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TRACTOR FUEL AND PROCESS OF MAKING SAME

Rodney V. Shankland, Chicago, Ill., assignor to Standard Oil Company, Chicago, Ill., a corporation of Indiana

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This invention relates to an improvement in tractor fuels and more particularly to a method of making tractor fuels by catalytic processes in which light hydrocarbons are converted at high temperatures with solid catalysts and the products are fractionated to the desired boiling range. One object of the invention is to produce a synthesized, heavy, volatile hydrocarbon fuel for use in internal combustion engines of the type employed on tractors, which fuel has less tendency to cause detonation and provides smoother operation of the tractor than do fuels ordinarily available. Another object of the invention is to convert low boiling hydrocarbon distillates into a valuable liquid tractor engine fuel having superior properties, either when used alone or when blended with other tractor fuels having an undesirable tendency toward detonation.

Tractor fuels commonly employed heretofore have been made by the distillation of crude petroleum oil or thermal cracking still products. They have had a distillation range generally overlapping the upper end of the gasoline boiling range and the lower end of the kerosene boiling range, even extending through the kerosene boiling range. Engines employing these fuels ordinarily operate at a higher temperature than gasoline engines and at a lower compression ratio, e. g., 4:1, although the compression ratio may be as high as 5:1 or 5½:1. Unlike "solid" injection engines, these tractor engines vaporize the fuel before ignition. For this reason the distillation characteristics of the fuel are quite important. Tractor engines using this fuel operate with a high intake manifold temperature as a result of which they are not adapted to burning gasoline because of excessive thermal expansion which has the effect of throttling the engine. Thus, the intake manifold temperature of the tractor engine under average load conditions is typically in the range of 250° F. to 300° F. whereas a gasoline engine operating under the same load conditions will have an intake manifold temperature of only about 180° F. The manifold temperature of the tractor engine is consistently about 50 to 100° F. higher than that of the gasoline engine.

Recently, there has been developed for tractor engines a special fuel, herein called light tractor fuel, which is characterized by a relatively low initial boiling point and low 10% distillation point but having about the same maximum boiling point as tractor fuels heretofore used. Following are typical A. S. T. M. distillation ranges for "heavy" and "light" tractor fuels of the types heretofore used:

	Heavy fuel	Light fuel specification
	° F.	
Initial boiling point.....	215	167° F. (minimum).
10% off.....	372	210° F. (maximum).
20% off.....	388	
30% off.....	400	
40% off.....	408	
50% off.....	419	284° F. (minimum).
60% off.....	426	
70% off.....	435	
80% off.....	454	
90% off.....	472	460° F. (maximum).
End point.....	506	510° F. (maximum).

In one example such a "heavy" fuel had an A. P. I. gravity of 42.6, an open cup flash point of 93° F. and sulfur content of about .032% to .05%. The knock rating of this fuel by the regular A. S. T. M. motor method was about 37.1 octane number. The specification for the light fuel just described also includes an octane number of at least 40 A. S. T. M. and an octane number of 50 to 65 is frequently desired for more recent designs of engines running at higher speeds, for example, 1500 R. P. M. instead of 800 R. P. M. previously.

I have now discovered that I can prepare, by catalytic conversion methods applied to petroleum distillates, a superior tractor fuel having a much higher octane number and also a higher boiling range and lower A. P. I. gravity than tractor fuels heretofore employed. In making this fuel I prefer to convert the heavy naptha fraction of crude petroleum. The crude petroleum fraction or virgin naptha employed may have a distillation range of about 250° F. to 450° F. Considerable variation in the boiling range is permissible, however, and I may employ naptha stocks having an end point within the gasoline boiling range, for example, about 400° F., or I may employ somewhat higher boiling naphthas, boiling up to about 500° F. Another naptha suitable for this purpose may have a boiling range of 300° F. to 425° F. In general, fractions boiling at least largely within the range from 250° F. to 450° F. are most suitable.

The catalytic operation is generally carried out by first vaporizing the naptha and conducting the vapors at conversion temperatures of the order of 850° F. to 1050° F. in contact with a catalyst, usually of the dehydrogenation type. For this purpose I may use a catalyst composed essentially of an oxide of a metal of the left column of the VIth group of the periodic system, preferably in combination with active alumina, although the oxide of vanadium and oxides of

other metals of the left columns of the IVth and Vth groups may also be used, alone or in combination with each other. Molybdenum oxide and chromium oxide are very effective and their effectiveness is enhanced by alumina used as a support. The Vth group metal oxide is preferably present in a minor proportion in the mixture, for example, 2 to 25%. The catalyst may be made by impregnating activated bauxite or active alumina or magnesia with ammonium chromate, ammonium molybdate, chromium nitrate or other suitable salt and subsequently heating the catalyst mixture. The catalyst may be employed in the form of a powder or in granular form, either suspended or maintained in a porous fixed bed through which the naphtha vapors are passed.

In processing naphtha I prefer to maintain a hydrogen pressure within the catalyst zone and this may be accomplished by mixing hydrogen with the naphtha vapors entering the reaction chamber or by adding superheated hydrogen directly to the reaction chamber. Hydrogen for this purpose may be obtained largely from the hydrogenous gases produced in the process and if desired these hydrogenous gases containing about 40 to 80% of hydrogen by volume may be directly recycled from the gas separator to the reaction chamber. The pressure employed in the reaction chamber will preferably be of the order of 50 to 450 pounds per square inch and the amount of hydrogen is preferably about 1 to 3 moles per mol of naphtha hydrocarbon treated.

The hydrogen pressure is insufficient to effect hydrogenation of the hydrocarbon products and the reaction occurring appears to be one of dehydrogenation accompanied by polymerization and condensation of the intermediate products to higher boiling hydrocarbons suitable for tractor fuels. The rate of contacting the naphtha vapors with the catalyst is preferably about 0.2 to 10 volumes of liquid naphtha per hour per apparent volume of catalyst (0.2 to 10 V. H. V.).

As a specific example of catalytic naphtha conversion, an East Texas straight run heavy naphtha was subjected to the action of a catalyst containing about 10% of active molybdena on active alumina. The naphtha feed has approximately the following characteristics:

Gravity A. P. I.	51.2
Distillation:	
10% ————— °F.	254
90% ————— °F.	370
End Point. ————— °F.	443
Octane number	45.9

The reaction conditions were:

Space velocity—V. H. V. about	0.75
Pressure—pounds per square inch gauge	315
Gas recycle rate—cubic feet per barrel of naphtha treated, about	3000

The temperature in the reactor was 930° F. to 990° F., varying somewhat with the age of the catalyst. About 2% of tractor fuel was obtained in this operation having the following characteristics:

Gravity—A. S. T. M.	12
Initial boiling point ————— °F.	430
10% ————— °F.	461
90% ————— °F.	566

After the reaction has proceeded for a period of time, generally from 1 to 20 hours, the catalyst activity is diminished by the deposition of carbonaceous matter thereon. It is accordingly de-

sirable to divert the hydrocarbon vapors to another catalyst chamber and regenerate the spent catalyst by blowing with air or oxygen-containing gases to remove carbon by combustion. The temperature of regeneration is preferably kept below 1200° F. and generally in the range of 1000° F. to 1100° F. After regeneration the catalyst is ready for reuse and this regeneration may be repeated almost indefinitely.

The products from the catalytic operation are separated by fractionation into gas, gasoline and higher boiling synthetic fuel fractions. The heavier fractions boiling above the gasoline boiling range constitute about 2 to 10% of the naphtha charged to the process. This material may have a boiling range of about 400° F. to 600° F. but the boiling range may be narrowed by redistillation to about 425° F. to 550° F. This fraction may be used directly as a tractor fuel but it is preferred to blend it with other stocks especially stocks boiling in a lower distillation range, the amount of such other stock being about 25 to 95% of the blend. Stocks suitable for this purpose may be virgin or cracked kerosene or virgin heavy naphtha. One of the characteristics of the polymer fraction is its very low A. P. I. gravity or high density which may equal or even exceed the density of water. A. P. I. gravities of 9.5 to 12 are readily obtainable, and the gravity is generally in the range of about 10 to 20 A. P. I. The high density of this fuel corresponds to a higher weight per gallon which is especially desirable for tractor operators who purchase the fuel on a volume basis. Accordingly, this fuel provides the tractor operator with a larger actual amount of fuel or power per gallon simultaneously with increased knock resistance which increases the smoothness of tractor operation.

Following are typical distillation inspections for my synthesized tractor fuel:

	Straight— synthetic fuel	Blended— 20% synthetic fuel; 80% heavy naphtha
	°F.	°F.
Initial boiling point.....	420	356
10% off.....	430	380
20% off.....	437	392
30% off.....	442	399
40% off.....	446	406
50% off.....	452	412
60% off.....	460	420
70% off.....	468	428
80% off.....	480	439
90% off.....	512	454
End point.....	616	520

The refractive index of the above unblended fuel was 1.583 and the A. P. I. gravity 12.2.

One of the characteristics of my synthetic tractor fuel is its high blending value which means that when blended with ordinary tractor fuels, it improves the knock rating of that fuel to a higher degree than would be expected from the amount employed on a straight proportional basis. The following table shows the results obtained:

	Octane number—A. S. T. M.
100% ordinary tractor fuel.....	37.1
90% ordinary tractor fuel plus 10% synthetic fuel.....	46.8
80% ordinary tractor fuel plus 20% synthetic fuel.....	52.5
60% ordinary tractor fuel plus 40% synthetic fuel.....	62.8
100% synthetic tractor fuel.....	90

The knock rating of my synthetic fuel is above 80 and generally between 80 and 110 A. S. T. M.

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Certain advantages are also obtainable by blending my relatively heavy synthetic tractor fuel with lower boiling fractions of the ordinary tractor fuel heretofore employed. Thus, a light fraction was made by distilling off 60% from ordinary tractor fuel. When this was blended in the ratio of 90 parts to 10 parts of synthetic tractor fuel, the knock rating A. S. T. M. was increased from 41.9 to 48. When blended in the ratio of 80 to 20, the knock rating, the A. S. T. M., of this same light tractor fuel was increased to 54. In another example, blending 20 parts of the synthetic fuel with 80 parts of a Mid-Continent virgin heavy naptha increased the knock rating, A. S. T. M., from 25.5 to 43.2. All ratios given here for blending are in parts by volume.

The blended fuel obtained in this way has a wide boiling range which includes those light constituents of the virgin fuel having the best knock rating and the heavy high knock rating constituents of the synthetic fuel. As a result, I obtain more uniform performance with this fuel under engine operating conditions where segregation of the fuel occurs due to partial vaporization in the intake manifold.

Although I have described my invention by means of specific examples, I do not intend that it be limited thereby but only by the scope of the following claims:

I claim:

1. A light tractor fuel having a knock rating in the range of about 47 to 63 which comprises

a petroleum distillate having a boiling range approximately that of heavy naptha and about 10 to 40 per cent of a synthetic hydrocarbon polymer fraction having a higher boiling range than the boiling range of said naptha prepared by contacting a petroleum naptha at conversion temperature in the presence of added hydrogen with a dehydrogenation catalyst and recovering from the product a polymer fraction boiling in the range of about 400 to 600° F. with an A. P. I. gravity of about 10 to 20, and a knock rating above about 80 A. S. T. M.

2. A light tractor fuel as described in claim 1 further characterized in that the finished tractor fuel has an initial boiling point of about 356° F. and a maximum boiling point of about 520° F.

3. The method of preparing a tractor fuel of high knock rating which comprises blending with a low knock rating heavy petroleum naptha boiling substantially within the gasoline boiling range about 10 to 40 per cent of a synthetic polymer fraction boiling in the range of about 400 to 600° F. with a gravity of about 10 to 20 A. P. I., derived from the conversion of a heavy petroleum naptha by contact with a dehydrogenating catalyst at conversion temperature and in the presence of added hydrogen.

4. The process of claim 3 wherein said heavy petroleum naptha is characterized by a knock rating of about 25.5 to 42 A. S. T. M.

RODNEY V. SHANKLAND.