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## METHOD OF PREPARING AN IMPROVED MOTOR FUEL

Albert L. Stanly, Berkeley, Calif., assignor to Shell Development Company, San Francisco, Calif., a corporation of Delaware

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This invention relates to motor fuels for use in high compression internal combustion spark ignition engines operating in the Otto cycle and more particularly deals with blended fuels of reduced knocking tendencies in spark ignition engines.

Supercharging is the most important known method of markedly raising the power output of internal combustion engines. For a given fuel, there is a fuel mixture strength determinable by increasing the cylinder pressure, as by supercharging the engine, until a knock is perceptible, which mixture gives maximum detonation. Fuel admixture having approximately 10% excess fuel over the correct stoichiometrical proportions normally exhibit maximum knock. Octane numbers are determined at this fuel mixture strength.

Some fuels having substantially the same octane rating, however, are known to give markedly different performance in engines which have high compression ratios or are supercharged. It is known, for example, that the tendency of fuels to knock can be suppressed within limits by increasing the ratio of fuel to air, with the result that higher pressures can be reached without encountering knock. Aromatics such as toluene, cumene, benzene, ethylbenzene, etc., and paraffinic fuels blended with these aromatics, are known to permit development of high pressures without knocking, and to give particularly high power outputs when fed to engines in enriched mixtures. However, aromatic blending agents are in general expensive and relatively difficult to obtain in technically pure form. Concentrated mixtures of aromatics obtained by extracting hydrocarbon fuels boiling within the range of the fuel with which the extract is to be blended, have been used although the maximum power outputs obtainable with such materials are usually considerably lower than with certain pure aromatic blending agents such as toluene, xylene, etc., because extracts normally include fairly large proportions of harmful non-aromatic components which lower the obtainable power output.

Now I have discovered that concentrated mixtures of aromatics containing the harmful components in much lower concentrations and being capable of developing excellent maxium power outputs can be obtained by solvent extraction of a gasoline distillate having a relatively wide boiling range and fractionally distilling the extract to remove the lower boiling constituents.

By this method, it is possible to obtain suitable fractions boiling within the gasoline boiling range containing a high percentage of aromatics. For example, an extract, obtained by $SO_2$ extraction of a 220° F. to 316° F. gasoline distillate, boiled from 237° F. to 341° F. This extract contained 67% by volume of aromatics. It was fractionally distilled and yielded fractions containing the following percentages of aromatics:

| Boiling range | Volume percent aromatics | Percent volume of extract |
|---|---|---|
| 245-293° F. | 50 | 14 |
| 278-302° F. | 62 | 18 |
| 296-330° F. | 52 | 10 |
| 313-335° F. | 70 | 28 |
| 333-371° F. | 82 | 30 |

As will be seen, the lowest boiling fraction contains the lowest percentage of aromatic material. Higher boiling portions of extract contain higher percentages of aromatics and therefore by selection of a fraction of the proper boiling range, a blending stock may be obtained from an extract obtainable by conventional solvent extraction without the aid of an excessive number of extraction stages, which blending stocks comprise at least about 40% and preferably 60–80% of the original extract and have a content of aromatics usually about 5–20% higher than that of the extract.

Blending stocks produced by first fractionally distilling to a narrow boiling unextracted fraction having a boiling range of from 25 to 50° F. and then extracting it under the same conditions does not result in extracts of the same high content of aromatics. The extracts thus obtained contain larger quantities of non-aromatic components than extracts produced by my method. As is well known, to make possible the production of extracts having aromatic contents of 80% to 90% by a single extraction normally is very difficult, requiring special equipment.

In carrying out my invention, I extract a gasoline distillate by any conventional method such as countercurrent liquid extraction with any selective solvent for aromatics useful under liquid phase extraction conditions. I, then, fractionally distil the extract so obtained under any convenient pressure in any conventional distillation apparatus. The resulting high boiling, highly concentrated aromatic fraction is then added to spark ignition engine fuels in quantities up to about 50% by volume of the fuels. The choice of relative sizes of low and higher boiling fractions depends on several considerations. In the first place, the desired content of aromatics in the high boiling fractions must be taken into ac-

count. The ease with which a desired minimum can be met, in turn, depends on the content of aromatics in the extract. If the extract is comparatively rich in aromatics, a larger high boiling fraction can be produced of a given aromatic content than when starting with an extract poorer in aromatics. In general, by fractionally distilling the extract to produce two fractions of about equal size and discarding the lower boiling fraction, the percentage of non-aromatics can easily be reduced by 10 to 20% of that contained in the extract, and the aromatic concentration can be increased proportionately.

The lower boiling fraction having the lower content of aromatics may, if desired, be further concentrated by re-extracting it; for example, by the process described in Egli, U. S. 2,114,524. According to this process, the aromatic content of gasoline extracts is increased by re-extracting it in the presence of a higher boiling paraffinic diluent.

Gasoline distillates, from which extracts can be produced containing appreciable quantities of aromatics, may be obtained, for example, by topping certain crude oils, such as California, Texas, Oklahoma, Borneo, etc., crudes or occasionally by cracking, particularly at temperatures in excess of 1000° F. For aviation gasolines, straight run gasoline distillates are in general preferred for my purpose because normally they have a low content of undesirable unsaturated hydrocarbons. As to the boiling range of suitable distillates, it is desirable that it be between about 150° F. and 450° F. Distillates boiling within this range are usually known as naphthas, which term generally includes materials boiling within the gasoline range and the lower end of the light kerosene range. While the boiling range of suitable naphthas which may be extracted to yield the desired extracts may be of any breadth falling within the above limits, I prefer boiling ranges of not more than about 100 F. spread. In conventional refining practice, gasoline distillates are generally separated into 3 or more cuts, each of roughly 100° F. boiling range or less, and it is both economically convenient and advantageous to extract these somewhat relatively narrow boiling cuts.

Some of the better known solvents having selective action toward aromatics which are useful for liquid-liquid extraction in any form are liquid sulfur dioxide, furfural, acetone, phenol, cresols, carbitols, beta-beta-dichlordiethyl ether, nitrobenzene, aniline, etc. This group of solvents is not meant to be all-inclusive, and is given merely by way of example.

The aromatic high boiling fractions obtained by the above method are useful as safety fuels, fuels for engines having fuel injection systems where volatility is secondary; or for blending with conventional straight-run or cracked automobile fuels, aviation fuel; or with synthetic, substantially non-aromatic fuels, which are useful alone or in blends as aviation fuels, such as alkylates, hot and cold acid octanes, etc., or with neohexane, 2,3,-dimethyl butane, triptane, and other saturated hydrocarbons, particularly those boiling in the lower gasoline boiling range, such as isopentane, cyclopentane, cyclohexane, etc., or blends of any of the above fuels, or blends of the above fuels with branched-chain alkyl ethers.

The amounts of my aromatic fractions that may be blended into fuels will depend upon the power, volatility, freezing point, and other requirements specified for the particular fuel. Amounts will vary generally from about 5% to 50%, preferably 5% to 30%. For automotive fuels, the factors controlling the amounts added are primarily the octane rating. In aviation fuels, on the other hand, the aromatic content generally should not exceed 30%, as fuel weight and economy on a weight basis which favor paraffinic fuels under cruising conditions are of great importance. In addition, concentrations of aromatics in excess of 30% are likely to cause damage to the self-sealing linings of airplane fuel tanks.

The anti-detonation properties of fuel blended with my aromatic fractions can be fortified or increased by addition of tetraethyl lead and other organo-metallic anti-knock agents.

The following example further illustrates my invention:

*Example*

Two straight-run gasoline distillates boiling between 220° to 316° F. and 306° to 385° F. obtained from a common stock, were subjected individually to countercurrent extraction with $SO_2$ and yielded extracts boiling between 237° to 341° F. and 311° F. to 402° F. respectively. Both extracts were fractionally distilled to yield two fractions of substantially identical boiling ranges. The first of these fractions was obtained from the low boiling extract and had a boiling range from 281° to 339° F. The second fraction was obtained from the higher boiling extract and had a boiling range from 270° to 339° F. The first fraction contained 80% by volume of aromatics while the second fraction contained 59% by volume of aromatics.

Each of the fractions was blended to produce two fuels as shown in the table below in the column "Blended fuels." The resulting four fuels were tested on the C. F. R. engine.

The tests were made by running the C. F. R. engine on each of the fuels at a normal fuel-air ratio and then raising the intake manifold pressure until a knock was perceptible, whereupon the power output was noted. The fuel mixture was then enriched and the intake pressure again increased until knocking was encountered. The maximum indicated mean effective pressure (I. M. E. P.) permitted by detonation for enriched fuel mixtures was determined by varying the intake manifold pressure. Results were as follows:

| Blended fuel | Percent aromatic | $\left(\frac{\text{I. M. E. P. of blended fuel}}{\text{I. M. E. P. of CP isooctane}}\right)\times 100$ |
|---|---|---|
| 281°-339° F. portion of low boiling extract+3 cc. T. E. L. | 80 | 161 |
| 270°-339° F. portion of the higher boiling extract +3 cc. T. E. L. | 59 | 108 |
| 50% 73 octane number straight run base stock—50% 281°-339° F. portion of low boiling extract +3 cc. T. E. L. per gal. | | 108 |
| 50% 73 octane number straight run base stock—50% 270°-339° F. portion of higher boiling extract+3 cc. T. E. L. | | 95 |

I claim as my invention:

1. The method of preparing an improved motor fuel for spark ignition engines comprising extracting a gasoline distillate, containing aromatic

components, with a selective solvent for aromatics, fractionally distilling the resulting extract to separate at least two fractions, a high boiling and a lower boiling one, the latter of which consists of at least 20% of said extract, and adding the high boiling fraction comprising at least 40% of the extract to gasoline.

2. The method of preparing an improved motor fuel for spark ignition engines comprising extracting a gasoline distillate, boiling between about 150° F. and 450° F. and containing aromatic components, with a selective solvent for aromatics, fractionally distilling the resulting extract to separate a lower boiling fraction consisting of at least 20% of said extract and a high boiling fraction, and adding the high boiling fraction comprising at least about 40% of the extract to gasoline.

3. The method of preparing an improved motor fuel for spark ignition engines comprising extracting a gasoline distillate having a boiling range not greater than 100° F. and containing aromatic components, with a selective solvent for aromatics, fractionally distilling the resulting extract to separate a lower boiling fraction consisting of at least 20% of said extract and a high boiling fraction, and adding the high boiling fraction comprising at least about 40% of the extract to gasoline.

4. The method of preparing an improved motor fuel for spark ignition engines comprising extracting a gasoline distillate, boiling between about 150° F. and 450° F. and containing aromatic components, with a selective solvent for aromatics, fractionally distilling the resulting extract to separate a lower boiling fraction and a high boiling fraction containing not more than the upper boiling half of said extract, and adding the high boiling half of the extract to gasoline.

5. The method of preparing an improved motor fuel for spark ignition engines comprising extracting a gasoline distillate, boiling between about 150° F. and 450° F. and containing aromatic components, with a selective solvent for aromatics, fractionally distilling the resulting extract to separate a lower boiling fraction, which is discarded, containing the material boiling in roughly the lower 20% of the extract boiling range and a high boiling fraction containing the balance of said extract, and adding the high boiling fraction of the extract to gasoline.

6. The method of claim 1 wherein the gasoline distillate is a straight run gasoline distillate.

ALBERT L. STANLY.