

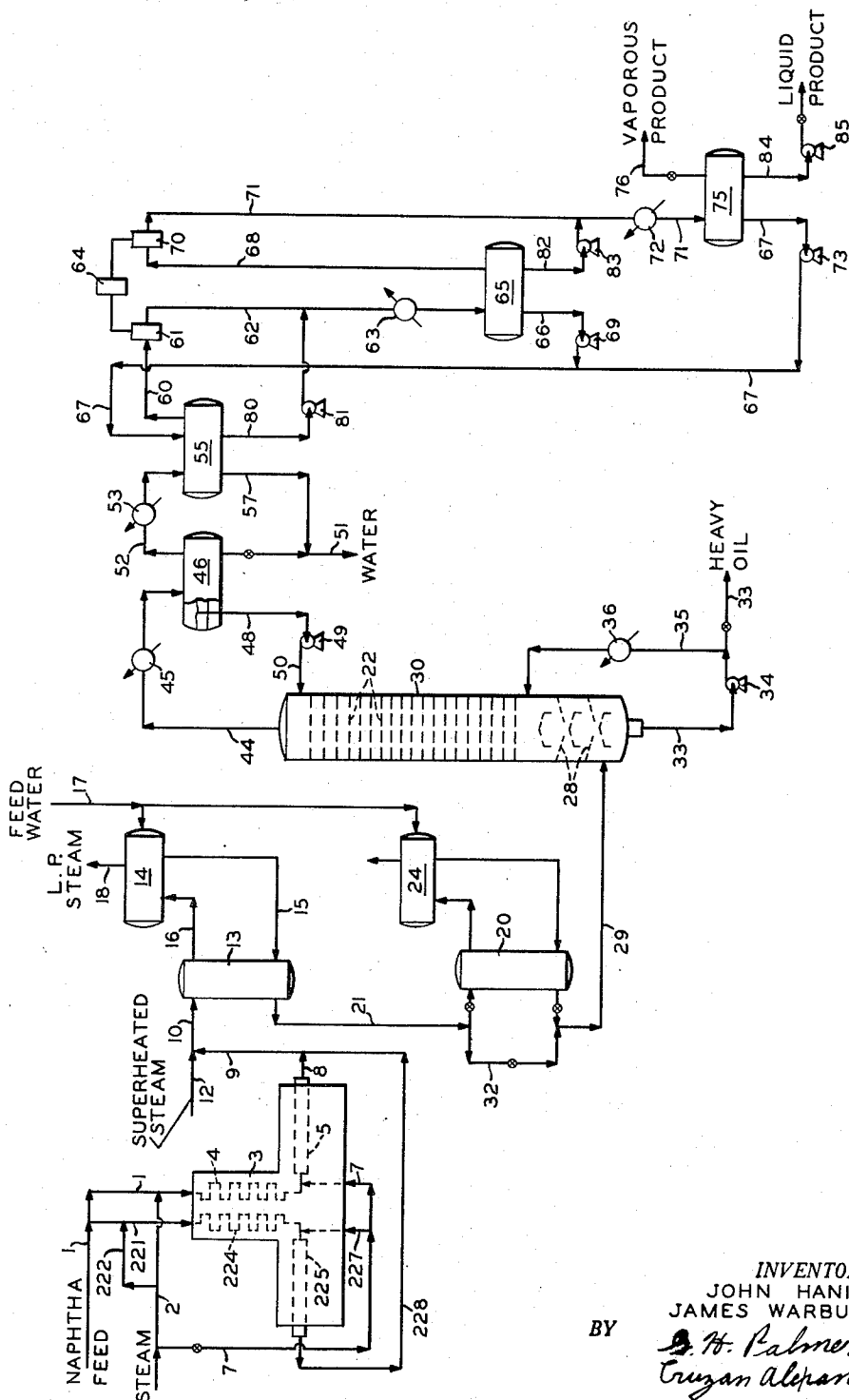
March 26, 1957

J. HANISIAN ET AL

2,786,802

SEPARATION OF STEAM AND HYDROCARBONS

Filed Aug. 17, 1955



INVENTORS
JOHN HANISIAN
JAMES WARBURTON
J. H. Palmer
Cruzan Alexander
ATTORNEYS

1

2,786,802

SEPARATION OF STEAM AND HYDROCARBONS

John Hanisian, Westbury, N. Y., and James Warburton, Rutherford, N. J., assignors to The M. W. Kellogg Company, Jersey City, N. J., a corporation of Delaware

Application August 17, 1955, Serial No. 528,937

7 Claims. (Cl. 196—95)

This invention relates to a new and useful process for the efficient separation of a mixture of steam and hydrocarbon vapors. In one aspect the present invention relates to a process for recovery of hydrocarbons from a mixture of steam and hydrocarbon vapors. In another aspect the invention relates to product recovery in a process for the production of ethylene by the pyrolytic conversion of hydrocarbons.

One of the more common methods of producing ethylene is by the pyrolytic conversion of hydrocarbons. Generally speaking, saturated hydrocarbons containing two or more carbon atoms or unsaturated hydrocarbons containing three or more carbon atoms may be pyrolytically converted to ethylene. Hydrocarbon liquids such as naphtha, gas oil or reduced crude are commonly used as feed materials for such a process. Normally gaseous hydrocarbons such as ethane and propane are also useful for conversion to ethylene, as are butanes, pentanes, natural gasoline, etc. The conversion may take place in an externally heated conversion zone such as a cracking coil or the necessary heat may be supplied by contacting with heated matter such as superheated steam. A combination of these methods or other suitable methods may also be used.

Water or steam is used in connection with most methods for the pyrolytic conversion of hydrocarbons to ethylene. Steam is commonly mixed with the feed prior to pyrolysis in a cracking coil in order to reduce the partial pressure of hydrocarbon in the coil thereby increasing the yield and also to keep the linear velocity through the coil to a maximum. This serves to minimize the formation of carbon deposits and can be used as a method of limiting the amount of cracking taking place in the coil. Superheated steam is commonly injected into transfer line conversion zones to bring about conversion temperatures. In addition, water is frequently used in the direct quenching of pyrolysis products. In any case, the resultant product contains comparatively large amounts of steam admixed with hydrocarbon vapors.

Our invention will be described as used in connection with the production of ethylene but it should be understood that our invention is not limited to use in connection with the production of ethylene but is applicable to any situation where water must be separated from a mixture of steam and hydrocarbon vapors.

It is an object of our invention to provide an improved process for the removal of water from a mixture of steam and hydrocarbon vapors.

It is also an object of our invention to provide an improved process for the recovery of hydrocarbons from a mixture of steam and hydrocarbon vapors.

It is a further object of our invention to provide an improved method for the removal of water from a mixture of steam and hydrocarbon vapors resulting from the production of ethylene by the pyrolytic conversion of hydrocarbons.

According to our invention, water is removed from a mixture of steam and hydrocarbon vapors by cooling the

2

mixture to condense steam at the existing pressure and separating the water thus formed from hydrocarbons in a first separation zone. Hydrocarbon vapors from the first separation zone are then compressed and cooled to condense more steam at a second and higher pressure level. This additional water is separated in a second separation zone and is returned to the first lower pressure separation zone. Further stages of compressing and cooling may be used with the water separated after each stage at a progressively higher pressure level and then returned to the first lower pressure separation zone. Condensed hydrocarbon liquids in each respective separation zone are withdrawn and then recovered separately or combined with the compressed vapors to the next succeeding condensation zone prior to cooling.

By returning water from the subsequent higher pressure separation zones to the primary lower pressure separation zone, I find it possible to recover otherwise unrecoverable hydrocarbons and at the same time simplify the disposal of the water. Water separated in subsequent separation zones usually contains entrained and/or dissolved hydrocarbon vapors, e. g. methane. Some of these vapors are explosive and constitute a safety hazard if they are allowed to collect in sewers or equipment and not removed from the water. It has been the usual practice previously to vent entrained vapors prior to releasing the water from the system. When the water is returned to the primary separation zone, according to our invention, the lower pressure in the primary separator causes the entrained vapors to be released when the water is flashed into the primary separator. Thus, instead of being vented and wasted, these valuable vapors are returned to the process stream and can be recovered along with the other hydrocarbon vapors present. Water which is returned to the primary separator from subsequent separation stages is combined with water separated in the primary separator and can possibly be utilized elsewhere in the system, as cooling water or boiler feed for instance.

Previously mixtures of steam and hydrocarbon vapors have been cooled to the desired operating temperature of the primary separator in one step. In a modification of our invention we have found that it is highly advantageous, although not essential to divide this primary cooling and separation into two stages.

By cooling to below the dew point of the steam, separating the water thus formed and then cooling to the desired operating temperature of the primary separator, we are able to effect considerable economies in heat exchange since the steam removed in the preliminary stage does not have to be cooled to the temperature of the primary separator.

According to one aspect of this modification of our invention a mixture of steam and vaporous hydrocarbons containing a desired vaporous overhead hydrocarbon product is cooled in the preliminary stage of the primary separator to the dew point of the overhead hydrocarbon product and most of the steam condenses and is separated. The vapors from this first stage are then further cooled in a second stage which results in more steam condensation. By thus cooling to the dew point of the overhead hydrocarbon product, separating water and then cooling further to the desired primary separation temperature it is possible to effect considerable economies in heat exchange equipment since the water removed in the first stage does not have to be cooled further while only the remaining steam has to be cooled to the temperature at which it is desired to operate the primary separator. Since large amounts of water are usually involved and it is usually desired to operate the primary separator at an ultimate temperature considerably below the dew point of the hydrocarbon vapors, it can be seen that substantial savings can be effected in this way.

The temperature of the first stage of the primary separation

rator should be maintained at the dew point of the overhead hydrocarbon product and must be below the dew point of the steam. The second stage of the primary separator should be operated at a lower temperature than the first stage. The subsequent separators can be operated at any convenient temperature provided that the temperature in each separation zone is less than the dew point of the steam in that separation zone. Temperatures of about 50 to about 150° F., more usually about 80 to about 120° F. are preferred in the primary and subsequent separation zones since these temperatures are conveniently obtainable through conventional cooling techniques.

In the event that the mixture of steam and hydrocarbon vapors entering the preliminary stage of the primary separator contains hydrocarbons having higher dew points than the dew point of the desired overhead product, such hydrocarbons will, of course, be condensed and may be separately withdrawn from the preliminary stage of the primary separator. The preliminary stage of the primary separator can thus be utilized to separate hydrocarbons of higher dew point than the desired overhead hydrocarbon product as well as to condense and separate steam from the overhead hydrocarbon product.

My invention can be practiced under a wide range of subatmospheric, atmospheric and superatmospheric pressures. Pressures of about —10 to about 50 p. s. i. g. more usually about 0 to about 20 p. s. i. g. and still more usually about 0 to about 5 p. s. i. g. are preferred for operation of the primary separator. The second separator is preferably operated at a pressure of about 20 to about 60 p. s. i. g., and more usually about 35 to about 45 p. s. i. g., and any subsequent separation zones at higher pressures.

For a better understanding of my invention, reference should be had to the accompanying drawing which is a diagrammatic view in elevation of a suitable arrangement of apparatus for carrying out my invention. The drawing illustrates a preferred embodiment of my invention in which the mixture of water and hydrocarbon vapor is obtained from a process for the pyrolysis of naphtha in the presence of steam to produce ethylene.

The production of ethylene by the pyrolytic conversion of hydrocarbons, is a type of process to which this invention is well adapted because of the large amounts of steam which are added to the process stream and which must be separated prior to recovery of ethylene product.

In the drawing, normally liquid hydrocarbon feed, such as naphtha, enters through conduits 1 and 221. Steam may be added to the feed by means of conduits 2 and 222. Preferably about 0.12 mol of steam is added per mol of hydrocarbon feed. Following addition of steam, the combined feed enters furnace 3 which contains heating coils 4 and 224 and enlarged tubular conversion zones 5 and 225. In the heating coils the feed is vaporized and heated to near conversion temperature, preferably to about 900° F. In the conversion zones, the naphtha is further heated and partially converted to ethylene. About 5% conversion of feed to ethylene takes place in the conversion zones 5 and 225 during which an outlet temperature of about 1275° F. is maintained. Residence time in the conversion zone is not more than about 0.5 second if formation of carbon and undesirable products is to be avoided. If desired, additional steam may be injected into the feed through conduits 7 and 227 before the feed enters the conversion zones. The additional steam may be added, if needed, to reduce the partial pressure of the naphtha in coils 5 and 225 and to keep the linear velocity through the coils to a maximum, thereby minimizing the formation of carbon deposits and limiting the amount of cracking in the coils.

The product from conversion zones 5 and 225 leaves furnace 3 through conduits 8 and 228 and passes to a transfer line conversion zone 10 by way of conduit 9. Superheated steam is injected into conversion zone 10 through conduit 12 to effect the remainder of the desired conversion. The steam entering through conduit 12 is

preferably at a temperature of about 1700° F. and about 1.5 lbs. of steam per lb. of hydrocarbon feed are usually employed. The amount of steam used will depend upon its temperature since enough should be injected to bring the temperature of resulting mixture to about 1500° F. in order to effect a sufficiently rapid conversion. Residence time in the transfer line conversion zone is about 1.5 seconds. About 18% of the naphtha feed is converted to ethylene in the transfer line conversion zone.

The product from the transfer line conversion zone is quenched in a quench boiler 13 by indirect contact with water to a temperature of about 700° F. to halt the formation of unwanted products such as olefin polymers. Quenching to temperatures below about 1000° F. will normally accomplish this purpose although lower temperatures may be employed without departing from the scope of this invention. Normally the product should not be quenched to a temperature lower than its dew point since lower temperatures result in condensation of olefin polymers which tend to create solids deposits in the quench boiler thereby reducing the efficiency of the quench boiler and possibly requiring a shutdown for cleaning.

Water is supplied to quench boiler 13 from steam drum 14 through conduit 15. Steam generated in the quenching process returns to the steam drum through conduit 16. Feed water is supplied to the steam drum through conduit 17 and low pressure steam is removed through conduit 18. If two stage quenching is desired, the product is only partially cooled in quench boiler 13 and is then passed to a quench boiler 20 through conduit 21 and in quench boiler 20 the product is further cooled to about 600° F. Quench boiler 20 and steam drum 24 operate in exactly the same manner as quench boiler 13 and steam drum 14. From quench boiler 20 the product passes through conduit 29 to a rectifier 30. If two stage quenching is not desired, the cooling may be completely effected in quench boiler 13 and the product passed directly to rectifier 30 by way of conduit 21, conduit 32, and conduit 29.

The product stream enters rectifier 30 below the baffles 28 and is further cooled to a temperature of about 400° F. to condense a polymer fraction which is separated and removed from rectifier 30 as a bottoms fraction through conduit 33 and pump 34. Part of the bottoms fraction is sent to storage as a product of the process and part is recycled to rectifier 30 via conduit 35 and cooler 36. The recycled fraction is cooled to a temperature of about 347° F. prior to being returned to rectifier 30. The cooled recycle fraction enters rectifier 30 above baffles 28 but below bubble plates 22 and serves to cool the hot product stream entering through line 29. Cooling the recycle stream is a convenient way of removing excess heat which may be introduced into the rectifier by the quenched product stream from line 29. In this way differences in the outlet temperature of the quench boiler can be compensated for and a considerable variation in the temperature of the quenched product stream can be tolerated without effecting the proper operation of the rectifier.

An overhead fraction consisting of steam and vaporous hydrocarbons is removed from rectifier 30 through conduit 44 and passed to the primary separation zone which is shown here divided into two stages, the first stage being represented by a condenser 45 and a preliminary separator drum 46 and the second stage by a condenser 53 and a primary separator drum 55.

The hydrocarbon vapors withdrawn through conduit 44 include the overhead hydrocarbon product and also hydrocarbons having a higher dew point than the hydrocarbon product. The vapors withdrawn through conduit 44 are passed through condenser 45, where they are cooled to below the dew point of the steam contained therein and the condensate and uncondensed vapors are passed to preliminary separator drum 46 where the water condensed in condenser 45 is separated and withdrawn through conduit 51. The condensate forms two liquid phases in drum 46, a lower water rich phase and an upper

5

hydrocarbon rich phase. The hydrocarbon rich phase which comprises those hydrocarbons having a higher dew point than the overhead hydrocarbon product is removed from drum 46 through conduit 48 and recycled to rectifier 30 as a reflux stream via pump 49 and conduit 50 to cool the upper portion of rectifier 30. A vaporous overhead product is withdrawn from drum 46 through conduit 52 and passes through condenser 53 to primary separator drum 55. Although a majority of the steam is usually condensed and separated in preliminary separator drum 46, a considerable quantity of steam remains in the hydrocarbon vapors. The additional cooling effected in condenser 53 condenses some of this steam and the water thus formed is removed from primary separator drum 55 through conduit 57. The water removed from separator drum 55 is, for convenience, combined with the water removed from drum 46 through conduit 51. An upper hydrocarbon rich liquid phase and a lower water rich liquid phase are formed in separator 55.

Uncondensed vapors from primary separator 55 are withdrawn through conduit 60 and compressed in a compressor 61. They are then passed to condenser 63 through conduit 62 and cooled to condense another portion of the remaining steam. The water thus formed is separated in separator 65 as a lower liquid phase, withdrawn through conduit 66 and returned to primary separator 55 through pump 69 and conduit 67. Uncondensed vapors from separator 65 are withdrawn through conduit 68, compressed in compressor 70 and passed via conduit 71 to condenser 72 and then to separator 75. Compressors 61 and 70 are driven by a common motor 64. Water formed as a lower liquid phase by the condensation of steam in condenser 72 is withdrawn from separator 75 through conduit 67 and returned to primary separator 55 by means of pump 73. From separator 75 vapors are withdrawn through conduit 76 and passed to product recovery equipment (not shown) for the recovery of ethylene.

Hydrocarbon liquid which is condensed in condenser 53 forms an upper liquid phase and is withdrawn from primary separator drum 55 through conduit 80 and passed via pump 81 to conduit 62 where it is combined with the compressed vapor prior to cooling in condenser 63. Similarly, hydrocarbon liquid from separator 65 forms an upper liquid phase and is withdrawn through conduit 82 and passed via pump 83 to conduit 71 where it is combined with the compressed vapor prior to cooling in condenser 72. Hydrocarbon liquid from separator drum 75 forms an upper liquid phase and is withdrawn by means of conduit 84 and pump 85 and sent to product recovery equipment (not shown) for the recovery of hydrocarbon products by conventional techniques.

I have illustrated my invention in connection with a process which results in both liquid and gaseous product. My invention can be used equally well in connection with a process in which hydrocarbon liquid product would appear only under the higher pressures present in the later stages of separation or one in which hydrocarbon liquid product would not appear at all. In such cases suitable changes can be made in the process equipment without departing from the scope of this invention. The fractionator, for instance, might be eliminated or replaced by a gas scrubber and some or all of the lines and pumps for handling hydrocarbon liquid might be eliminated.

I have described my invention as used with separators operated at three different pressure levels. Any number of separators can be used, of course, providing there are at least two operating at different pressure levels, the second or last being at a higher pressure level than the first.

The following specific example illustrates a practical application of my invention using the process described and shown in the drawing.

6

EXAMPLE

A 52.2° A. P. I. naphtha feed is treated at the rate of 3,430 BPSD according to the process illustrated in the drawing described above. The overhead fraction from the rectifier is treated in accordance with my invention under conditions shown in Table I. In this example about 5,000,000 B. t. u./hr. of cooling duty is saved by the use of a preliminary separator at the dew point of the hydrocarbon product instead of cooling all the steam to the temperature of the primary separator.

Table I

	Temp., ° F.	Press., p. s. i. g.	Water, #/Hr.	Steam, #/Hr.	HC Vap., #/Hr.	HC Liq., #/Hr.
Overhead from rectifier	240	7.6	-----	84,730	130,389	-----
Preliminary separator drum	163	4.5	77,430	7,300	35,976	94,413
Primary separator drum	100	3.5	7,180	1,040	28,978	6,998
Second separator drum	100	41	712	328	26,242	0,734
Third separator drum	106	168	208	120	24,026	11,950

We claim:

1. The process for the removal of water from a mixture of steam and a hydrocarbon vapor which comprises cooling said mixture to below the dew point of the steam thereby condensing a portion of said steam, separating at a relatively low pressure water from hydrocarbons in a first separation zone, withdrawing uncondensed vapors from said first separation zone, compressing uncondensed vapors from said first separation zone, cooling said compressed vapors from said first separation zone whereby additional steam is condensed and separating water thus formed in a second separation zone maintained at a relatively higher pressure than said first separation zone, passing water from said second separation zone to said first separation zone and withdrawing water from said first separation zone.

2. The process for the removal of water from a mixture of steam and a hydrocarbon vapor which comprises cooling said mixture to below the dew point of the steam thereby condensing a portion of said steam, separating at a relatively low pressure water from hydrocarbons in a first separation zone, withdrawing uncondensed vapors from said first separation zone, cooling said vapors from said first separation zone whereby additional steam is condensed and separating water thus formed in a second separation zone maintained at substantially the same pressure as said first separation zone, compressing uncondensed vapors from said second separation zone, cooling said compressed vapors whereby additional steam is condensed and separating water thus formed in a subsequent separation zone maintained at a relatively higher pressure than said second separation zone, passing water from said subsequent separation zone to said second separation zone, removing water from said second separation zone, removing water from said first separation zone and recovering hydrocarbon product from said subsequent separation zone.

3. A process for the removal of water from a mixture of steam and hydrocarbon vapors which comprise passing said mixture to a first separation step, maintained at a relatively low pressure level, in said first separation step cooling said mixture to form a water rich phase, a liquid hydrocarbon rich phase and an uncondensed vapor phase containing steam and hydrocarbon, passing said uncondensed vapor phase from said first separation step to a subsequent separation step maintained at a substantially higher pressure level than said first separation step, passing said liquid hydrocarbon phase from said first separation step to said subsequent separation step, in said subsequent step cooling said vapor phase from said first separation

step to form a water rich phase, a liquid hydrocarbon rich phase and an uncondensed hydrocarbon phase, passing said water rich phase from said subsequent separation step to said first separation step whereby hydrocarbons admixed therein are flashed off as the result of decrease in pressure, withdrawing water from said first separation step, and recovering said uncondensed hydrocarbon phase and said liquid hydrocarbon phase from said subsequent step as products of the process.

4. In a process for the pyrolysis of a hydrocarbon in the presence of steam to produce ethylene admixed with steam and higher boiling hydrocarbons in the form of a vaporous product stream, the method for making an efficient separation of hydrocarbon and water which comprises passing said product stream containing ethylene, steam and higher boiling hydrocarbons to a rectification zone, in said rectification zone cooling and separating a liquid higher boiling hydrocarbon phase and a low boiling vapor phase containing steam, ethylene and other hydrocarbons, withdrawing said liquid high boiling hydrocarbon phase from said rectification zone, passing said low boiling vapor phase from said rectification zone to a first separation step maintained at a relatively low pressure level, in said first separation step cooling said vapor phase to form a water rich phase, a liquid hydrocarbon rich phase and an uncondensed vapor phase containing steam and hydrocarbon, passing said uncondensed vapor phase from said first separation step to a subsequent separation step maintained at a substantially higher pressure level than said first separation step, passing said liquid hydrocarbon phase from said first separation step to said second separation step, in said subsequent separation step cooling said vapor phase from said first separation step to form a water rich phase, a liquid hydrocarbon rich phase and an uncondensed hydrocarbon phase, containing ethylene, passing said water rich phase from said second separation step to said first separation step whereby hydrocarbons admixed therein are flashed off as the result of decrease in pressure, withdrawing water from said first separation step, and recovering said uncondensed hydrocarbon phase containing ethylene and said liquid hydrocarbon phase from said subsequent separation step as products of the process.

5. In a process for the pyrolysis of a hydrocarbon in the presence of steam to produce ethylene admixed with steam and higher boiling hydrocarbons in the form of a vaporous product stream, the method for making an efficient separation of hydrocarbon and water which comprises passing said product stream containing ethylene, steam and higher boiling hydrocarbons to a rectification zone, in said rectification zone cooling and separating a liquid higher boiling hydrocarbon phase and a low boiling vapor phase containing steam, ethylene and other hydrocarbons, withdrawing said liquid high boiling hydrocarbon phase from said rectification zone, passing said low boiling vapor phase from said rectification zone to a first separation step maintained at a relatively low pressure level, in said first separation step cooling said vapor phase to form a water rich phase, a liquid hydrocarbon rich phase and an uncondensed vapor phase containing steam and hydrocarbon, passing said uncondensed vapor phase from said first separation step to a second separation step maintained at substantially the same pressure level as said first separation step, passing said liquid hydrocarbon phase from said first separation step to said rectification zone, in said second separation step cooling said vapor phase from said first separation step to form a water rich phase, a liquid hydrocarbon rich phase and an uncondensed hydrocarbon phase containing ethylene, passing said uncondensed vapor phase from said second separation step to a subsequent separation step maintained at a substantially higher pressure level than said second separation step, passing said liquid hydrocarbon phase from said second separation step to said subsequent separation step,

in said subsequent separation step cooling said vapor phase from said second separation step to form a water rich phase, a liquid hydrocarbon rich phase and an uncondensed hydrocarbon vapor phase containing ethylene, passing said water rich phase from said subsequent step to said second separation step whereby hydrocarbons admixed therein are flashed off as the result of decrease in pressure, withdrawing water from said first separation step withdrawing water from said second separation step, and recovering said uncondensed hydrocarbon phase containing ethylene and said liquid hydrocarbon phase from said subsequent separation step as products of the process.

6. In a process for the pyrolysis of naphtha in the presence of steam to produce ethylene admixed with steam and higher boiling hydrocarbons in the form of a vaporous product stream, the method for making an efficient separation of hydrocarbon and water which comprises passing said product stream containing ethylene, steam and higher boiling hydrocarbons to a rectification zone, in said rectification zone cooling and separating a liquid higher boiling hydrocarbon phase and a low boiling vapor phase containing steam, ethylene and other hydrocarbons, withdrawing said liquid high boiling hydrocarbon phase from said rectification zone, passing said low boiling hydrocarbon vapor phase at a temperature of about 240° F. and a pressure of about 7.6 p. s. i. g., from said rectification zone to a first separation step, maintained at a pressure of about 3.5 p. s. i. g., in said first separation step cooling said vapor phase to a temperature of about 100° F., to form a water rich phase, a liquid hydrocarbon rich phase and an uncondensed vapor phase containing steam and hydrocarbon, passing said uncondensed vapor phase from said first separation step to a subsequent separation step maintained at a pressure of about 41 p. s. i. g., passing said liquid hydrocarbon phase from said first separation step to said subsequent separation step, in said subsequent separation step cooling said vapor phase from said first separation step to a temperature of about 100° F. to form a water rich phase, a liquid hydrocarbon rich phase and an uncondensed hydrocarbon phase containing ethylene, passing said water rich phase from said subsequent separation step to said first separation step whereby hydrocarbons admixed therein are flashed off as the result of decrease in pressure, withdrawing water from said first separation step, and recovering said uncondensed hydrocarbon phase containing ethylene and said liquid hydrocarbon phase from said subsequent separation step as products of the process.

7. In a process for the pyrolysis of a hydrocarbon in the presence of steam to produce ethylene admixed with steam and higher boiling hydrocarbons in the form of a vaporous product stream, the method for making an efficient separation of hydrocarbon and water which comprises passing said product stream containing ethylene, steam and higher boiling hydrocarbons to a rectification zone, in said rectification zone cooling and separating a liquid higher boiling hydrocarbon phase and a low boiling vapor phase containing steam, ethylene and other hydrocarbons, withdrawing said liquid high boiling hydrocarbon phase from said rectification zone, passing said low boiling vapor phase at a temperature of about 240° F. and a pressure of about 7.6 p. s. i. g. from said rectification zone to a first separation step maintained at a pressure of about 4.5 p. s. i. g., in said first separation step cooling said vapor phase to a temperature of about 163° F. to form a water rich phase, a liquid hydrocarbon rich phase and an uncondensed vapor phase containing steam and hydrocarbon, passing said uncondensed vapor phase from said first separation step to a second separation step maintained at a pressure of about 3.5 p. s. i. g., passing said liquid hydrocarbon phase from said first separation step to said second separation step, in said second separation step cooling said vapor phase from said first separation step to a temperature of about 100° F. to form a

9

water rich phase, a liquid hydrocarbon rich phase and an uncondensed hydrocarbon phase containing ethylene, passing said uncondensed vapor phase from said second separation step to a subsequent separation step maintained at a pressure of about 41 p. s. i. g., passing said liquid hydrocarbon phase from said second separation step to said subsequent separation step, cooling said vapor phase from said second separation step to a temperature of about 100° F., to form a water rich phase, a liquid hydrocarbon rich phase and an uncondensed hydrocarbon vapor phase containing ethylene, passing said water

10

rich phase from said subsequent separation step to said second separation step whereby hydrocarbons admixed therein are flashed off as the result of decrease in pressure, withdrawing water from said first separation step, withdrawing water from said second separation step, and recovering said uncondensed hydrocarbon phase containing ethylene and said liquid hydrocarbon phase from said subsequent separation step as products of the process.

No references cited.