

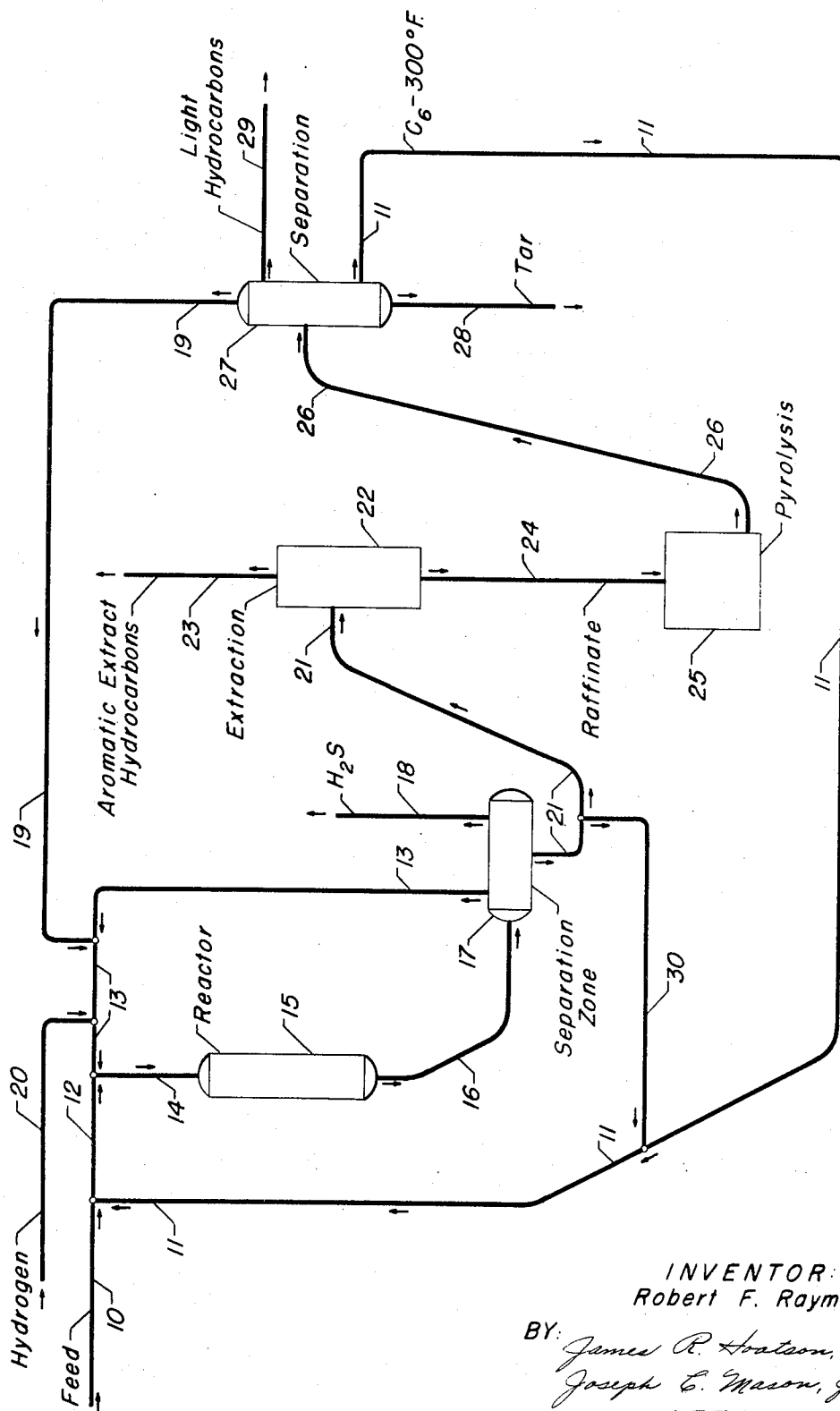
Oct. 14, 1969

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3,472,909

PROCESS FOR PRODUCING OLEFINIC HYDROCARBONS

Filed Feb. 27, 1967



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3,472,909

PROCESS FOR PRODUCING OLEFINIC
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Filed Feb. 27, 1967, Ser. No. 618,815

Int. Cl. C07c 11/04, 3/30

U.S. Cl. 260—683

7 Claims

ABSTRACT OF THE DISCLOSURE

Process for producing olefins such as ethylene by a series of processing steps including using a portion of the feed (naphtha) to dilute the pyrolysis gasoline which is to be charged to the hydrogenation unit, and charging only the non-aromatic portion of the feed to the pyrolysis unit. The effluent from the hydrogenation unit is extracted with a solvent selective for aromatic hydrocarbons in order to produce a paraffinic charge stock for the pyrolysis unit.

BACKGROUND OF THE INVENTION

This invention relates to a process for producing olefinic hydrocarbons. It particularly relates to a process for producing ethylene by the steam-pyrolysis of a paraffinic hydrocarbon.

It is known in the art that one of the commercially attractive routes to the production of valuable normally gaseous olefinic hydrocarbons is the thermal cracking or pyrolysis of hydrocarbons, such as the light paraffin hydrocarbons and/or light or heavy naphtha fractions. Usually the pyrolysis reaction is effected in the substantial absence of a catalyst at high temperatures, often in the presence of a diluent, such as superheated steam, utilizing a tubular reactor or a plurality of cracking furnace coils. Depending upon the charge stock and specific operating conditions employed in the reaction, the pyrolysis zone effluent may comprise light olefinic hydrocarbons such as ethylene, propylene, butylene, etc. or mixtures thereof, all of which may constitute the principal product or products. However, as used in the description of the present invention hereinbelow, the term "ethylene" will be used to embody any or all of these as principal products.

Conventional prior art schemes usually charge a straight-run naphtha fraction containing, say, 5% aromatic hydrocarbons to a pyrolysis unit. The pyrolysis effluent is separated into desired fractions; one fraction of which usually comprises a C₅-400° F. pyrolysis gasoline which represents, for example, approximately 20% to 30% by weight of the original naphtha feed. The pyrolysis gasoline is then hydrotreated for at least partial saturation of olefin and/or diolefin compounds (herein discussed, for convenience, as "olefin" saturation) and for removal of sulfur compounds. The prior art schemes also frequently charge the hydrotreated gasoline fraction to an aromatic extraction unit for recovery of the aromatic hydrocarbons such as benzene, toluene, and xylene therefrom.

However, as is known by those skilled in the art, the diene content of the pyrolysis gasoline, as measured by its Diene Value (a standard, well-known test procedure), is usually within the range of from 20 to 70 for C₅-400° F. gasolines. The diolefin compounds pose particular difficulty in the operation of the hydrotreating facilities since these compounds cause extensive equipment fouling and catalyst bed fouling. So far as is known, the prior art hydrotreating processes all experience this fouling from polymer formation to some extent. Usually,

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the prior art will attempt to improve the on-stream efficiency of the hydrotreating unit by either promoting the polymerization reaction prior to the hydrotreating step thereby preventing the polymer from reaching downstream equipment and/or by the judicious selection of catalyst, operating conditions, and flow schemes so as to minimize the chance of polymer formation. Neither of these prior art approaches are successful in overcoming the fouling difficulty resulting from the diolefin compounds present in the pyrolysis gasoline.

SUMMARY OF THE INVENTION

Therefore, it is an object of this invention to provide a process for producing normally gaseous olefinic hydrocarbons.

It is another object of this invention to provide a process for producing ethylene in a manner which substantially overcomes the fouling problem during the hydrotreating operation.

It is a specific object of this invention to provide a process for producing ethylene in a facile and economical manner by the pyrolysis of a substantially paraffinic raffinate obtained from a solvent extraction operation.

Thus, in accordance with the practice of this invention there is provided a process for producing normally gaseous olefinic hydrocarbons which comprises commingling a normally liquid hydrocarbon feedstock with a hereinafter specified pyrolysis gasoline stream in an amount sufficient to produce a combined feed stream having a Diene Value of less than 10; passing the combined feed stream into a hydrogenation zone maintained under hydrogenating conditions sufficient to at least partially saturate olefin hydrocarbons and to at least partially convert sulfur compounds to hydrogen sulfide; separating the effluent from the hydrogenating zone into an aromatic hydrocarbon-rich fraction and a nonaromatic hydrocarbon-rich fraction; subjecting at least a portion of the non-aromatic hydrocarbon-rich fraction to pyrolysis in a conversion zone maintained under conditions sufficient to produce a fraction containing normally gaseous olefinic hydrocarbons and a stream containing pyrolysis gasoline having a Diene Value of more than 10; returning the pyrolysis gasoline to the hydrogenation zone commingled with said feedstock as specified; and recovering normally gaseous olefinic hydrocarbons in high concentration.

Another embodiment of the present invention is the broad process hereinabove wherein said normally gaseous olefinic hydrocarbons comprise ethylene.

The production of normally gaseous olefinic hydrocarbons to which this invention is distinctly applicable is by methods well-known to those skilled in the art. Thus, the pyrolysis reaction, per se, forms no part of the present invention except in an interdependent and interrelated manner as shown by the broad embodiments described herein. Thus, a typical pyrolysis operation usually involves the simultaneous cracking, in separate parallel cracking zones, of a normally gaseous paraffinic charge stock and a naphtha charge stock. The effluents from the two cracking or pyrolysis zones are combined and then charged to a prefractionation zone to effect a rough separation between light and heavy ends, and the prefractionator overhead material containing the pyrolysis products is passed through a fractionation train from which the several valuable olefinic products are recovered. The fractionation train separates the gaseous products from the pyrolysis zone into light hydrocarbons including methane, ethane, ethylene, acetylene, propane, propylene, butane, C₄ olefins, and, preferably, also the pentanes. As will become more evident from the discussion presented herein it is particularly advantageous in the practice of this invention that the pentanes be sep-

arated from the pyrolysis gasoline which is charged to the hydrotreating zone.

Prior to product recovery the prefractionator overhead gas is compressed to sub-atmospheric pressure and charged as feed to a first distillation zone, the overhead from which is rich in C_3 and lighter hydrocarbons and the bottoms product is rich in C_4 and heavier hydrocarbons. The feed composition is often such that the first distillation zone, or more commonly known as a depropanizer, must be operated with refrigerated reflux to provide a commercially satisfactory operation. The C_3 fraction is then separated in a series of low temperature fractionating columns while the C_4+ fraction is separated also in a series of fractionating columns. As is well-known to those skilled in the art, water vapor must be removed from these pyrolysis gases such that hydrate formation can be avoided at the low temperature operations required for the recovery of the normally gaseous olefinic hydrocarbons such as ethylene and propylene. Removal of water from such a gas stream is conventionally accomplished by passing the stream through a fixed bed of solid dessicant such as activated alumina, activated charcoal, silica gel, and the like. In short, the separation of the gaseous hydrocarbons from the pyrolysis effluent into valuable and/or desired components is by conventional means known to those skilled in the art and need not be presented in any more detail herein. As previously mentioned, for convenience sake, the term "ethylene" is used to embody the production of any or all of the normally gaseous olefinic hydrocarbons.

The prior art schemes of pyrolysis have used a variety of feedstocks for the conversion thereof into light hydrocarbons such as ethylene. It is known that ethane and propane are distinctly preferred hydrocarbons for this reaction; although, there is no technical reason why naphtha fractions, kerosene fractions boiling up to 550°F. and even gas oil fraction boiling up to 800°F. cannot be satisfactorily pyrolyzed into more valuable light hydrocarbon components. However, in the practice of this invention it is a requirement that at least a significant portion of the feedstock to the pyrolysis zone be composed of a substantially paraffinic hydrocarbon liquid fraction which has been separated from the effluent of a hydrotreating reaction zone. Thus, the present invention broadly embodies the use of any of the known feedstocks to the pyrolysis reaction as long as a substantially paraffinic liquid fraction is also charged to the pyrolysis zone.

In the separation of the pyrolysis zone effluent into its various desired fractions there is obtained a pyrolysis gasoline stream which, by its very nature, is unsatisfactory for most commercial uses without further treating. Its olefinic and diolefinic content makes it undesirable as a motor fuel component. Therefore, the pyrolysis gasoline is charged to a hydrogenation zone for saturation of the olefin and diolefin materials present therein. As will become more evident from the discussion presented hereinbelow, it has now been discovered that improvements in the hydrogenation reaction can be obtained if the C_5 portion of the pyrolysis gasoline is removed prior to the hydrogenation zone. Therefore, in the preferred practice of this invention the pyrolysis gasoline will be a fraction boiling within the range from C_6 - 300°F. ; although, material boiling above and below this range may, in some cases, be included in the operation with satisfactory results.

The hydrogenation reaction is accomplished by means generally known to those skilled in the art. Any suitable granular solid hydrogenation catalyst can be employed in the process such as, for example, cobalt, molybdenum, platinum, palladium, iron, nickel, oxides, or sulfides of such metals, mixtures of such metals, etc. Conventional supports for the catalyst can also be employed such as, for example, silica gel, alumina, bauxite, activated clay, activated carbon, etc. It is preferred that the catalyst be

a mixture of cobalt and molybdenum supported on an alumina base.

The operating conditions for the hydrogenation reaction may be varied over a relatively wide range. However, since it is desirable to not only saturate the olefin and diolefin compounds but also to remove the sulfur compounds, it is distinctly preferred that the hydrogenation reaction be accomplished in two catalytic stages, although other process schemes known to those in the art may be used with satisfactory results. For example, the operating conditions for a first stage include an inlet temperature from 350°F. to 450°F. , a pressure from 700 p.s.i.g. to 1000 p.s.i.g., and a liquid hourly space velocity (LHSV) of from 2 to 5 volumes of oil per hour per volume of catalyst. Typically, the space velocity will be about 3 LHSV based on combined feed. The amount of hydrogen present in the reaction zone of the first stage will be from 400 to 1,000 standard cubic feet per barrel of oil, with a typical amount being about 500 standard cubic feet per barrel. The above conditions are chosen so that the olefin and diolefin compounds are saturated to the desired extent without significant saturation of aromatic hydrocarbons present and without significant cracking of paraffinic hydrocarbons present.

The second stage of the preferred hydrogenation reaction scheme is designed primarily to convert sulfur compounds present in the effluent of the first stage into hydrogen sulfide. These conditions include a temperature within the range from about 650°F. to 780°F. , a pressure of from 750 p.s.i.g. to 950 p.s.i.g., and an LHSV substantially the same as that for the first stage operation. The amount of hydrogen present in the second stage should be within the range from 1,000 to 2,000 s.c.f./b., with a typical amount being about 1,500 s.c.f./b.

The last major step involved in the inventive process is the separation of the hydrogenation zone effluent into an aromatic extract fraction and a non-aromatic raffinate fraction. Usually this is accomplished by solvent extraction means using a solvent which is selective for the aromatic hydrocarbons. Of course, other means known to those skilled in the art, such as adsorption using, for example, silica gel, can also be used to perform this separation operation. However, in the practice of this invention it is preferred to use solvent extraction for the separation of aromatic hydrocarbons from non-aromatic hydrocarbons.

The solvent extraction means are generally well-known to those skilled in the art. In such a step a solvent selective for aromatic hydrocarbons is contacted with hydrocarbon feed mixture containing both aromatic and non-aromatic hydrocarbons in a suitable contactor for effectuating intimate contact between the hydrocarbon phases and the selective solvent. A raffinate stream composed primarily of paraffinic hydrocarbons is removed from one end of the extractor together with a small quantity of aromatic hydrocarbons. However, for convenience, this raffinate stream is termed a "non-aromatic hydrocarbon" fraction. In similar fashion, the extract removed from the contactor contains a major proportion of the solvent having the aromatic hydrocarbons dissolved therein. The raffinate phase is then washed with a suitable second solvent, such as water, to remove the primary solvent for recovery and recycle to the process. The raffinate phase contaminated with a small amount of aromatic hydrocarbons and contaminated with an extremely minor amount of solvent leaves the extraction step for further handling in accordance with the practice of this invention. The extract or aromatic hydrocarbon containing phase is processed through a series of distillation columns wherein the solvent is removed from the aromatic hydrocarbons for recycle and reuse in the extraction step with the aromatic hydrocarbons, such as benzene, xylene, and toluene, being recovered as distillate fractions in very high purity and high yield.

It is to be noted from the embodiments of the invention presented hereinabove that the solvent which is used in the solvent extraction step is conventional as well as being selective for aromatic hydrocarbons. Representatives of satisfactory aromatic-selective solvents include the sulfolane-type solvent which possesses a five-membered ring containing 1 atom of sulfur and 4 atoms of carbon with 2 oxygen atoms bonded to the sulfur atom of the ring. Included in this class of selective solvents is 2-methyl sulfolane, 2,4-dimethyl sulfolane; other satisfactory solvents include methyl-2-sulfolene ether, various polyethylene glycols, dipropylene glycols, various polypropylene glycols, dimethyl sulfide, etc. The art of solvent extraction, as previously mentioned, is well-known to those skilled in the art and need not be further discussed herein.

The conversion process or pyrolysis reaction for the conversion of hydrocarbons into normally gaseous olefinic hydrocarbons is operated conventionally utilizing (in the practice of this invention) the raffinate stream obtained from the solvent extraction step as the feed to the pyrolysis reaction zone. The operating conditions for effectuating this reaction include a temperature from 1000° F. to 700° F., preferably, 1350° F. to 1550° F.; a pressure from 0 to 20 p.s.i.g., preferably, 5 to 10 p.s.i.g.; and a residence time in the reaction zone of from 0.5 to 25 seconds, preferably, from 3 to 10 seconds. As used herein, the term "residence time" is obtained from the arithmetic average of the inlet velocity and outlet velocity from the portion of reaction zone in question. Typically, the residence time for a commercially successful operation will be about 4 seconds. In order for the pyrolysis reaction to proceed smoothly without undue plugging of the reaction tubes, an inert diluent such as steam, methane, etc. is used in admixture with the feed. For convenience, it is distinctly preferable to use superheated steam as the diluent. Generally, steam will be added to the reaction zone in an amount from 0.2 to 1 pound of steam per pound of hydrocarbon, preferably, from 0.3 to 0.7 pound per pound, and, typically, about 0.5 pound per pound. Those skilled in the art will know how to choose the proper operating conditions for the production of the predetermined desired light hydrocarbon fraction.

The invention may be more fully understood with reference to the appended drawing which is a schematic representation of apparatus which may be utilized in practicing one embodiment of the invention.

DESCRIPTION OF THE DRAWING

Referring now to the drawing, a normally liquid hydrocarbon feedstock, such as a naphtha boiling within the range from about 100° F. to about 400° F., enters the process via line 10. A pyrolysis gasoline returning from the separation zone of the pyrolysis reaction step via line 11 is commingled with the feedstock in line 12 to produce a combined feed having a Diene Value of less than 10, preferably, less than 5. Sufficient hydrogen from line 13 is admixed with the combined feed from line 12 and the mixture of oil and hydrogen is passed via line 14 into reactor 15.

Reactor 15 is composed of two stages containing, typically, a catalyst comprising 2.2% cobalt and 5.7% molybdenum calculated as the metal disposed on alumina in each stage. The material in line 14 passes into reactor 15 at a temperature of about 400° F. and passes over the catalyst in the first stage at an LHSV of about 3. The pressure in the first stage is usually in excess of 800 pounds and is dependent upon the pressure maintained in the hereinafter described second stage. The effluent from the first stage is passed directly into the second stage hydrogenation zone, the details of which are not shown, at a temperature of about 730° F. with the pressure in the second stage reaction zone being maintained at about 800 p.s.i.g. The space velocity over the catalyst is substantially 3. Sufficient hydrogen is added to the second

stage, by means not shown, so that approximately 1,500 s.c.f./b. of hydrogen is present in the second stage reaction zone. The combined operating conditions of the first stage and the second stage are such that the diolefins and olefins are substantially saturated and sulfur compounds present therein are substantially converted into hydrogen sulfide. Other operating conditions known to those skilled in the art may be chosen so that olefin and diolefin saturation and sulfur conversion may be accomplished in a single stage or a plurality of stages (more than 2).

The total effluent from reactor 15 is removed via line 16 and passed into separation zone 17 which is maintained at a considerably lower temperature (e.g., 100° F.) than is present in reactor 15. Separator 17 also is maintained under sufficient conditions and includes sufficient means for the separation from the effluent of hydrogen sulfide which is removed via line 18 and relatively pure hydrogen gas which is removed via line 13 and recycled in admixture with the incoming combined feed as hereinabove specified. Since the hydrogenation reaction consumes hydrogen, additional hydrogen is added, as needed, to the process via line 20. The normally liquid hydrocarbon effluent which is now substantially desulfurized and olefin-free is removed from separation zone 17 via line 21 and passed into solvent extraction zone 22. Sufficient operating conditions are maintained in extraction zone 22 for the separation of the material from line 21 into an aromatic hydrocarbon-rich stream which is removed via line 23 and a non-aromatic hydrocarbon-rich stream which is removed via line 24. It is to be noted at this point that the material in line 24, commonly called a raffinate stream, is composed primarily of paraffinic hydrocarbons and is, by consequence, substantially olefinic-hydrocarbon free. As mentioned previously, this material may contain a small amount of aromatic hydrocarbons.

This raffinate stream is passed via line 24 into pyrolysis reaction zone 25 in admixture with sufficient superheated steam, from means not shown, for effectuating the pyrolysis reaction. The aromatic hydrocarbons which are present in the raffinate stream pass through the pyrolysis zone substantially unchanged; however, it is recognized that if alkylbenzene hydrocarbons are present in line 24 these may be substantially dealkylated by the pyrolysis reaction. The paraffinic hydrocarbons present in the raffinate stream are substantially converted into gaseous products including, for example, hydrogen, carbon monoxide, carbon dioxide, methane, ethane, ethylene, acetylene, propane, propylene, butane, C₄ olefins; and other products such as the pentanes, and C₆+ material. The entire pyrolysis reaction zone effluent containing, typically, the above-enumerated components is passed via line 26 into separation zone 27.

Separation zone 27 contains sufficient equipment and apparatus for the separation of the pyrolysis zone effluent into desired fractions, as previously discussed. For example, the hydrogen produced in the reaction is recovered in relatively high purity and returned via line 19 to hydrogenation zone 15 via lines 13 and 14. A light hydrocarbon fraction is removed via line 29 and passed into sufficient separation facilities, such as discussed generally hereinabove, for the recovery therefrom of normally gaseous olefinic hydrocarbons including ethylene and propylene. The C₅ fraction is also included in the light hydrocarbon fraction removed via line 29. In the practice of this invention it is preferred that the pyrolysis gasoline be composed of material boiling within the range from C₈ to 300° F.; although material boiling above 300° F. such as, for example, up to 400° F. may be included in a proper situation without unduly complicating the reaction of the hydrogenation section. In any event, the C₈ to 300° F. pyrolysis gasoline fraction is removed from separation zone 27 via line 11 and passed into admixture with the incoming feedstock via line 10 as previously discussed hereinabove. It is to be noted that the amount

of material coming into the system via line 10 is sufficient to reduce the material in line 12 to a Diene Value of less than 10. As previously mentioned, the pyrolysis gasoline in line 11 may have a Diene Value from 20 to 70; and the particular C₆ to 300° F. cut may have a Diene Value in excess of 10, typically between 10 and 60. Accordingly, sufficient naphtha must be added to reduce the Diene Value to less than 10, preferably, about less than 5. If desired, additional naphtha or other suitable feedstocks may be charged (by means not shown) directly into pyrolysis zone 25 for conversion into the desired products as discussed.

The reject material, such as the hydrocarbons boiling in excess of 300° F., are removed from separation zone 27 via line 28 and utilized as fuel or by other means known to those skilled in the art.

Additionally, it may be desirable to recycle a portion of the hydrogenated material back to the reaction zone. In such case, a portion of the material in line 21 is diverted via line 30 into line 11 for recycle to reactor 15. The purpose of the recycle stream in line 30 may be to increase the degree of saturation of the olefin and diolefin compounds and/or increase the degree to which sulfur compounds are converted to hydrogen sulfide. On the other hand, the amount of material recycled via line 30 may be used to control the Diene Value of the material in line 12 for those situations where sufficient fresh feed is not available for dilution processes.

PREFERRED EMBODIMENT

Thus, it can be seen from the description presented hereinabove that the preferred embodiment of the invention provides a process for producing ethylene which comprises the steps of: (a) introducing naphtha into a hereinafter specified gasoline stream in an amount sufficient to produce a combined feed stream having a Diene Value of less than 10; (b) passing the combined feed stream into a first hydrogenation zone under conditions including the presence of hydrogen sufficient to at least partially saturate olefin hydrocarbons; (c) introducing at least a portion of the normally liquid effluent from said first zone into a second hydrogenation zone under conditions sufficient to convert sulfur compounds to hydrogen sulfide; (d) separating the desulfurized hydrocarbons into an aromatic hydrocarbon fraction and a non-aromatic hydrocarbon fraction; (e) subjecting at least a portion of the non-aromatic hydrocarbon fraction to pyrolysis in the presence of steam under conditions including a temperature from 1000° F. to 1700° F., a pressure from 0 to 20 p.s.i.g., and a residence time from 0.5 second to 25 seconds sufficient to convert at least a portion of said non-aromatic hydrocarbon fraction to ethylene; (f) separating the effluent from the pyrolysis reaction into an ethylene-containing fraction and a gasoline stream having a Diene Value from 20 to 70; (g) returning said gasoline stream to step (a) in admixture with said naphtha, and (h) recovering ethylene in high concentration.

A distinctly preferred embodiment of the invention includes the embodiment hereinabove wherein said naphtha boils within the range from about 100° F. to 400° F. and said gasoline stream of step (f) boils within the range of C₆ to 300° F.

It is to be noted that one of the features of the present invention is that the troublesome pyrolysis gasoline fraction is, in effect, recycled to extinction. In other words, the only products from the practice of this invention are desired light hydrocarbons, aromatic hydrocarbons, and a necessary reject stream of heavy boiling tars. In addition, it has been found that the practice of this invention permits for considerably longer on-stream periods for the hydrogenation units than has heretofore been realized by the prior art. Still further, increased yield of valuable aromatic hydrocarbons are obtained from the integrated process of the invention.

Thus, in a process for producing ethylene by the steam pyrolysis of naphtha wherein the pyrolysis gasoline product is hydrotreated for olefin saturation and desulfurized the present invention provides the improvement which comprises reducing the diene value of the pyrolysis gasoline to a predetermined value by admixture of said gasoline with said naphtha, hydrogenating the admixture, solvent extracting the hydrogenated hydrocarbons to produce a paraffinic hydrocarbon concentrate, and pyrolyzing said concentrate in the presence of steam to produce ethylene.

The invention claimed:

1. Process for producing normally gaseous olefinic hydrocarbons which comprises commingling a normally liquid hydrocarbon feedstock with a hereinafter specified pyrolysis gasoline stream in an amount sufficient to produce a combined feed stream having a Diene Value of less than 10; passing the combined feed stream into a hydrogenation zone maintained under hydrogenating conditions sufficient to at least partially saturate olefinic hydrocarbons and to at least partially convert sulfur compounds to hydrogen sulfide; separating the effluent from the hydrogenating zone into an aromatic hydrocarbon-rich fraction and a non-aromatic hydrocarbon-rich fraction; subjecting at least a portion of the non-aromatic hydrocarbon-rich fraction to pyrolysis in a conversion zone maintained under conditions sufficient to produce a fraction containing normally gaseous olefinic hydrocarbons and a stream containing pyrolysis gasoline having a diene value of more than 10; returning the pyrolysis gasoline to the hydrogenation zone commingled with said feedstock as specified; and, recovering normally gaseous olefinic hydrocarbons in high concentration.

2. Process according to claim 1 wherein said normally gaseous olefinic hydrocarbon comprises ethylene.

3. Process according to claim 2 wherein said feedstock comprises a naphtha fraction boiling within the range from about 100° F. to 400° F.

4. Process for producing ethylene which comprises the steps of:

(a) introducing naphtha into a hereinafter specified gasoline stream in an amount sufficient to produce a combined feed stream having a diene value of less than 10;

(b) passing the combined feed stream into a first hydrogenation zone under conditions including the presence of hydrogen sufficient to at least partially saturate olefin hydrocarbons;

(c) introducing at least a portion of the normally liquid effluent from said first zone into a second hydrogenation zone under conditions sufficient to convert sulfur compounds to hydrogen sulfide;

(d) separating the desulfurized hydrocarbons into an aromatic hydrocarbon fraction and a non-aromatic hydrocarbon fraction;

(e) subjecting at least a portion of the non-aromatic hydrocarbon fraction to pyrolysis in the presence of steam under conditions including a temperature from 1000° F. to 1700° F., a pressure from 0 to 20 p.s.i.g. and a residence time from 0.5 second to 25 seconds sufficient to convert at least a portion of said non-aromatic hydrocarbon fraction to ethylene;

(f) separating the effluent from the pyrolysis reaction into an ethylene-containing fraction and a gasoline stream having a diene value from 20 to 70;

(g) returning said gasoline stream to step (a) in admixture with said naphtha; and,

(h) recovering ethylene in high concentration.

5. Process according to claim 4 wherein said naphtha boils within the range from about 100° F. to 400° F. and said gasoline stream of step (f) boils within the range from C₆ to 300° F.

6. Process according to claim 4 wherein said separating of step (d) comprises solvent extraction using a solvent selective for aromatic hydrocarbons, said solvent comprising sulfolane.

7. In a process for producing ethylene by the steam pyrolysis of naphtha wherein the pyrolysis gasoline product is hydrotreated for olefin saturation and desulfurization, the improvement which comprised reducing the Diene Value of the pyrolysis gasoline to a predetermined value by admixture of said gasoline with said naphtha, hydrogenating the admixture, solvent extracting the hydrogenated hydrocarbons to produce a paraffinic hydrocarbon concentrate, and pyrolyzing said concentrate in the presence of steam to produce ethylene.

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U.S. Cl. X.R.

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