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[54] **COMBINATION OCTANE NUMBER CONTROL OF DISTILLATION COLUMN OVERHEAD AND BLENDING CONTROL**

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[*] Notice: The portion of the term of this patent subsequent to Mar. 7, 1989, has been disclaimed.

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 868,459, Oct. 22, 1969, Pat. No. 3,647,635.

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[51] **Int. Cl.** **B01d 3/42**

[58] **Field of Search** .... 196/132, 100; 203/1, 203/2, 3, DIG. 18; 202/160; 208/DIG. 1, 358

[56] **References Cited**

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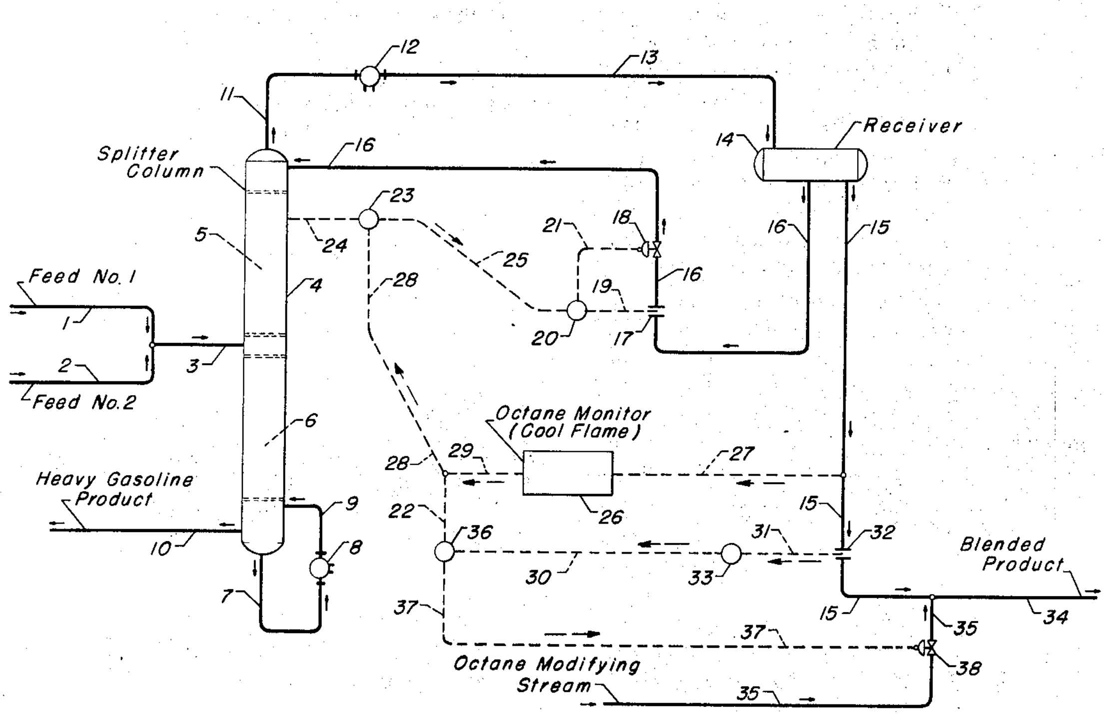
[57] **ABSTRACT**

A fractional distillation column operating as gasoline splitter is controlled by measuring the octane number of the column overhead fraction and adjusting the reflux to the column in response to the octane number. The octane measurement is effected by an analyzer comprising a stabilized cool flame generator with servo-positioned flame front which provides a real time output signal indicative of a sample octane number. The output signal is utilized to control reflux to maintain a given octane number in the overhead and to provide a control means for downstream blending of the overhead make.

18 Claims, 1 Drawing Figure



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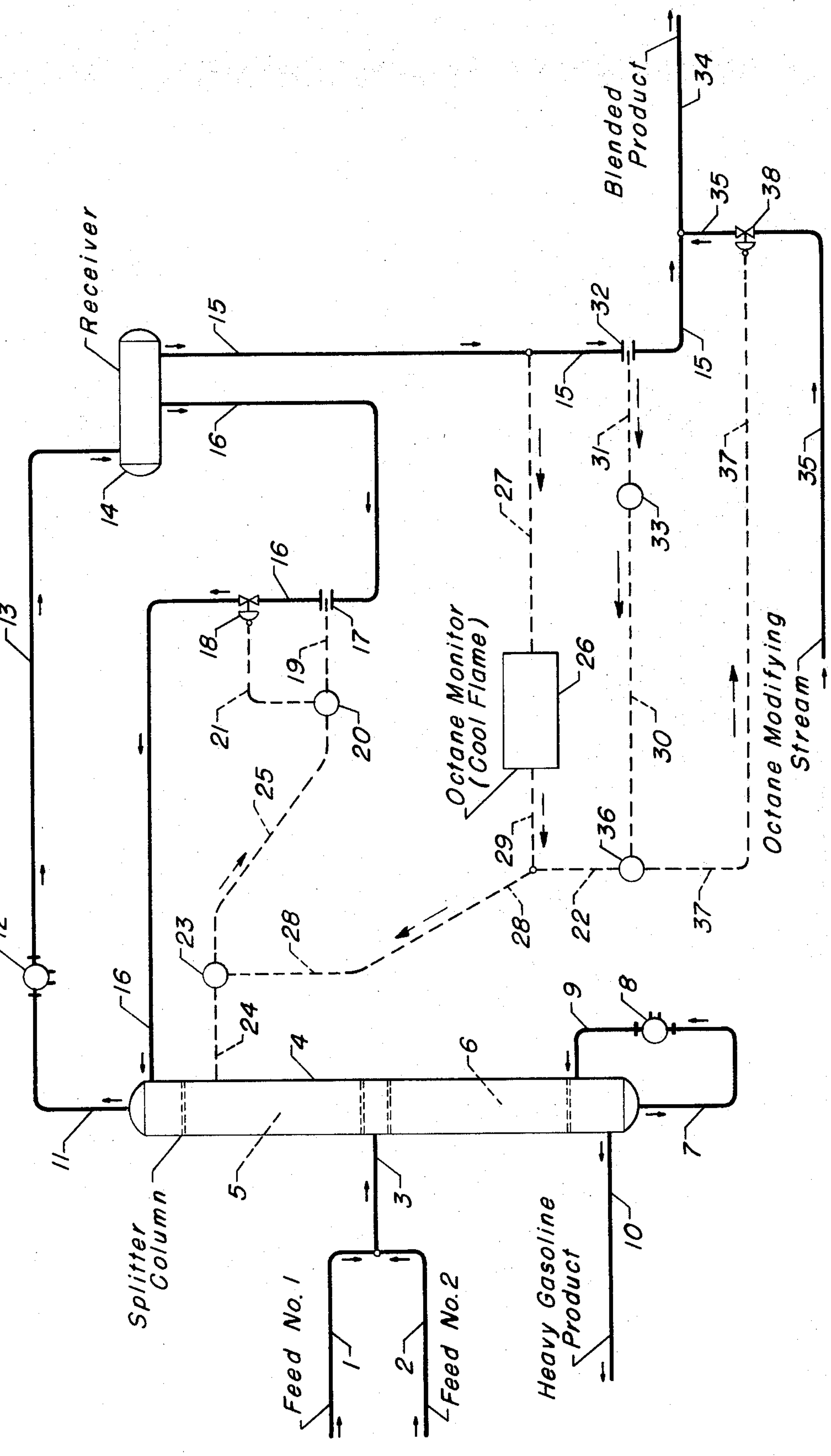

COMBINATION OCTANE NUMBER CONTROL OF DISTILLATION COLUMN OVERHEAD AND BLENDING CONTROL

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part application of our co-pending application Ser. No. 868,459, filed on Oct. 22, 1969 now U.S. Pat. No. 3,647,635. All the teachings of said co-pending application are incorporated into this specification by specific reference thereto.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The field of art to which this invention pertains is hydrocarbon distillation control. More specifically, this invention relates to a fractional distillation of gasoline utilizing a method of control which incorporates an octane number analyzer to control the column reflux and to control the method of blending the overhead with other blending components.

2. Description of the Prior Art

The prior art is abundant with patents and published articles relating to the reflux control of fraction facilities based on octane number of the overhead. Our invention centers around the use of an octane analyzer which in effect produces an octane number output signal at essentially the same instant that the overhead gasoline stream is being monitored. Essentially our process allows the control of both a fractionating column on a reflux basis and the blending of the overhead product through the use of an octane analyzer and a flow indicator which determines the volumetric-octane number of the overhead stream essentially at the same time a sample is taken. The output signal from the octane monitor is utilized to both reset a reflux control loop, if necessary, and to offer an input signal to a blending loop which blends the overhead with varying quantities of blending stock depending on the octane number and the flow of overhead material from the column.

Our invention basically monitors both the octane number of the overhead and its flow rate to offer output signals to the reflux control and the blending scheme. It may be necessary in blending of the overhead produced from a gasoline splitter to know the octane number and quantity of overhead material produced since gasoline may be further used or sold on an octane barrel basis. By incorporating the flow recording means along with the octane monitor, a combined output signal from these two measuring devices can be utilized as an input signal to a blending control loop which can add lead or other hydrocarbons having higher or lower octane numbers to the overhead to produce a desired quantity of a desired octane number gasoline.

SUMMARY OF THE INVENTION

Our invention can be summarized as a process for the control of the overhead octane number from a gasoline splitter and the blending of that stream with blending stock depending on the output signal from a flow recorder and the octane monitor. Our invention resides in the ability to control the distillation reflux thereby controlling overhead temperature and octane number and controlling the blending of the overhead fraction with lead or a higher or lower octane number component to produce a predetermined volumetric octane pool product.

DESCRIPTION OF THE DRAWING

With reference now to the drawing, there is shown a gasoline splitter column **4** receiving a plurality of stabilized gasoline feeds. Splitter column **4** is a conventional continuous flow externally refluxed fractional distillation column containing from 10 to 50 or more vertically spaced vapor-liquid contacting stages as, for example, bubble decks, sieve decks, perforated trays or the like. Line **1** carries a Feed No. **1** comprising stabilized reformate from the stabilizer column of a naphtha reforming unit No. **1.** Line **2** carries Feed No. **2** comprising stabilized reformate from the stabilizer column of a naphtha reforming unit No. **2.** The combined reformates are charged to the column **4** via line **3** which connects with the column at a locus approximately midway in the height thereof. A plurality of vapor-liquid contact stages above this locus comprises the rectification zone **5** and a plurality of contact stages below the locus comprises the stripping zone **6** of the column.

The two reforming units are separate, independently operated catalytic naphtha reforming units; the details thereof form no part of the present invention, being conventional and well known in the art. A typical catalytic naphtha hydroreforming unit is described in U.S. Pat. No. 3,296,118 (Class 208-100) to which reference may be had for specific information concerning flow arrangement, catalyst, conditions, etc. The feed to column **4** is generally under stabilizer reboiler level control from the preceding reforming units rather than direct flow control. Accordingly, the feed rate is usually, but not always, relatively constant, but it may be subject to some variation due to changes in naphtha feed composition, catalyst and/or operating conditions in either or both of the catalytic reforming unit reaction zones, or due to changes in operating conditions of the reforming unit stabilizer columns.

Gasoline splitter column **4** is maintained under operating conditions sufficient to separate the combined reformate feed stock into an overhead gasoline fraction having an end boiling point of about 400° F. and a bottoms fraction comprising heavy hydrocarbon constituents of the combined reformate feed having a boiling range of from about 400°F. to about 500° F., or even higher. While the refiner will typically set control of splitter column **4** to produce an overhead fraction having an end point of about 400° F., this is only a secondary consideration. The primary consideration is normally to produce an overhead fraction having an octane number of predetermined value, and this octane number is the primary control for operation of the column **4.** Any deviation of octane number will require a compensating deviation of endpoint in order to produce an overhead product of constant octane number.

In order to accomplish the desired separation, the gasoline splitter column **4** will contain the rectification zone **5** and the stripping zone **6,** as indicated hereinabove, in order that the most effective and efficient separation of hydrocarbon constituents may be accomplished within the fractionating column. In addition to the rectification and stripping zones, the column is provided with a reboiling section for heat input, and an overhead section which provides reflux liquid in a manner which shall be set forth hereinafter.

The reboiler section of fractionating column 4 comprises a reboiler liquid line 7, a reboiler heat exchanger 8, and a reboiler vapor return line 9 which are of conventional construction and design. Conventional instrumentation, not shown, is provided to control the heat input to the reboiler system. In addition, gasoline splitter column 4 is provided with a bottoms fraction draw-off line 10, whereby the heavy gasoline product may be withdrawn and sent to storage or to other processing. The bottoms draw-off flow rate is generally controlled by liquid level control in the reboiler.

The desired gasoline constituents of the combined reformate feed which is introduced into splitter column 4, are withdrawn in a vapor phase from column 4 via line 11 and passed to a heat exchanger 12 wherein they are condensed and cooled to about 100° F. or less. The condensed and cooled gasoline fraction passes from the heat exchanger 12 via line 13 into a fractionator overhead receiver 14 which is typically maintained at a pressure of from about 5 to 100 psig., or more, in order to maintain low boiling constituents within the liquid phase. The liquid accumulated in the overhead receiver 14 is separated into two portions. A first portion is withdrawn via line 15 as a light gasoline overhead product blended with a material passing through line 35 and sent to storage facilities via line 34. This light gasoline product typically will have a boiling range of from about C_5 to about 400° F. as indicated by ASTM Method D-86.

The second portion of the condensed overhead is withdrawn from the overhead receiver 14 via line 16 as the reflux which is returned to the column 4 in order to maintain the proper degree of vapor rectification within zone 5. The reflux conduit 16 also contains therein a flow measuring means such as an orifice 17 and a flow controlling means such as control valve 18. The reflux flow rate is regulated by a flow control loop comprising the orifice 17, a flow signal line 19, a flow controller 20, a controller output line 21, and the control valve 18. The set point of flow controller 20 is automatically adjustable.

A temperature controller 23, also provided with an automatically adjustable set point, senses and controls the rectification zone temperature as detected by a thermocouple or other sensing means 24 located within the rectification zone at a locus below the reflux inlet of the column. The resulting temperature output signal is transmitted from the temperature controller 23 via controller output line 25 to adjust or reset the setpoint of low controller 20.

Octane monitor 26, utilizing a stabilized cool flame generator with servo-positioned flame front, is field-installed adjacent column 4. In a preferred embodiment, the flows of oxidizer (air) and fuel (gasoline sample) are fixed as is the induction zone temperature. Combustion pressure is the parameter which is varied in a manner to immobilize the stabilized cool flame front. Upon a change in sample octane member, the change in pressure required to immobilize the flame front provides a direct indication of the change in octane number. Typical operating conditions for the octane monitor are:

Air Flow — 3,500 cc/min. (STP)
Fuel Flow — 1cc/min.
Induction Zone Temperature — 700° F. (Research Octane)
— 800° F. (Motor Octane)
Combustion Pressure — 4–20 psig.
Octane Range (max.) — 80–102*

*The actual calibrated span of the octane monitor as here utilized will, in general, be considerably narrower. For example, if the target octane is 95 clear (research method), a suitable span may be 92–98 research octane. When a relatively narrow span is employed, the change in octane number is essentially directly proportional to the change in combustion pressure.

A further explanation of the octane monitor is presented at a later time below.

Dashed line 27 represents a suitable sampling system to provide a continuous sample of column overhead to the octane monitor. For example, the sampling system 27 may comprise a sample loop taking the light gasoline product at a rate of 100 cc. per minute from a point upstream of a control valve and returning it to a point downstream from the control valve, the sample itself being drawn off from an intermediate portion of the sample loop and injected at a controlled rate by a metering pump to the combustion tube of the octane monitor. The octane monitor output signal transmitted via line 29 is split and passes via line 28 to the setpoint of temperature controller 23 and via line 22 to a volumetric-octane measurement means 36. Another embodiment would be to have the setpoint of controller 23 and volume-octane means 36 in series.

Preferably the octane monitor output will first be sent to an octane controller-recorder located in the refinery control house, with the control signal therefrom then being sent to reset the setpoint of temperature controller 23 and the volumetric-octane measurement means 36 both of which may be located in the control house.

Flow measuring means 33 is connected via line 31 to orifice 32 which measures the flow rate of overhead gasoline passing through line 15. Other methods may be utilized to measure the flow through line 15 but in all cases a signal is generated by flow measuring means 33 to indicate the quantity of flow.

Flow measuring means 33 produces an overhead flow rate output signal which passes through line 30 to the volumetric-octane measurement means 36. Means 36 combines the two signals passed to it and generates a volumetric-octane output signal which passes via line 37 to an octane blending means. The signal passing through line 37 may be intercepted by passing to a barrel-octane recorder and then reconveyed to the blending means 38.

The blending means 38 effects the addition of an octane blending stream passing through line 35 to be combined with the overhead stream passing through line 15. The combined product passes through line 34 to storage as a blended product.

Valve 38 of the octane blending means preferably controls the flow of the octane modifying stream passing through line 35 by adjusting line 35 flow as a function of the signal received from line 37. The set point of valve 38 can be adjusted in response to the volumetric-octane signal from volumetric-octane measurement means 36. Generally the set point is readjusted when the volume of the overhead make changes since the reflux control loop maintains a generally steady octane number on the overhead make. However, in some instances the octane number and the flow rate of the overhead will vary and the set point of the blending control means will compensate for the deviation.

In other embodiments of this invention the overhead material from line 15 may be passed into a header system which directs the overhead stream to different blending tanks which may contain varying quantities of various octane number components. By dividing the overhead to each tank when the overhead flow rate varies, it is possible to produce a desired quantity of a desired octane number gasoline.

It is also preferred to utilize a ratio station in connection with the blending means so that a given volume of known octane overhead material can be blended with a predetermined quantity of a known octane modifying stream. In this manner the ratio of volumes of the overhead material produced and the octane modifying stream used is the method of controlling the final blended product octane.

Also a second octane monitor can be used to monitor the octane of the blended product passing through line **34** to help determine if any drift is occurring in the blending means control system. The second octane monitor can also be provided with control means to temporarily override the blending means should drift occur.

The heavy ends of most reformate gasolines are high in octane number due to the fact that high boiling aromatic constituents are concentrated in the heavy end of the reformate. In splitting reformates to make various boiling range fractions, it is generally found that the octane number of the heavy gasoline product which is withdrawn via line **10** is consistently higher than the octane number of the light gasoline product which is withdrawn via line **15.** This correlation of octane number with gasoline fraction is found to occur even when as little as 5 volume percent or as much as 60 volume percent of the reformate gasoline is removed as a bottoms product via line **10.**

Thus, when operating column **4** on a reformate feed stock, any decrease in the measured octane number of the overhead product indicates that an insufficient amount of heavy boiling gasoline components is being withdrawn as a portion of the overhead product. In order to compensate for this condition, the octane monitor **26** will call for an increase in the rectification zone temperature in order to include a greater portion of the high octane number heavy ends in the overhead vapor which leaves column **4** via line **11.** Temperature controller **23,** being reset by the octane monitor, will then call for a decrease in reflux flow which in turn will be effected by flow controller **20** and control valve **18.**

Again, when operating column **4** on a reformate feed stock, an increase in the measured octane number of the overhead product is an indication that an excess of high octane number heavy ends is being withdrawn from column **4** in the overhead fraction. The octane monitor **26** therefore will call for a decrease in the rectification zone temperature in order to eliminate a greater portion of the heavy ends from the overhead vapor. Temperature controller **23** being reset by the octane monitor will call for an increase in the reflux flow which in turn will be effected by flow controller **20** and control valve **18.**

Those skilled in the art realize, of course, that a gasoline splitter column such as column **4** does not always operate on a feed stock comprising reformate gasoline. In many instances splitter column **4** may operate to separate an overhead and a bottoms fraction from a gasoline feed stock which may comprise one or more gasolines such as cracked gasoline, natural gasoline, alkylate gasoline, etc., and the feed stock may comprise stabilized and unstabilized gasolines which may include debutanized, depentanized and dehexanized gasolines. Thus, it is possible that there will be embodiments of operation wherein the heavy gasoline product withdrawn via line **10** will have an octane number which is consistently lower than the octane number of the light gasoline product withdrawn via line **15.** In those instances, the octane monitor **26** will call for overall corrective action which will be the reverse of that which has been indicated hereinabove for operations on reformate feed stocks. That is to say, if the overhead product of line **15** indicates a decrease in the measured octane number, this would be an indication that an excessive amount of low octane heavy ends is being withdrawn overhead via line **11,** and the control system would function to increase the amount of reflux in order to eliminate a greater portion of the heavy ends from the overhead vapor. On the other hand, if an increase in the measured octane number of the overhead product is indicated, then the octane monitor **26** would compensate by calling for a decrease in the amount of reflux to column **4** in order to allow a greater portion of the low octane heavy ends in the overhead vapor leaving via line **11.**

Those skilled in the art will readily ascertain the proper direction of corrective action which is to be taken in the inventive control system for any specific gasoline feed stock composition and any specific fractionation cut-point from the teachings which have now been presented hereinabove.

Those skilled in the art realize, of course, that thermocouple **24** could be placed in locations other than that shown as, for example, in vapor outlet line **11.** The drawing, however, illustrates a preferred embodiment wherein the temperature controller **23** senses and controls not the overhead vapor as it emerges directly from column **4,** but rather the liquid or vapor temperature obtaining within the rectification zone at a point some distance below the reflux inlet of line **16** and above the feed inlet of line **3.** In this preferred embodiment, the thermocouple **24** is typically located several trays (for example, two–six trays) below the reflux inlet of line **16.** This arrangement will afford a more immediate detection of changing heavy ends concentration, at least several minutes before such heavy ends reach the overhead vapor line **11** to cause a change in the octane number of the overhead product.

While the double cascade arrangement illustrated in the drawing represents a preferred embodiment, it is within the scope of this invention to omit the temperature controller **23** and to reset flow controller **20** directly by the octane monitor output signal transmitted via lines **28** and **29.** Alternatively, the flow controller **20** could also be omitted, in which case octane monitor output signal lines **28** and **29** would connect directly with valve **18.** It may be expected, however, that elimination of either or both of the subloops will result in somewhat poor overall control because rectification zone temperature and reflux flow variations will become a source of additional upsets, and also because the relatively large time constant of the stabilizer column itself tends to make single loop control unstable.

DETAILED DESCRIPTION OF THE INVENTION

The invention of this application is a process control application of the hydrocarbon analyzer described in U.S. Pat. No. 3,463,613 by E. R. Fenske and J. H.

McLaughlin, all the teachings of which, both general and specific, are incorporated by reference herein.

As set forth in U.S. Pat. No. 3,463,613, the composition of a hydrocarbon sample can be determined by burning the sample in a combustion tube under conditions to generate therein a stabilized cool flame. The position of the flame front is automatically detected and used to develop a control signal which, in turn, is used to vary a combustion parameter, such as combustion pressure, induction zone temperature or air flow, in a manner to immobilize the flame front regardless of changes in composition of the sample. The change in such combustion parameter required to immobilize the flame following a change of sample composition is correlatable with such composition change. An appropriate read-out device connecting therewith may be calibrated in terms of the desired identifying characteristic of the hydrocarbon sample, as, for example, octane number. Such an instrument is conveniently identified as a hydrocarbon analyzer comprising a stabilized cool flame generator with a servo-positioned flame front.

The type of analysis effected thereby is not a compound-by-compound analysis of the type presented by instruments such as mass spectrometers or vapor phase chromatographs. On the contrary, the analysis is represented by a continuous output signal which is responsive to and indicative of hydrocarbon composition and, more specifically, is empirically correlatable with one or more conventional identifications or specifications of petroleum products such as Reid vapor pressure, ASTM or Engler distillations or, for motor fuels, knock characteristics such as research octane number, motor octane number or composite of such octane numbers.

For the purpose of the present application, the hydrocarbon analyzer is further limited to that specific embodiment which is designed to receive a hydrocarbon sample mixture containing predominantly gasoline boiling range components, and the output signal of which analyzer provides a direct measure of octane number, i.e., research octane, motor octane or a predetermined composite of the two octane ratings. For brevity, the hydrocarbon analyzer will be referred to in the following description and accompanying drawing simply as an "octane monitor."

An octane monitor based on a stabilized cool flame generator possesses numerous advantages over conventional octane number instruments such as the CFR engine or automated knock-engine monitoring systems. Among these are: elimination of moving parts with corresponding minimal maintenance and down-time; high accuracy and reproducibility; rapid speed of response providing a continuous, real-time output; compatibility of output signal with computer or controller inputs; ability to receive and rate gasoline samples of high vapor pressure, e.g., up to as high as 500 psig., as well as lower vapor pressure samples (5–250 psig.). These characteristics make the octane monitor eminently suitable not only for an indicating or recording function, but particularly for a process control function wherein the octane monitor is the primary sensing element of a closed loop control system comprising zero, one, two or more subloops connected in cascade.

The present invention has as its principal objective the direct control of octane number of a gasoline splitter column overhead stream. A typical gasoline splitter is an externally refluxed, multiple tray, fractional distillation column employed to separate the light ends and lower boiling normally liquid gasoline components from the higher boiling components. The feed to such a column may typically comprise a stabilized reformate from a catalytic naphtha hydroreforming unit. Such a reformate will contain C_5 and heavier hydrocarbon constituents, with the end point dependent upon the original end point of the naphtha fraction which was hydroreformed. For example, the reformate which is produced from a naphtha having a 390° F. end point will typically have an end point in the range of about 440° to 450° F. It is normal to fractionate such a reformate to remove the heavier hydrocarbon components. Components boiling at a temperature in excess of about 400° F. have a high octane number, but they are predominantly aromatic hydrocarbons which are precursors to gum formation during gasoline storage and they can cause excessive deposition of carbonaceous material in an automobile engine during combustion. The overhead stream from the gasoline splitter column will thus typically comprise hydrocarbons in the C_5 to 400° F. end point boiling range, and the bottoms stream from the column will comprise heavy hydrocarbon constituents boiling above 400° F. (As used herein, the term "end point" and the temperatures illustrated are those typically defined by laboratory distillation in accordance with ASTM Method D-86.)

By and large it has been the practice to operate such a column mostly "in the dark" so far as the octane number of the product overhead fraction is concerned. That is to say, the column overhead product is manually sampled perhaps once every eight hour shift or perhaps even only once a day. The samples are picked up and taken to the laboratory where the sample is run and the result is then transmitted back to the unit operator who, until then, has not been able to ascertain what change, if any, should have been made at the time the sample was taken. Therefore, to be on the safe side, the unit operator will usually run the gasoline splitter column with excessive heat input and with corresponding over-reflux whereby the overhead fraction of the stabilized reformate will actually be outside of product specifications with respect to octane number a good part of the time. This method of "blind" fractionator operation clearly increases the refiner's costs.

The control problem is further complicated by the not uncommon practice of using a single fractionation column to process more than one gasoline stream. For example, a single gasoline splitter column will often receive plural or combined feeds which are stabilized reformates from two or more independently operated catalytic naphtha reforming units. Or the splitter column may be operated on a gasoline feed comprising a mixture of stabilized reformate, cat cracked gasoline, natural gasoline, etc. An upset in the operation of a single such reformer (or other similar gasoline feed source) will carry through to the gasoline splitter and be reflected in off-specification product since the splitter column overhead product is no longer indicative of only the operation of a single reformer or other gasoline source. Continuously meeting octane number specification is, therefore, an exceedingly difficult and haphazard task when employing a single splitter column to handle such a plurality of gasoline streams.

In accordance with the present invention, the octane monitor comprising a stabilized cool flame generator with servo-positioned flame front is connected to receive a continuous sample of the splitter column overhead product. The output signal of the octane monitor, which can be, and preferably is, calibrated directly in terms of octane number, is utilized to reset or adjust the rate of flow of reflux to the rectification section of the column so that the octane number of the net overhead fraction is maintained at a substantially constant predetermined level. The varying flow rate of overhead make is measured and sent to a volumetric-octane measurement means which produces a volumetric-octane output signal which is sent to the blending means.

The control system is clearly applicable to any distillation wherein a gasoline fraction is separated into an overhead containing the lower boiling components of the fraction and a bottoms containing the higher boiling components of the fraction, regardless of the distillation cut-point between the fractions. As used herein, the term "higher boiling components" refers to those hydrocarbon constituents which boil at a temperature above the distillation cut-point for the overhead fraction. Thus, if the fractional distillation is undertaken to produce an overhead gasoline having an end point of, say, 380° F., the higher boiling components will comprise the bottoms fraction of the distillation. And if the distillation is undertaken to dehexanize the gasoline feed, the higher boiling components comprise hydrocarbons having seven or more carbon atoms per molecule. Similarly, the term "lower boiling components" refers to those hydrocarbon constituents which boil at a temperature below the distillation cut-point.

The octane blending streams referred to in the specification and the claims are generally of higher octane number than the overhead make. In some instances in which a high octane overhead material is produced, the blending stream will be of lower octane material.

Specific blending streams include butanes, and aromatics such as benzene, toluene, xylenes and alcohols and tetraethyl lead. Also gasolines of higher or lower octane numbers than the overhead make can be used as blending stocks.

Because there is a direct measurement and control of octane rating, this control system is to be distinguished from those prior art control systems wherein some composition property, such as percent aromatics or conductivity or dielectric constant, is measured and controlled, all of these latter properties being merely an indirect indication of octane rating which is only narrowly correlatable therewith. Such indirect correlation becomes invalid for any significant deviation from the design control point.

The control system of this invention is also to be distinguished from those prior art systems employing automatic knock-engines as the octane measuring device. The instant octane monitor is compact in size, can be totally enclosed by an explosion-proof housing and therefore can be used in hazardous locations. In fact it is normally field-installed immediately adjacent to the gasoline splitter column. A knock-engine, however, cannot be employed in hazardous locations and must therefore be situated remote from the sample point.

The sample transport lag or dead time of a close-coupled octane monitor is typically of the order of 2 minutes, and its 90 percent response time is another 2 minutes. This is a very good approach to an essentially instantaneous or real time output. By way of contrast, the transport lag alone of a knock-engine may be of the order of 30 minutes or more, which those skilled in the control system art will recognize to be a substantial departure from real time output. With that much dead time built into a closed loop, it is extremely difficult to achieve and maintain stability. The injection of an outside disturbance of any appreciable magnitude, in such a potentially unstable system, will often result in undampened cycling with the consequence that the system will have to be put on manual control.

In a broad embodiment, the present invention is directed to a control system for use and in combination with a continuous flow, fractional distillation column, the feed to which is a gasoline fraction, the overhead from which comprises the lower boiling components of said fraction and the bottoms from which comprises the higher boiling components of said fraction, said column including a rectification zone having a reflux conduit means in communication therewith at a first locus and means to supply reflux to said reflux conduit means, said control system for said column comprising: (*a*) means operatively associated with said reflux conduit means to vary the flow of reflux to said rectification zone; (*b*) a hydrocarbon analyzer comprising a stabilized cool flame generator with a servo-positioned flame front continuously receiving a sample of said column overhead and developing an output signal which in turn provides a measure of sample octane number; (*c*) means transmitting said analyzer output signal to said reflux flow varying means (*a*) whereby the flow of reflux to said column is regulated responsive to octane member of said column overhead and said octane number is thereby maintained at a substantially constant predetermined level; (*d*) means measuring the flow rate of overhead make and transmitting an output signal together with the octane number signal to an octane blending means which blends said overhead make with an octane blending stream(s) to form a predetermined octane pool gasoline.

In referring to a volumetric-octane value in the claims and the specification we mean what is typically used in the art, the term "barrel-octane." This term refers to the product of the octane number of the overhead and its volume. It is used in refining technology as a measure of the octane pool and is helpful to the refiner in determining his saleable product quality and quantity.

The volumetric-octane measurement means refers to an instrument which receives the overhead octane signal and the overhead flow rate signal, combines them to produce a volumetric-octane output signal which is sent to the blending means. The instrument which can be used to perform this operation is known to the art. In some instances the volumetric-octane measurement means may be combined with the blending means so that the octane and flow rate signals are passed directly to the blending means.

The blending means is typically a control loop which controls the flow of a blending stream and/or the overhead make stream in response to the signal from the volumetric-octane measurement means. Typically, when the blending means controls the flow rate of the blending stream, the blending stream flow rate is altered depending on both the quantity and quality of the overhead product produced.

If the blending stream is tetraethyl lead or another octane booster, it will be added to the overhead make stream when the volumetric-octane output signal is below a certain reset valve. When the volumetric-octane output signal is above a certain preset valve the blending stream will not be added.

The preset valve of the blending means can include a quantity desired to be the minimum volumetric-octane value. In this case all of the gasoline pool produced will be of at least a certain barrel-octane value.

We claim as our invention:

1. In combination with a continuous flow, fractional distillation column, the feed to which comprises a gasoline fraction, the overhead from which comprises the lower boiling components of said fraction and the bottoms from which comprises the higher boiling components of said fraction, said column including a rectification zone having a reflux conduit means in communication therewith at a first locus and means to supply reflux to said reflux conduit means, a control system for said column comprising:

a. means operatively associated with said reflux conduit means to vary the flow of reflux to said rectification zone;

b. a hydrocarbon analyzer comprising a stabilized cool flame generator with a servo-positioned flame front receiving a sample of said column overhead and developing an overhead octane output signal which provides a measure of sample octane number:

c. means transmitting said overhead octane output signal to said reflux flow varying means whereby the flow of reflux to said rectification zone is regulated responsive to octane number of said column overhead and said octane number is thereby maintained at a substantially constant predetermined level;

d. flow measurement means operatively associated with the overhead stream to measure the flow rate of overhead make and produce an overhead flow rate output signal;

e. means transmitting said overhead flow rate output signal and said overhead octane output signal to a volume-octane measurement means which means produces a volumetric-octane output signal responsive to said octane and flow rate output signals; and

f. means transmitting said volumetric-octane output signal to an octane blending means which effects the blending of said overhead make with an octane modifying stream to produce a gasoline product having a preset volumetric-octane value.

2. The system of claim **1** wherein the feed to said column comprises at least one stabilized gasoline fraction.

3. The system of claim **1** wherein said reflux flow varying means comprises a flow control loop including a flow controller having an adjustable set point regulating the rate of flow of reflux through said reflux conduit means, said setpoint being adjusted in response to said overhead octane output signal.

4. The system of claim **3** further characterized in the provision of means to sense the temperature in said column at a second locus, temperature control means having an adjustable setpoint connecting with said temperature sensing means and developing a temperature output signal, and means transmitting the last-mentioned output signal to the setpoint of said flow controller, means transmitting said overhead octane output signal to the temperature control means setpoint whereby the setpoint is adjusted responsive to overhead octane number.

5. The system of claim **4** wherein said temperature sensing means is located in said rectification zone.

6. The system of claim **5** wherein said second locus is below said first locus.

7. The system of claim **6** wherein said distillation column contains a plurality of fractionation trays and said temperature sensing means is located several trays below said first locus.

8. The system of claim **1** wherein said octane blending means comprises a flow control loop including a flow controller which controls the blending of an octane modifying stream with said overhead make and has an adjustable setpoint regulating the rate of flow of said octane modifying stream, said setpoint being adjusted in response to said volumetric-octane output signal.

9. The system of claim **8** wherein said octane modifying stream comprises tetraethyl lead.

10. The systm of claim **8** wherein said octane modifying stream comprises butane.

11. The system of claim **8** wherein said octane modifying stream comprises an aromatic selected from the group consisting of benzene, toluene and xylene.

12. The system of claim **8** wherein said octane modifying stream comprises a gasoline having an octane number higher than the octane number of said overhead stream.

13. In combination with a continuous flow, fractional distillation column, the feed to which comprises a gasoline fraction, the overhead from which omprises the lower boiling components of said fraction and the bottoms from which comprises the higher boiling components of said fraction, said column including a rectification zone having a reflux conduit means in communication therewith at a first locus and means to supply reflux to said reflux conduit means, a control system for said column comprising:

a. means operatively associated with said reflux conduit means to vary the flow of reflux to said rectification zone;

b. a hydrocarbon analyzer comprising a stabilized cool flame generator with a servo-positioned flame front receiving a sample of said column overhead and developing an overhead octane output signal which provides a measure of sample octane number;

c. means transmitting said overhead octane output signal to said reflux flow varying means whereby the flow of reflux to said rectification zone is regulated responsive to octane number of said column overhead and said octane number is thereby maintained at a substantially constant predetermined level;

d. flow measurement means operatively associated with the overhead streams to measure the flow rate of overhead make and produce an overhead flow rate output signal;

e. means transmitting said overhead flow rate output signal and said overhead octane output signal to a volume-octane measurement means which means produces a volumetric-octane output signal responsive to said octane and flow rate output signals; and

f. means transmitting said volumetric-octane output signal to an octane blending means which comprises a flow control loop including a flow controller which controls the blending of an octane modifying stream with said overhead make and has an adjustable setpoint regulating the rate of flow of said octane modifying stream, said setpoint being adjusted in response to said volumetric-octane signal.

14. The system of claim **13** wherein said octane modifying stream comprises tetraethyl lead.

15. The system of claim **13** wherein said octane modifying stream comprises butane.

16. The system of claim **13** wherein said octane modifying stream comprises an aromatic selected from the group consisting of benzene, toluene and xylene.

17. The system of claim **13** wherein said octane modifying stream comprises a gasoline having an octane number higher than the octane number of said overhead stream.

18. In combination with a continuous flow, fractional distillation column, the feed to which comprises a gasoline fraction, the overhead from which comprises the lower boiling components of said fraction and the bottoms from which comprises the higher boiling components of said fraction, said column including a rectification zone having a reflux conduit means in communication therewith at a first locus and means to supply reflux to said reflux conduit means, a control system for said column comprising:

a. means operatively associated with said reflux conduit means to vary the flow of reflux to said rectification zone;

b. a hydrocarbon analyzer comprising a stabilized cool flame generator with a servo-positioned flame front receiving a sample of said column overhead and developing an overhead octane output signal which provides a measure of sample octane number;

c. means transmitting said overhead octane output signal to said reflux flow varying means whereby the flow of reflux to said rectification zone is regulated responsive to octane number of said column overhead and said octane number is thereby maintained at a substantially constant predetermined level;

d. flow measurement means operatively associated with the overhead stream to measure the flow rate of overhead make and produce an overhead flow rate output signal;

e. means transmitting said overhead flow rate output signal and said overhead octane output signal to a volume-octane measurement means which means produces a volumetric-octane output signal responsive to said octane and flow rate output signals; and

f. means transmitting said volumetric-octane output signal to an octane blending means which comprises a flow control loop including a flow controller which controls the blending of an octane modifying stream with said overhead make and has an adjustable setpoint regulating the rate of flow of said overhead make to be blended with said modifying stream, said setpoint being adjusted in response to said volumetric-octane signal.

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