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J. F. M. TAYLOR ET AL

2,025,255

METHOD OF TREATING CRACKED OIL DISTILLATES

Filed Feb. 7, 1934

2 Sheets-Sheet 1

Fig. 1.

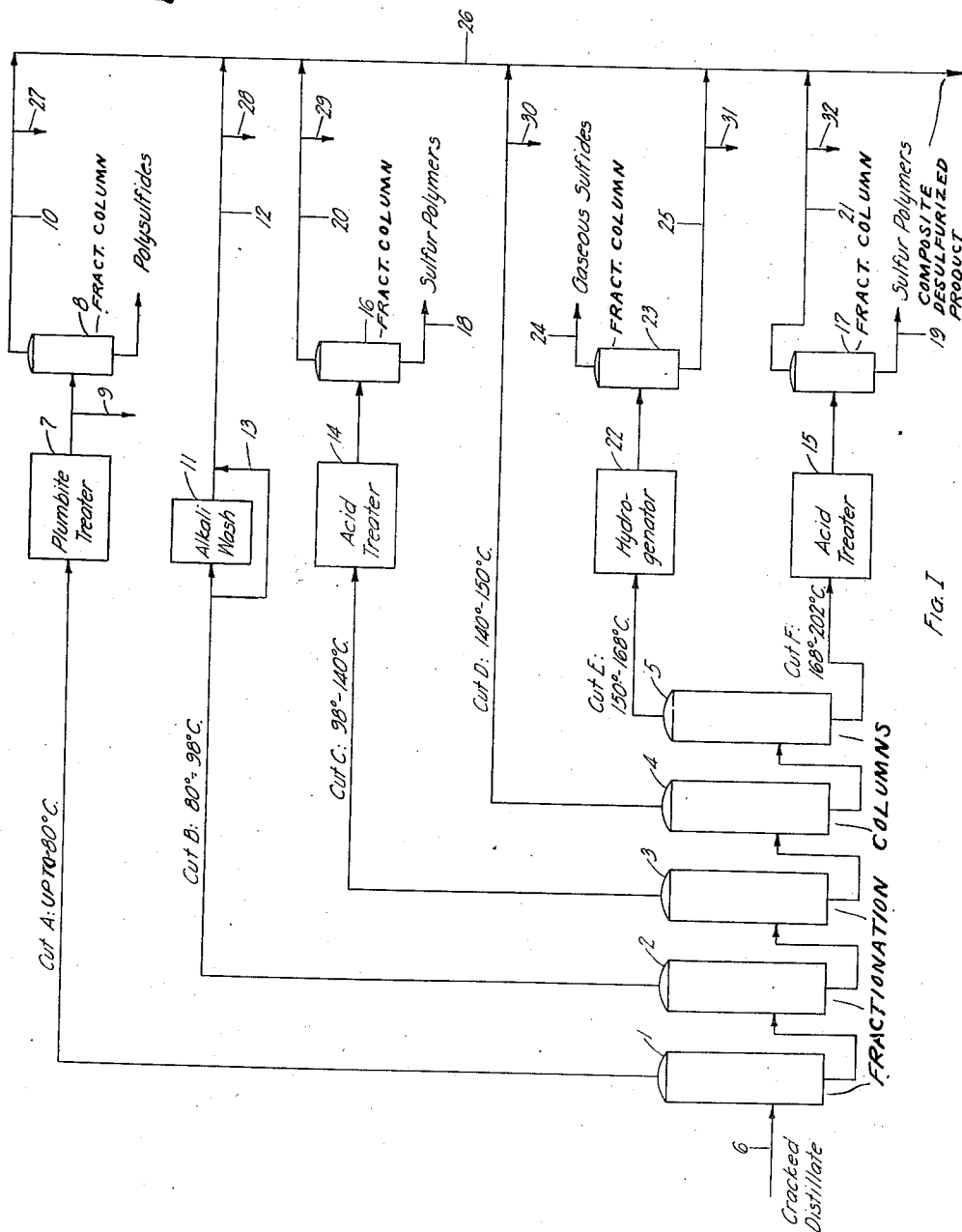


Fig. 1

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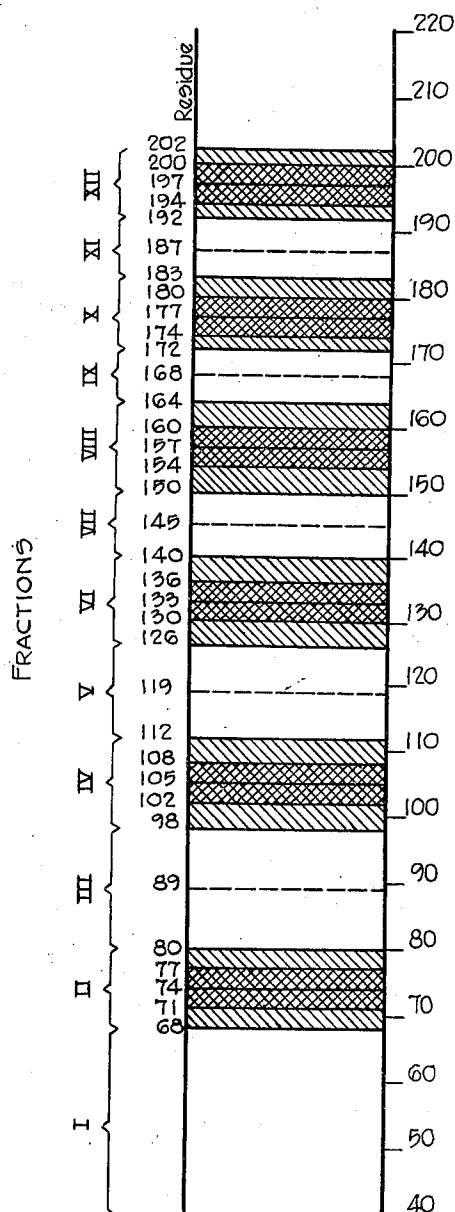
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2 Sheets-Sheet 2

DISTRIBUTION OF SULFUR IN CRACKED DISTILLATES



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UNITED STATES PATENT OFFICE

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METHOD OF TREATING CRACKED OIL
DISTILLATES

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19 Claims. (Cl. 196—24)

This application is a continuation in part of our application, Serial No. 601,880, filed March 29, 1932, and is particularly concerned with certain specific forms of the original invention.

It is a common practice in the art to treat a mineral oil distillate as a whole, subjecting it to the action of various reagents, with the same conditions of temperature, concentration of the reagent, etc., prevailing through the whole mass of the material being treated. However, some distillates, and particularly cracked distillates, are very difficult to refine by ordinary methods on account of their relatively high sulfur content, their sluggish response to refining processes, and the presence in the cracked distillates of unsaturated hydrocarbons which interfere with most treatments intended to remove sulfur compounds, thereby decreasing the effectiveness of the treatment and increasing treating loss.

It is an object of this invention to provide an efficient method for reducing the sulfur content of a hydrocarbon oil, whereby this removal of sulfur may be accompanied by improvements in other properties of the treated oil, such, for example, as volatility, knock rating, color, etc.

It is also an object of this invention to increase the effectiveness of the sulfuric acid treatment, or other similar refining treatments, with regard to the removal of sulfur from the oil distillates, thereby reducing the amount of chemicals used in the process and increasing the yield of the refined distillates.

Broadly, the process of our invention consists of separating a distillate to be treated into a number of fractions boiling at progressively higher temperature and subjecting all of some of these fractions, separately, to chemical treating processes most suitable for each individual fraction, whereby the original sulfur compounds are converted into other sulfur compounds of markedly different boiling range, so that, when each of the treated fractions is separately redistilled, the newly formed sulfur compounds readily separate from the major portion of hydrocarbon components of the fraction being distilled. The resulting desulfurized fractions can then be blended to make the final product of considerably lower sulfur content, than it would have been possible to obtain from the same material by treating it in bulk and redistilling or by treating its fractions separately and redistilling a composite obtained by combining the treated fractions. In the last two cases, a large portion of the changed sulfur compounds would remain within the boiling range of the final distillate, thus diminishing the effect of treating.

According to our invention, changes in the boiling temperatures of sulfur compounds may be obtained in either direction, e. g. some fractions

may be treated so as to raise the boiling points of sulfur-bearing components by converting the original sulfur compounds into higher boiling compounds, while others may be treated to convert their sulfur compounds, into lighter compounds, for example, by reducing disulfides or other sulfur-containing substances to mercaptans, and/or to H_2S , and in either case the resulting sulfur bodies are then removed by distillation; in case of reduction to mercaptans or to H_2S these are removed as first runnings, while high-boiling sulfur compounds resulting from other refining treatments can be removed as bottoms.

Among various known chemical treatments whereby the volatilities of sulfur compounds may be changed, we found the plumbite treatment, with or without addition of free sulfur, treatments with clay or fuller's earth in the vapor phase, and sulfuric acid treatments, mild treatments with $AlCl_3$ and similar polymerizing catalysts, very effective for raising the boiling range of sulfur compounds, while well known methods for reduction with nascent hydrogen in acidic, neutral or alkaline media, or with hydrogen in the presence of a catalyst, can be used to convert certain sulfur compounds into mercaptans and/or H_2S . The extent and the general efficiency of these treatments can be very accurately regulated to control the treating conditions of temperature, concentration, time of contact, etc.

It is not always necessary, however, to treat all fractions of the distillate by one of these methods, as some of them may not contain a sufficiently high percentage of sulfur to require any other treatment but a soda, or water wash. In some cases certain fractions may be sweetened either by doctor or Lachman or hypochlorite treatments and may not require redistillation. The most effective and economical combination of the various treatments can be best ascertained by preliminary tests on a small scale, and the method and conditions selected are then reproduced on a plant scale.

While, as stated above, the objectionable fractions of sulfur-bearing hydrocarbon mixtures to be treated by our method can be ascertained by simple tests of the individual fractions into which a cracked distillate is divided by efficient fractionation, we have found a new method of selecting such objectionable fractions.

We have observed that the distribution of sulfur in narrow-boiling fractions of various cracked distillates, produced under similar or different conditions of pressure and temperature, and derived from the same or different sources, can be graphically represented by a diagram such as shown in Figure 2 of the accompanying drawings. Roman numerals of the diagram designate frac-

tions whose major portions boil within indicated ranges. The significance of the diagram resides in the fact, based on a number of observations, that sulfur-bearing compounds of substantially any hydrocarbon mixture, and regardless of their distribution in the mixture, tend, when the mixture is subjected to cracking or destructive distillation, to become concentrated within certain definite boiling ranges of the cracked product. The shaded bands of this diagram represent the boiling ranges of substantially any cracked mineral oil distillate wherein concentrations of sulfur are relatively high, while the intermediate unshaded bands represent fractions with relatively low sulfur contents. The double-shaded bands indicate the narrow boiling ranges within which the concentrations of sulfur-bearing substances are usually particularly high.

It is seen from this diagram that the relatively highly sulfurous fractions II, IV, VI, VIII, X and XII, lie within the following boiling ranges: 68–80° C., 98–112° C., 126–140° C., 150–164° C., 172–183° C. and 192–202° C. The intermediate fractions, i. e., one below 68° C., and fractions I, III, V, VII, IX, XI and XIII, within the boiling ranges of 80–98° C., 112–126° C., 140–150° C., 164–172° C., 183–192° C. and from 202° C. up, usually contain lower concentrations of sulfur than the intermediate fractions of the same distillate.

This manner of distribution of sulfur, it was found, is brought about quite consistently by any known cracking method to which a sulfur-containing mineral oil may be subjected; in general, the heating of such oil at temperatures of about 400° C. or about, either in liquid or in vapor phases would normally result in rearranging sulfur-bearing substances within the distillate being cracked so that the sulfur contents of the sharply separated fractions can be represented in the manner shown in the diagram.

The above and other boiling ranges disclosed herein indicate the temperatures within which the bulk (at least 80% by vol.) of each of the fractions is distilled under approximately atmospheric pressure by the known A. S. T. M. method.

According to one form of our invention, we separate fractions with relatively high concentrations of sulfur from those containing less sulfur, and in doing this we prefer to select these different fractions in accordance with the diagram shown in the drawings. The fractions with relatively high concentrations of sulfur are separated from the others by sharp fractionation, so as to be within the A. S. T. M. boiling ranges set forth hereinbefore. Or these sulfurous fractions may be so selected as to have their 50% A. S. T. M. boiling temperatures at about 74° ± 3° C., 105° ± 3° C., 133° ± 3° C., 157° ± 3° C., 177° ± 3° C., and 197° ± 3° C., i. e. substantially within the double-shaded bands of the diagram and to be substantially free of the substances boiling outside the respective ranges of sulfurous fractions. Correspondingly, the fractions with relatively low sulfur contents may then have their 50% A. S. T. M. temperatures at about 89° ± 3° C., 119° ± 3° C., 145° ± 3° C., 168° ± 3° C., 187° ± 3° C., and be substantially free of substances boiling within the ranges of sulfurous fractions, the residual fraction boiling substantially from about 202° C. up to about 220° C. or above. We found, that the efficiency of our method of refining cracked distillates is favored by the sharpness of fractionation of the cracked distillate, so that the less is the overlap of boil-

ing ranges of the adjacent fractions, or the wider are the gaps therebetween, the more efficient is the concentration of sulfur-bearing compounds in the sulfurous fractions.

The separated fractions are then subjected separately to chemical treatments under conditions most suitable for each fraction. As a general rule, fractions with low sulfur contents are subjected to such chemical or physical treatments, as alkali wash, plumbite, or doctor, or Lachman treatments, extraction with a selective solvent, etc., while at least some of the fractions with high sulfur contents are treated with a chemical reagent either more or less selectively to oxidize, or to reduce, or to polymerize, sulfur compounds, thereby producing new sulfur-containing substances boiling outside of the boiling ranges which these fractions had before the treatment.

The chemical treatment of sulfurous fractions is followed by the redistillation of each of the treated fractions substantially to their original boiling ranges, whereby sulfur compounds produced by the treatment are either distilled off as the first runnings, if the original sulfur compounds were converted into lighter substances, or remain in the distillation residue, if heavier sulfur-containing substances were formed by the chemical treatment of the original fractions. The desulfurized portions of the refined fractions may then be combined with other fractions, which were or were not chemically treated, to produce the refined distillate corresponding in physical properties, such as the boiling range, to the original untreated distillate. It may be found desirable in some cases to combine into a composite not all of the desulfurized fractions, but only a series of consecutive or alternate fractions produced from either the lighter or heavier or intermediate portion of the original distillate, the uncombined fractions being used separately from the composite.

Among other refining treatments to which sulfurous fractions may be subjected, we find the polymerizing treatment with a concentrated acid, such as hydrochloric, phosphoric, and particularly concentrated sulfuric acid, to be preferable in many cases. By the concentrated sulfuric acid treatment is meant an acid treatment wherein a sulfuric acid having a concentration preferably not below 70% H₂SO₄ is employed; the treatment is carried out at a temperature which usually should not be below 32° F. or above 160° F. and may be so selected by actual tests, if desired, as to cause the desired polymerization and/or condensation of sulfur-bearing substances, with the least effect upon polymerizable hydrocarbons. By using this method, various sulfur compounds in these sulfurous fractions are so transformed that the bulk of the sulfur can be removed from the treated fractions by distillation, the sulfur-bearing compounds remaining in the distillation residue, while the desulfurized distillates can be condensed and used for compounding desulfurized products, such as gasoline.

With reference to various characteristics of cracked gasolines produced by our method of refining, it can be noted, that by properly selecting and controlling refining treatments of individual sulfurous fractions it was found readily possible to desulfurize cracked gasolines without impairing and sometimes with accompanied improvement in their knock ratings; the refined fractions were combined in such cases in substantially the same proportions in which the corresponding un-

treated fractions were present in the original cracked gasoline distillate.

In many cases we found it particularly advantageous to subject some of the fractions to the known Lachman treatment with ZnCl_2 aqueous solution. Preferably this treatment should be applied to the narrow boiling light fractions, such as either of the fractions I to V or their composites, or to the higher boiling sulfurous fractions VI, VIII, X and XII, preferably after the sulfurous fraction or fractions to be so treated were chemically treated and redistilled to remove reformed sulfur compounds.

The following is an illustrative example of applying the hereinbefore outlined method of refining:

A Dubbs cracked distillate having gravity of about 60.0° A. P. I., A. S. T. M. boiling range of about 30–215° C., sulfur content of about .70% by weight and octane number 70 is fractionated into twelve overhead fractions and a residue of the following characteristics:

ing beyond the boiling ranges of the original fractions and then separate these portions from the bulk of each treated fraction by distillation. As an example of suitable acid treatments the following can be mentioned:

Table B

Sulfuric acid	Fractions				
	IV	VI	VIII	X	XII
Concentration, percent by weight H_2SO_4	93	98	98	100	100
Lbs./bbl.....	3	10	10	6	6
Treating temperature, ° F.....	80	100	100	100	100

The tabulated specific conditions of acid treating can be varied in different cases in accordance with compositions of the individual fractions, the efforts being directed to preserve hydrocarbon components while polymerizing sulfur-bearing substances. In general, the intensities of chemi-

Table A

	Fractions												Residue
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
A. S. T. M. 10%, ° C.....	30	69	83	98	113	127	140	150	165	172	184	192	202
A. S. T. M. 90%, ° C.....	68	80	98	110	126	138	150	163	171	183	191	202	215
Sulfur percent by weight.....	.18	.40	.16	.97	.27	1.30	.73	1.21	.77	1.15	.74	.86	.70

Each of these fractions can be refined by a method particularly effective for each individual fraction, and so that either all or some of the fractions II, IV, VI, VIII, X and XII, are separately chemically treated to segregate sulfur-containing components into fractions boiling outside of the original boiling ranges and the treated fractions are then separately distilled to separate such sulfur concentrates from desulfurized portions. We prefer, however, to segregate some of the fractions into groups and subject such composites to suitable refining treatments, while refining other uncombined fractions separately from each other. For example:

Fractions I, III and V, and sometimes fractions II, can be combined, washed with an alkali solution and/or sweetened by doctor or hypochlorite or some other method, and/or otherwise refined, e. g. desulfurized.

Fractions VII, IX, XI, and sometimes the fraction XII, and the residue can be desulfurized, each separately, by such treatments as a polymerizing acid treatment following by distilling each treated fraction substantially to its original boiling range. Some of these fractions can often be readily desulfurized by extraction with selective solvents, such as liquid SO_2 , or cold fuming H_2SO_4 (at about or below 0° C.). We found that some of these fractions can also be sweetened and their sulfur content reduced by Lachman treatment.

Fractions IV, VI, VIII, X and XII are usually more difficult to desulfurize, and, while occasionally some of them may sufficiently respond to methods of treatment proposed for fractions VII, IX and XI and the residue, it is more often preferable to subject all or at least some of these fractions to a polymerizing acid treatment under such conditions as to segregate sulfur-bearing substances into portions of treated fractions boil-

cal treatments for efficient sulfur reduction are dependent not only on the concentrations of sulfur compounds but the type or nature of the sulfur compounds. Each of the acid treated fractions is then redistilled substantially to its original boiling range to produce desulfurized distillate, leaving a residue with high content of sulfur.

After the fractions of the cracked distillate are refined, they may be combined in desired combinations and proportions to produce either high-grade motor fuels or intermediate products, such as light naphthas, intended for further treatment. For example, the individual or combined desulfurized fractions with relatively high contents of unsaturated hydrocarbons may be used as charging materials for production of synthetic oils by polymerization with AlCl_3 or similar catalysts.

By carefully treating cracked distillates of gasoline type by our method it is often possible to reduce the sulfur content from as high as .70% by wt. to about or less than .20% by wt. in the distillate composed of treated fractions, said composite having substantially the same boiling range as the original distillate substantially unchanged or only slightly affected knock rating, and only slightly decreased unsaturated hydrocarbon content.

According to another form of our invention we may separate cracked distillates of a normal gasoline range into smaller number of fractions than heretofore described. In practicing this method of refining we are guided by the information provided by the accompanying diagram insofar as it indicates the distribution of sulfur compounds within the indicated boiling ranges and thus provides means for determining the most effective method of dividing cracked distillates into fractions to be chemically treated.

For example, vaporized products of cracking 75

were fractionally condensed to produce the following composite fractions:

Table C

	Fractions				Composite
	1	2	3	4	
10. A. S. T. M. 10%, °C.....	24	86	142	182	61
A. S. T. M. 90%, °C.....	78	137	164	204	190
Sulfur, percent by weight.....	.37	.61	1.04	.90	.73
Octane No., C. F. R. research method.....					74
Unsaturation and aromatics, percent by weight.....	42	44	43	40	44

It is to be noted that these fractions represent composites of the twelve fractions previously described and shown on the diagram. Those fractions are now found to be so combined that the higher boiling portions of the composites contain fractions having relatively high sulfur contents, their 90% A. S. T. M. temperatures closely corresponding to the higher boiling limits of the fractions II, VI, VIII and XII, each of the composites being substantially free of substances boiling within the ranges of other composites. The sulfurous fraction IV is included in this example into fraction 2, while fractions IX and X, are distributed between fractions 3 and 4.

These composite fractions were treated as follows:

Table D

	Fractions			
	1	2	3	4
Sulfuric acid concentration, percent by weight.....		93	98	98
Lbs./bbl.....		3	10	10
Alkali wash, followed by doctor treatment.....	Yes.	No.	No.	No.

While, as a more or less general rule, the redistillation of the doctor treated light fraction is not necessary, in this particular case all four treated fractions were redistilled substantially to the boiling ranges of Table C, and the distillates combined into a composite of the following characteristics:

Table E

A. S. T. M. 10%, °C.....	60
A. S. T. M. 90%, °C.....	187
Sulphur, percent by weight.....	.35
Octane No. C. F. R. research.....	77
Unsaturation and aromatics, percent by volume.....	40

With a yield substantially corresponding to that obtained by a conventional treatment, we were enabled, by using the method of our invention, further to reduce sulfur to about 65% of the conventional figure, save over 60% acid, and raise the octane number by 4 units.

Figure 1 of the drawings is a diagrammatic flow sheet illustrating one embodiment of my invention. Numerals 1, 2, 3, 4 and 5 indicate fractionating columns serially connected by conduits, as shown, and adapted to closely fractionate a cracked distillate, introduced by means of a pipe 6, into a number of sharp cuts or fractions, A, B, C, D, E and F. In this example, the boiling ranges of fractions produced by fractional distillation or by fractional condensation

of the cracked distillate are as follows: A, up to 80° (fractions I and II); B, 80°-98° (fraction III); C, 98° to 140° (fractions IV, V and VI); D, 140°-150° (fraction VII); E, 150°-168° (fraction VIII and the lower boiling part of IX); F, 168° to the end, or to about 202° (the remainder of fraction IX and fractions X, XI and XII). It will be noted that at least one of the limits of each of these fractions corresponds to a boundary between a shaded and unshaded portion of the diagram shown in Figure 2.

These fractions may be treated as follows:

Fraction A, assumed to be easily desulfurized, may be treated with sodium plumbite, with or without the addition of sulfur, in a treater 7, and, if desired, may be fractionated in a column 8 to remove higher boiling sulfur compounds formed by chemical treatment. When the sweetened fraction does not require redistillation, it may be withdrawn for blending through a conduit 9. The top product from the column 8 is withdrawn at 10. An alkali wash of the fraction A may precede plumbite treatment.

Fraction B is usually low in sulfur compounds and may require little or no desulfurizing treatment. It may be subjected to an alkali wash in a treater 11 and discharged through a conduit 12. If no treatment is necessary, this fraction may by-pass the heater through a conduit 13.

Fractions C and F, assumed to contain large amounts of sulfur compounds, are given polymerizing treatments in acid treaters 14 and 15, respectively, under such conditions as to segregate sulfur-bearing substances into portions of treated fractions boiling beyond the boiling ranges of the original fractions. Thus, the sulfur compounds of the acid treated fraction C will boil above 140° C. and those of the fraction F will boil above 202° C. These treated fractions are fractionated then in fractionating columns 16 and 17, where sulfur polymers are separated and withdrawn as bottoms, thru conduits 18 and 19, and the desulfurized distillates having boiling ranges substantially corresponding to those of the original fractions C and F are withdrawn by means 20 and 21 as top products.

Fraction D is assumed to be low in sulphur compounds, (at least lower than the adjacent fractions) and may require no desulfurization treatment. It could, however, be subjected to a mild treatment, similarly to fractions A or B.

Fraction E has its lower limit on a boundary between a shaded and an unshaded portion of Figure 2. It is, therefore, advantageous to treat it to lower the boiling points of its sulfur compounds. This may be accomplished by treating it with hydrogen in the presence of a catalyst in a treater 22. The treated fraction is then fractionated in a column 23, and the light sulfur products removed at 24. The desulfurized distillate is removed as the bottom product at 25.

Any or all of the treated and/or untreated fractions may now be blended by feeding them into a manifold 26 to form the final product which may have the boiling range of the original cracked distillate. Unused portions may be withdrawn separately through conduits 27, 28, 30, 31 and 32.

By setting forth three specific examples of practicing our invention we do not intend to limit the same to these three procedures, as it is quite evident that other forms of our refining method can be used to a great advantage over conventional treating methods. For example, the fol-

lowing schemes of combining the twelve simplest fractions into composite fractions may be used: either combined into desired composites or used

Table F

Method of segregating simple fractions	Fractions												Residue
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
a.....	1	2	3	4	5	6	7						
b.....	1	2	3	4									
c.....	1	2	3	4	5								
d.....	1	2	3	4									
e.....	1	2	3	4									
f.....	1	2	3	4									
g.....	1	2	3	4									
h.....	1	2	3	4									

Arabic numerals in the Table F designate composite fractions formed by combining some of the simplest fractions, as indicated by brackets. While many other methods of combining fractions may readily be evolved from the above table used in conjunction with the accompanying diagram, we have found that those indicated above are well suited in many cases. To illustrate the use of the Table F, the method *e* may be explained. The table indicates, that a sulfur-containing cracked hydrocarbon mixture of gasoline type boiling up to about 220° C. or above is separated (for example, either by fractional distillation or condensation) into three consecutive composite fractions: 1—at least 80% of which boil up to about 112° C., 2—at least 80% of which boil from about 112° to 164° C., and 3—having its A. S. T. M. 10% point at about 164° C. or above, each fraction being substantially free of substances boiling within the boiling ranges of other fractions. Each of the three fractions is then subjected to a refining treatment either to desulfurize all three fractions, or to desulfurize only some of them. Our preferable method of desulfurizing one or more of the separated fractions consists of two steps: 1, the chemical treatment of the fraction, such as a polymerizing acid treatment, whereby the concentration of sulfur-bearing substances outside of the original boiling range of the untreated fraction is effected, and 2, the separation of such a concentrate from the bulk of the treated fraction by fractionation. As an example, the first of the three fractions produced in accordance with the method *e* may be sweetened by a hypochlorite treatment; the second fraction may be subjected to a treatment with 93% H₂SO₄ at about 100° F. and redistilled to about its original final or 90% boiling temperature; the distillate of the second fraction may then be treated with zinc chloride according to the Lachman process as described by Arthur Lachman in *The Oil and Gas Journal*, vol. 30, No. 26, pages 30, 133-4 (1931), which often would cause further reduction in the sulfur content of this fraction; the third fraction may be treated with 98% or 100% or even more concentrated H₂SO₄ at a subnormal temperature, if desired, and redistilled to remove polymerized sulfur compounds; often this fraction requires no sweeten-

separately, for example, as a source of synthetic oils, solvent naphthas, etc.

In practicing our invention we also found that some of the not highly sulfurous cracked distillates do not require fractional treatments outlined above, but can be refined by: first, being fractionated into fractions with alternate low and high sulfur contents, second, combining together the sulfurous fractions into a sulfurous composite and combining other fractions into a composite with low sulfur content, and, third, refining each composite separately from the other; the refined composites may then be blended or used separately.

It is also within the spirit of our invention to refine by our method the portions of cracked distillates which may boil only within a part of the range indicated on the diagram. For example, a distillate consisting only of the fractions III to VIII, i. e. boiling substantially within the range 80-164° C. (about 80% of the whole distillate), may be fractionally treated in the described manner after having been divided by fractionation into three composite fractions, for example, such as III-IV, V-VI, and VII-VIII. We found, that the portion of a cracked distillate boiling above 80° C. is usually far more difficult to desulfurize than the lighter portion; therefore, our invention is particularly suited for refining the higher boiling portions of cracked distillates and is especially useful for desulfurizing the middle portion of such distillates, i. e. the portions consisting either of all or some of the fractions III to X, usually containing the bulk of sulfur-bearing substances which are difficult to remove from the distillate.

We claim as our invention:

1. In the process of refining a cracked sulfur-containing gasoline distillate the step of dividing said distillate by fractionation into a series of fractions boiling within progressively rising temperature ranges, one of the limits of one of the boiling temperature ranges being so selected as substantially to correspond to a boiling range limit of one of the sulfurous fractions, in which sulfur-bearing substances are concentrated as the result of cracking, and to include said sulfurous fraction into the fraction having said corresponding boiling range limit.

2. In the process of refining a cracked sulfur-containing gasoline distillate the steps of dividing said distillate by fractionation into a series of fractions boiling within progressively rising temperature ranges, one of the limits of one of the boiling temperature ranges being so selected as substantially to correspond to a boiling range limit of one of the sulfurous fractions, in which sulfur-bearing substances are concentrated as the result of cracking, and to include such sulfurous fraction into the fraction having said corresponding boiling range limit, then subjecting the last referred to fraction to a desulfurizing treatment.

3. In the process of refining a cracked sulfur-containing gasoline distillate the steps of dividing said distillate by fractionation into a series of fractions boiling within progressively rising temperature ranges, one of the limits of one of the said boiling ranges being so selected as substantially to correspond to a boiling range limit of one of the sulfurous fractions, in which sulfur-bearing substances are concentrated as the result of cracking, and to include such sulfurous fraction into the fraction having said corresponding boiling range limit, then subjecting the last referred to fraction to a chemical treatment to convert sulfur compounds of the sulfurous fraction into compounds boiling outside of the said boiling range limit and then subjecting the treated fraction to distillation to separate said sulfur compounds from the desulfurized portion of the treated fraction.

4. In the process of refining a cracked sulfur-containing gasoline distillate, the steps of dividing the distillate into a series of fractions boiling at progressively higher boiling temperature ranges having, alternately, low and high sulfur concentrations and blending together at least two non-adjacent fractions having low sulfur concentrations.

5. In the process of refining a cracked sulfur-containing gasoline distillate, the steps of dividing the distillate into a series of fractions boiling at progressively higher boiling temperature ranges having, alternately, low and high sulfur concentrations subjecting at least one fraction of high sulfur concentration to a desulfurizing treatment, and blending together said desulfurized fraction and at least two non-adjacent fractions having low sulfur concentrations.

6. In the process of refining a cracked sulfur-containing gasoline distillate, the steps of dividing the distillate into a series of fractions boiling at progressively higher boiling temperature ranges having, alternately, low and high sulfur concentrations subjecting at least one intermediate fraction of high sulfur concentration to a desulfurizing treatment and blending together said desulfurized fraction and at least two non-adjacent fractions having low sulfur concentrations, at least one of said non-adjacent fractions boiling at a higher boiling temperature range than said desulfurized fraction, and at least one of said non-adjacent fractions boiling at a lower temperature boiling range than said desulfurized fraction.

7. The process according to claim 5 in which the fractions having low sulfur concentrations are combined into one composite and the resulting composite is subjected to a desulfurizing treatment before being blended with the desulfurized fraction originally having a high sulfur content.

8. In the process of refining a cracked sulfur-containing gasoline distillate the steps of dividing said distillate by fractionation into a series of fractions, the upper limit of the boiling range of at least one fraction being substantially at one of the following temperatures: 80° C., 112° C., 140° C., 164° C., 183° C. and 202° C., separately treating at least the fraction having said upper boiling range limit to raise the boiling temperatures of its sulfur compounds to temperatures which are above the original boiling range of the treated fraction, and separately redistilling the treated fraction, to recover a portion thereof having a boiling range substantially corresponding to that of the original fraction.

9. In the process of refining a cracked, sulfur-containing gasoline distillate the steps of dividing said distillate by fractionation into a series of fractions, the upper limit of the boiling range of at least one fraction being substantially at one of the following temperatures: 80° C., 112° C., 140° C., 164° C., 183° C., and 202° C., separately treating at least the fraction having said upper boiling range limit to raise the boiling temperatures of its sulfur compounds to temperatures which are above the original boiling range of the treated fraction, separately distilling the treated fraction, to recover a portion thereof having a boiling range substantially corresponding to that of the original fraction, and blending a redistilled portion with at least the adjacent higher boiling fraction which may or may not have been chemically treated.

10. In the process of refining a cracked sulfur-containing gasoline distillate, the steps of dividing said distillate by fractionation into a series of fractions, the lower limit of the boiling range of at least one fraction being substantially at one of the following temperatures: 68° C., 98° C., 126° C., 150° C., 172° C., and 192° C., separately treating at least the fraction having said lower boiling range limit to lower the boiling temperature of its sulfur compounds to temperatures which are below the original boiling range of the treated fraction, and separately redistilling the treated fraction to recover a portion thereof having a boiling range corresponding to that of the original fraction.

11. In the process of refining a cracked sulfur-containing gasoline distillate, the steps of dividing said distillate by fractionation into a series of fractions, the lower limit of the boiling range of at least one fraction being substantially at one of the following temperatures: 68° C., 98° C., 126° C., 150° C., 172° C., and 192° C., separately treating at least the fraction having said lower boiling range limit to lower the boiling temperature of its sulfur compounds to temperatures which are below the original boiling range of the treated fraction, separately redistilling the treated fraction to recover a portion thereof having a boiling range corresponding to that of the original fraction, and blending a redistilled portion with at least the adjacent lower boiling fraction which may or may not have been chemically treated.

12. In the process of refining a cracked sulfur-containing gasoline distillate, the steps of dividing the distillate by fractionation into a series of fractions, the upper limit of the boiling range of at least one fraction being substantially at one of the following temperatures: 80° C., 112° C., 140° C., 164° C., 183° C., and 202° C., separately treating at least said fraction having said upper boiling range limit to raise the boiling

temperature of its sulfur compounds to temperatures which fall within the boiling range of a higher boiling fraction of said gasoline distillate, separately redistilling said treated fraction to recover a portion thereof having a boiling range substantially corresponding to that of the original fraction, and blending the redistilled portion with at least said higher boiling fraction, which may or may not have been chemically treated.

13. In the process of refining a cracked sulfur-containing gasoline distillate, the steps of dividing said distillate by fractionation into a series of fractions, the lower limit of the boiling range of at least one fraction being substantially at one of the following temperatures: 68° C., 98° C., 126° C., 150° C., 172° C., and 192° C., separately treating at least the fraction having said lower boiling range limit to lower the boiling temperature of its sulfur compounds to temperatures which fall within a lower boiling fraction of said gasoline distillate, separately redistilling the treated fraction to recover a portion thereof having a boiling range substantially corresponding to that of the original fraction, and blending the redistilled portion with said lower boiling fraction, which may or may not have been chemically treated.

14. In the process of refining a cracked sulfur-containing gasoline distillate the steps of separating from the distillate a fraction boiling substantially between 98° C. and 164° C., subjecting this fraction to a refining treatment to convert at least a substantial portion of its sulfur components into sulfur compounds boiling outside of the boiling range of the untreated fraction, and then separating the treated fraction into a portion boiling substantially between 98° C. and 164° C. and another portion containing said sulfur compounds.

15. In the process of refining cracked sulfur-containing gasoline distillate the steps of separating from the distillate a fraction having an initial boiling temperature below 150° C. within the gasoline boiling range and boiling up to 164° C., subjecting this fraction to a refining treatment to convert at least a substantial portion of its sulfur components into sulfur containing compounds boiling above the boiling range of the untreated fraction, and then separating the treated fraction into a portion boiling up to 164° C. and another portion containing said sulfur compounds.

16. In the process of refining cracked sulfur-containing gasoline distillate the steps of separating from the distillate a fraction having an initial boiling temperature below 126° C. within the gasoline boiling range and boiling up to 140°

C., subjecting this fraction to a refining treatment to convert at least a substantial portion of its sulfur components into sulfur containing compounds boiling above the boiling range of the untreated fraction, and then separating the treated fraction into a portion boiling up to 140° C. and another portion containing said sulfur compounds.

17. In the process of refining cracked sulfur-containing gasoline distillate the steps of separating from the distillate a fraction having an initial boiling temperature below 98° C. within the gasoline boiling range and boiling up to 112° C., subjecting this fraction to a refining treatment to convert at least a substantial portion of its sulfur components into sulfur containing compounds boiling above the boiling range of the untreated fraction, and then separating the treated fraction into a portion boiling up to 112° C. and another portion containing said sulfur compounds.

18. In the process of refining a cracked sulfur-containing gasoline distillate, the steps of dividing the distillate into a series of fractions boiling at progressively higher boiling temperature ranges having, alternately, low and high sulfur concentrations, at least one of the fractions having high sulfur concentrations boiling substantially within one of the following ranges: 68-80° C., 98-112° C., 126-140° C., 150-164° C., 172-183° C., and 192-202° C., and blending together at least two fractions having low sulfur concentrations at least one of which has a boiling temperature range above said fraction of high sulfur concentration, and at least one of which has a boiling temperature range below said fraction of high sulfur concentration.

19. In the process of refining a cracked sulfur-containing gasoline distillate, the steps of dividing the distillate into a series of fractions boiling at progressively higher boiling temperature ranges and having, alternately, low and high sulfur concentrations, separately treating at least one fraction of high sulfur concentration to raise the boiling temperatures of its sulfur components to temperatures which are above the original boiling range of the treated fraction, separately redistilling the treated fraction to recover a portion thereof having a boiling range substantially corresponding to that of the original fraction, and blending together the desulfurized fraction and the adjacent low-sulfur fraction boiling at a higher temperature range than that of the treated fraction.

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