approximate 65,000,000 of high pressure gas treated. From another point of view, this "increased" gasoline yield amounts to three tank cars of gasoline. Conventional gasoline tank cars hold approximately 10,000 gallons of liquid at 60° F.

TABLE I

High pressure absorption with and without saturation of absorption oil. (64,931,253 S. C. F. wet gas feed to high pressure absorber in each case.)

	Residue Gas—			
	Without Lean Oil Saturation ¹		With Lean Oil Saturation ²	
	Percent	Cu. Ft. @ 60° F. and 14.696 p. s. i. a.	Percent	Cu. Ft. @ 60° F. and 14.696 p. s. i. a.
N ₂	3.89	2,024,653.85	3.86	2,024,441.15
CO ₂	0.82	427,912.84	0.81	424,817.96
H ₂ S.....	0.07	37,422.41	0.07	36,712.66
C ₁	77.43	40,337,364.66	77.23	40,504,556.92
C ₂	15.80	8,231,076.13	15.17	7,956,158.60
C ₃	1.99	1,037,258.22	2.20	1,153,826.56
nC ₄	0.00	280.80	0.17	89,159.33
iC ₄	0.00	—	0.48	241,254.64
iC ₅	0.00	—	0.03	15,734.00
Total..	100.00	52,095,969.01	100.00	52,446,661.82

Gross heating value:

¹ Dry basis @ 60° F. and 14.696 p. s. i. a., 1113.3 B. t. u./cu. ft.

² Dry basis @ 60° F. and 14.696 p. s. i. a., 1127.1 B. t. u./cu. ft.

	Absorbed Constituents—			
	Without Lean Oil Saturation		With Lean Oil Saturation	
	Vol. percent	Gallons @ 60° F.	Vol. percent	Gallons @ 60° F.
10 H ₂ S.....	0.11	379.75	0.12	432.49
C ₁	15.08	51,134.34	13.85	51,167.74
C ₂	24.60	83,394.48	26.40	97,541.06
C ₃	31.76	107,695.72	31.26	115,381.02
iC ₄	5.39	18,289.72	5.09	18,771.13
nC ₄	14.33	48,596.64	14.49	53,411.62
iC ₅	3.96	13,419.96	4.00	14,756.48
nC ₅	3.20	10,860.92	3.35	12,374.23
C ₆	1.15	3,887.83	1.06	3,893.29
C ₇	0.42	1,417.87	0.38	1,417.87
Total..	100.00	339,077.23	100.00	369,127.36
Gross Heating Value:				
B. t. u./Gal. of Liq. @ 60° F.				
20		84,773.8		94,740.8

In Table II are given the stream compositions in terms of mols and mol per cent of the wet gas feed to my process, of the lean oil and of several intermediate streams, of rich absorption oils, residue gases and gasoline products. The circled numerals on the drawing are the stream numbers for identification in Table II.

The term MSO as used in Tables II and III and throughout the specification and claims is a shortened form of "mineral seal oil." Mineral seal oils used for absorption of hydrocarbons from gases are usually oils having a boiling range similar to that of kerosene or somewhat higher.

Table III shows the composition of the several streams including the raw gas, high pressure separator bottoms (compression condensate), separator gas, which gas is fed to a conventional high pressure absorber, and residue gas, lean oil, and rich oil compositions for a conventional high pressure absorption operation. A separate drawing showing these process stages is not given since it is believed that since this operation involves only compression, cooling, separation of gas and liquid, and a high pressure absorber, a separate drawing is not necessary. The stream compositions shown in Table III are given directly under the column headings which are believed to be self-explanatory. The second column which is headed "Separator gas" is the gas separated from the compression condensate of the third column and this condensate results from the cooling of the compressed gas of column 1. The data of Tables II and III are based on the processing of 64,931,253 standard cubic feet of high pressure gas of the composition given in the first column of Tables II and III. It should be noted that the residue gas as stream 9 from the high pressure absorber of my process is of greater volume by 350,692 cubic feet than the high pressure gas produced by the conventional high pressure process illustrated in Table III. Thus the volume of high pressure gas was increased by this 350,692 cubic feet without the compression of any additional gas by using the process of my invention. It should be further noted that while there is slightly less ethane in my high pressure residue gas, there is more propane, butanes, and some pentanes, while in the high pressure residue from the conventional absorber there is substantially nothing higher boiling than propane.

TABLE II

Stream No.	(1)		(3)		(4)		(6)		(7)	
	Mols	Percent	Mols	Percent	Mols	Percent	Mols	Percent	Mols	Percent
N ₂	3,557.97	3.00	4.87	0.01	3,553.10	3.19	3,547.88	3.30	5.22	0.01
CO ₂	830.19	0.70	7.88	0.02	822.31	0.74	813.96	0.76	8.35	0.02
H ₂ S	113.60	0.10	5.88	0.01	112.72	0.10	106.21	0.10	6.51	0.01
C ₁	75,595.00	63.74	415.77	1.05	75,179.23	67.48	74,737.93	69.42	441.30	1.04
C ₂	20,665.07	17.34	717.93	1.82	19,847.14	17.81	19,102.08	17.74	745.06	1.75
C ₃	9,559.08	8.06	1,108.47	2.81	8,450.61	7.58	7,410.09	6.88	1,040.52	2.44
i-C ₄	1,233.43	1.04	322.97	0.82	910.46	0.82	634.83	0.59	275.63	0.65
n-C ₄	3,688.43	3.11	1,345.65	3.41	2,342.78	2.10	1,295.79	1.20	1,048.99	2.46
i-C ₅	1,185.99	1.00	1,028.85	2.60	157.14	0.14	13.36	0.01	143.73	0.34
n-C ₅	1,114.83	0.94	1,066.89	2.70	47.94	0.04	0.55	0.00	47.39	0.11
C ₆	664.15	0.56	663.75	1.68	0.40	0.00	0.00	0.00	0.40	0.00
C ₇	486.26	0.41	486.26	1.23	0.00	0.00	0.00	0.00	0.00	0.00
MSO			32,329.53	81.84					38,807.44	91.17
Total	118,599.00	100.00	39,504.70	100.00	111,423.83	100.00	107,662.68	100.00	42,568.59	100.00

Stream No.	(8)		(9)		(10)		(11)		(2)	(5)
	Mols	Percent	Mols	Percent	Mols	Percent	Mols	Percent	Mols	Mols
N ₂	90.84	0.12	5,328.62	3.86	5,415.24	3.14	11.77	0.14		
CO ₂	140.16	0.18	1,117.01	0.81	1,248.82	0.73	17.25	0.20		
H ₂ S	83.49	0.11	94.95	0.07	171.93	0.10	8.94	0.10		
C ₁	7,994.96	10.45	106,737.26	77.23	114,290.92	66.38	993.71	11.44		
C ₂	10,118.37	13.22	20,968.95	15.17	30,342.26	17.62	1,020.08	11.74		
C ₃	11,081.75	14.48	3,037.67	2.20	13,078.90	7.60	1,498.98	17.25		
i-C ₄	1,516.25	1.98	237.48	0.17	1,478.10	0.86	402.92	4.64		
n-C ₄	4,473.34	5.84	643.72	0.46	4,070.07	2.36	1,554.89	17.89		
i-C ₅	1,066.22	1.39	37.21	0.03	959.65	0.56	849.02	9.77		
n-C ₅	829.63	1.08	9.95	0.00	792.19	0.46	907.96	10.45		
C ₆	250.07	0.33	0.03	0.00	249.70	0.15	763.15	8.78		
C ₇	81.16	0.11	0.00	0.00	81.16	0.04	660.39	7.60		
MSO	38,807.44	50.71							32,329.53	38,807.59
Total	76,533.68	100.00	138,212.85	100.00	172,177.94	100.00	8,689.06	100.00	32,329.53	38,807.59

TABLE III

	Raw Gas		Compression Separator Gas		Compression Condensate		HP Rich Oil		HP Residue Gas		Lean Oil	
	Mols	Mol percent	Mols	Mol percent	Mols	Mol percent	Mols	Mol percent	Mols	Mol percent	Mols	Mol percent
N ₂	5,426.01	3.00	5,414.24	3.14	11.77	0.14	78.40	0.11	5,335.84	3.89		
CO ₂	1,266.07	0.70	1,248.82	0.73	17.25	0.20	121.14	0.16	1,127.68	0.82		
H ₂ S	180.87	0.10	171.93	0.10	8.94	0.10	73.31	0.10	93.62	0.07		
C ₁	115,284.63	63.14	114,290.92	66.38	993.71	11.44	7,989.74	10.84	106,301.18	77.43		
C ₂	31,362.34	17.34	30,342.26	17.62	1,020.08	11.74	8,650.88	11.74	21,691.38	15.80		
C ₃	14,577.88	8.06	13,078.90	7.60	1,498.98	17.25	10,345.41	14.04	2,733.49	1.99		
i-C ₄	1,881.02	1.04	1,478.10	0.86	402.92	4.64	1,477.36	2.01	0.74			
n-C ₄	5,624.96	3.11	4,070.07	2.36	1,554.89	17.89	4,070.07	5.52	0.00			
i-C ₅	1,808.67	1.00	959.65	0.56	849.02	9.77	959.65	1.30	0.00			
n-C ₅	1,700.15	0.94	792.19	0.46	907.96	10.45	792.19	1.07	0.00			
C ₆	1,012.85	0.56	249.70	0.15	763.15	8.78	249.70	0.34	0.00			
C ₇	741.55	0.41	81.16	0.04	660.39	7.60	81.16	0.11	0.00			
MSO							38,807.44	52.66			38,807.44	100.00
Total	180,867.00	100.00	172,177.94	100.00	8,689.06	100.00	73,696.45	100.00	137,288.93	100.00	38,807.44	100.00

Natural gasoline and LPG fractions are extracted from a wide variety of natural gases by well known absorption processes. The natural gas may be produced along with crude oil in which case the gas is available from a gas-oil separator or from the casinghead of the well. Usually such a natural gas contains a relatively great percentage of heavier or high boiling hydrocarbon constituents and is available under relatively low pressures ranging from near atmospheric to 50 or 100 pounds per square inch. Natural gas may also originate from a gas cap from which only gas is being produced under relatively high pressures initially; but as the reservoir is depleted, the pressure falls. The natural gas from this source is usually drier, that is, contains less higher boiling hydrocarbon constituents. A typical low pressure gas from a source such as noted above may be passed to a low pressure absorber such as absorber 8 wherein substantially all of the natural gasoline hydro-

carbons together with a portion of the LPG hydrocarbons are extracted by absorption in an absorption oil. Usually it will be desirable to circulate sufficient absorption oil to extract all of the pentane and heavier hydrocarbons. The residue gas from such a low pressure absorber contains substantial quantities of propane and butane which are valuable hydrocarbons for LPG markets. Nevertheless, it is not economically feasible to extract the major portion of these constituents in a conventional low pressure absorber. The low pressure residue is normally used as fuel for the gasoline plant and for the surrounding leases from which gas and oil are being produced. Also it is frequently necessary to dispose of excess low pressure residue by burning it from flares. Such a fuel gas has no specified B. t. u. value and thus the propane and butane content does not enhance its value. In fact if the residue fuel gas is to be used as fuel for gas engines, it is usually preferable that the

propane and butane content be reduced so as to lower the B. t. u. value.

With the advent of the utility pipe lines for the transmission of residue gas from the gas fields to domestic and industrial markets located several hundred miles distant, it has become necessary to substantially increase the pressure on the gas which is to be so transmitted. In many cases, it has been necessary to compress a low pressure gas which may be available at pressures below 100 pounds up to pressures ranging from 300 to 1000 pounds. In a few cases, the natural gas is naturally available at sufficiently high pressures to permit injection into a utility pipe line without compression. In either case, a residue gas marketed to a utility pipe line must have a specified calorific value. In other words, the B. t. u. value of the residue gas so marketed must not fall below a certain specified minimum which is usually set by contract. It is well known that the compression of gas to pressures in the order of 600 pounds and above is an expensive operation and, therefore, any means for reducing the amount of gas which must be compressed represents a valuable improvement. The process of my invention provides a means for transferring constituents from a low pressure gas to a high pressure residue gas without compression. Furthermore, my process provides a means for extracting substantial quantities of butane and propane which are actually being wasted in low pressure fuel gases and transferring a portion of these constituents to a high pressure residue gas so as to increase its calorific value and/or its volume. The low pressure absorber may actually be a part of a complete gasoline plant located at some distance from the high pressure plant in which case the low pressure residue is passed to the saturator in the high pressure plant or the lean absorption oil from the high pressure plant is passed to a saturator in the low pressure plant. In either case, selected constituents free of undesirable diluents, such as nitrogen and carbon dioxide, are absorbed from the low pressure gas and are transferred in the oil passing to the high pressure absorber and thus these selected constituents may be used to increase the volume and/or the calorific value of the high pressure residue gas without incurring any compression cost.

In the specific application of my process as discussed hereinabove, all of the gas available to the gasoline plant is at a relatively low pressure. A sufficient quantity of this gas to supply fuel and lease needs is processed through the low pressure absorber and only the quantity needed for the high pressure pipe line sale is compressed. It is well known that the volume of gas initially compressed for processing in the high pressure absorber is subject to shrinkage due to extraction of hydrocarbons in the absorber. Such shrinkage requires the compression of an additional quantity of gas in order to supply a specified volume to a utility pipe line. A portion of this compression cost may be eliminated by transferring a selected portion of the low pressure residue gas to the high pressure residue by the process of my invention. In this particular application, the low pressure absorber was operating under a pressure of 50 pounds p. s. i. g. and was processing about 41 million cubic feet of natural gas with a lean oil circulation of 1 million gallons per day and an absorber pressure of 50 pounds per square inch. The high pressure absorber was processing about 68.5 million cubic

feet per day with an oil circulation of 1,200,000 gallons per day and an absorber pressure of 600 pounds per square inch. By the process of this invention, it was possible to transfer about 350,000 cubic feet per day of low pressure residue constituents to the high pressure residue and thereby increase the calorific value by 13.8 B. t. u. per cubic foot and simultaneously increase the overall recovery of natural gasoline and LPG constituents by 30,000 gallons per day. Had it been unnecessary to increase the calorific value, the volume of the high pressure residue could have been increased and the B. t. u. value held constant and the recovery or yield of condensable hydrocarbons increased still further.

From the foregoing, it should be apparent that my process is especially advantageous where both high and low pressure wet gas streams are available to a natural gasoline plant or where it is necessary to compress a substantial quantity of low pressure gas for marketing through a utility pipe line on a specified minimum B. t. u. basis. My process may be employed advantageously to accomplish the following results:

(1) The volume of both the high pressure residue gas and the recovered condensable hydrocarbons may be increased and the calorific value of the high pressure residue gas increased without increasing the low pressure and the high pressure wet gas feeds to the plant.

(2) The wet gas feed stream may be maintained constant and a higher extraction of condensable hydrocarbons, such as propane and butane, may be effected by increasing oil circulation to the high pressure absorber to the extent necessary to maintain the calorific value of the high pressure gas at a predetermined level.

(3) The volume of high pressure gas processed can be reduced and the calorific value maintained at a predetermined level without appreciably effecting the recovery of condensable hydrocarbons.

(4) The volume of low pressure gas processed can be increased and the volume of high pressure gas decreased while still maintaining a predetermined calorific value for the high pressure residue.

The gas volumes, temperatures and pressures given herein are given merely as exemplary and it is not intended that these conditions be limiting in any way. For example, the low pressure absorber may be operated at 10, 25, 65 or 100 pounds per square inch as well as at 50 pounds as described. In addition, the high pressure absorber may be operated at other pressures than the 600 pounds stated. The high pressure absorber should, however, be operated at a pressure considerably higher than the low pressure absorber. The process has little advantage when the ratio of pressures, that is, high pressure-to-low pressure, is less than 2, and the advantage increases as the ratio increases. It is possible, of course, for the ratio to be increased up to the order of 40:1. A preferable ratio of pressures lies between about 6:1 to 20:1.

The saturator will usually be operated at a pressure some lower than that of the low pressure absorber on account of the pressure drop of the low pressure residue gas in transit from the low pressure absorber to the saturator.

Many valves, pumps, meters, controllers and other auxiliary apparatus are not shown on the drawing nor described in the specification for purposes of simplicity. That such auxiliary apparatus is necessary in the operation of such a process is understood by those skilled in the art. It

will be obvious to those skilled in the art that many variations and alterations of my process may be made and yet remain within the intended spirit and scope of my invention.

I claim:

1. The process of treating a raw wet natural gas containing propane and heavier constituents to transfer gaseous constituents consisting of propane and heavier from a low pressure residue gas stream to a high pressure residue gas stream, without compressing as a gas said gaseous constituents, which comprises absorbing a portion of said gaseous constituents from a first stream of said natural gas at a first superatmospheric pressure with a first stream of a liquid lean absorption oil in a first absorption step to produce a first residue gas, absorbing an additional portion of said gaseous constituents from said first residue gas at substantially no greater pressure than said first pressure with a second stream of the same liquid lean absorption oil in a second absorption step to produce a second residue gas and a partly presaturated liquid absorption oil, pumping said presaturated liquid from said first pressure to a second superatmospheric pressure which is at least twice said first pressure, and absorbing a portion of said gaseous constituents from a second stream of that portion of the same said natural gas that remains gaseous at said second pressure with said presaturated liquid in a third absorption step to produce a third residue gas, whereby said third residue gas contains more propane and heavier constituents than if said

lean oil were employed in place of said presaturated liquid.

2. The combination of claim 1 in which the resulting rich absorption oils from the first and third absorption steps are fractionated to produce said lean absorption oil which is recycled to said first and second absorption steps.

3. The combination of claim 2 in which the rich absorption oil from the third absorption step is flashed by lowering its pressure before said fractionation, and the vapors from said flashing step are compressed and recycled to said third absorption step.

4. The combination of claim 2 in which vapors from the distillate of said fractionation are compressed and recycled to said third absorption step.

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