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REACTIONS WITH ISOPENTANE IN THE PRESENCE OF A LIQUID CATALYST

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12 Claims. (Cl. 196—78)

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This invention relates to a process of "averaging" hydrocarbons, in which one of the reacting hydrocarbons is a pentane.

In my patent application Serial No. 423,073, filed December 15, 1941, there is set forth the reacting of normally gaseous hydrocarbons with normally liquid hydrocarbons. In the present invention, action of such general type is extended to include reaction of such a normally liquid hydrocarbon as isopentane or mixtures of isopentane and normally gaseous hydrocarbons, preferably isobutane, with hydrocarbons of higher molecular weight. I have found that when isopentane is applied in reaction with hydrocarbons of six or more carbon atoms, large quantities of isobutane are formed along with highly branched gasoline fractions. Neohexane, in particular, is readily made by thus averaging with isopentane. And, generally isopentane or mixtures of isopentane and normally gaseous hydrocarbons may be reacted with hydrocarbons of more than five carbon atoms such that products in the gasoline range are obtained.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described, and particularly pointed out in the claims, the following description setting forth in detail certain illustrative embodiments of the invention, these being indicative however, of but a few of the various ways in which the principle of the invention may be employed.

Any convenient source of hydrocarbons may be used, and isopentane or mixtures thereof with lower hydrocarbons are applicable for the lighter component, the isopentane or mixtures being used in amounts of 1–10 mols per mol of heavier hydrocarbon. The heavier hydrocarbons employed are those containing preferably more than six carbon atoms. Where hydrocarbon stocks contain aromatic compounds these may be first removed by extracting with selective solvents or by reacting out in formation of complexes with the catalyst, although reaction can be proceeded with in spite of the aromatic content. Desirably, the aromatic content should be less than 2 per cent. The material may contain other unsaturated hydrocarbons. Kerosene and gas oil distillates are preferred stocks.

The catalyst consists of liquid hydrofluoric acid in which one-half to 50 mol per cent of boron fluoride is dissolved. The partial pressure of boron fluoride may be 5–550 pounds per square inch, and preferably 10–150 pounds. The amount of such promoted catalyst applied to the hydrocarbon may be 5–300 volume per cent of the liquid hydrocarbon used. The amount of boron fluoride applied depends upon the desired activity of the catalyst. Very exact control of the catalyst and a particularly flexible control of operation and product is thus possible. The pressure is maintained sufficient to keep the hydrogen fluoride in liquid state. The catalyst may finally be separated from the hydrocarbons and be returned for reaction with the incoming feed.

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The temperatures may be relatively low, minus 30° C. up, and particularly 20 to 100° C.

In reaction with isopentane and hydrocarbons of at least six carbon atoms, the course of the reaction may be represented as follows:

$$\text{Isopentane} + C_nH_{2n+} \rightarrow \text{i-butane} + \text{branched hexanes, heptanes, octanes, etc.}$$

As an example: A kerosene distillate from Illinois petroleum was reacted with 4.9 mols of i-pentane per mol of kerosene at 32° C., the catalyst being 33 volume per cent HF used with 150 pounds partial pressure of BF_3, and reaction time two hours. The product showed 77.6 per cent of the total charge that was converted, the products comprising 0.75 per cent of propane, 42.8 per cent of isobutane, 16.2 per cent of neohexane, and a gasoline yield of 37 per cent.

As another example: A similar kerosene distillate was reacted with a mixture of isopentane and a butane fraction containing 15 per cent of isopentane at 0° C., the mol ratios of the hydrocarbon for reaction being 5.3 C_4:1.45 C_5:1 kerosene. The catalyst was 28.3 volume per cent of HF used with 150 pounds pressure of BF_3. The product showed 96.6 per cent of the total charge converted. Of the product, 86.3 weight per cent was a gasoline, including 2,3 dimethylbutane and triptane as shown by the Ewell distillation curve.

By "averaging" as used herein I mean the reaction of a higher and a lower molecular weight hydrocarbon to form a hydrocarbon of intermediate molecular weight.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims, or the equivalent of such, be employed.

I therefore particularly point out and distinctly claim as my invention:

1. A process of averaging a liquid petroleum fraction comprised primarily of normal hydrocarbons having at least six carbon atoms, with another petroleum fraction containing an appre-

ciable amount of isopentane, in the presence of a catalyst comprised essentially of liquid hydrogen fluoride in which is dissolved not over 50 mol percent of boron trifluoride (based on the hydrogen fluoride) to provide a partial pressure of boron trifluoride of 5 to 550 pounds per square inch, and continuing the reaction under a pressure to maintain the hydrogen fluoride liquid thereby to form hydrocarbons intermediate said reacting petroleum fractions.

2. A process of averaging a liquid petroleum fraction comprised primarily of normal hydrocarbons having at least six carbon atoms, with another petroleum fraction containing butane and an appreciable amount of isopentane, in the presence of a catalyst comprised essentially of liquid hydrogen fluoride in which is dissolved not over 50 mol percent of boron trifluoride (based on the hydrogen fluoride) to provide a partial pressure of boron trifluoride of 5 to 550 pounds per square inch, and continuing the reaction under a pressure to maintain the hydrogen fluoride liquid thereby to form hydrocarbons intermediate said reacting petroleum fractions.

3. A process of averaging a liquid petroleum fraction comprised primarily of normal hydrocarbons having at least six carbon atoms and boiling in the gas oil-kerosene range, with another petroleum fraction containing an appreciable amount of isopentane, at a temperature of not over 100° C. and in the presence of 5 to 300 volume percent (based on the liquid hydrocarbons) of a catalyst comprised essentially of liquid hydrogen fluoride in which is dissolved not over 50 mol percent of boron trifluoride (based on the hydrogen fluoride) to provide a partial pressure of boron trifluoride of 5 to 550 pounds per square inch, and continuing the reaction under a pressure to maintain the hydrogen fluoride liquid thereby to form hydrocarbons intermediate said reacting petroleum fractions.

4. A process of averaging a liquid petroleum fraction comprised primarily of normal hydrocarbons having at least six carbon atoms and boiling in the gas oil-kerosene range, with another petroleum fraction containing butane and an appreciable amount of isopentane, at a temperature of not over 100° C., and in the presence of 5 to 300 volume percent (based on the liquid hydrocarbons) of a catalyst comprised essentially of liquid hydrogen fluoride in which is dissolved not over 50 mol percent of boron trifluoride (based on the hydrogen fluoride) to provide a partial pressure of boron trifluoride of 5 to 550 pounds per square inch, and continuing the reaction under a pressure to maintain the hydrogen fluoride liquid thereby to form hydrocarbons intermediate said reacting petroleum fractions.

5. A process of averaging kerosene with another petroleum fraction containing an appreciable amount of isopentane, at a temperature of not over 100° C. and in the presence of 5 to 300 volume percent (based on the liquid hydrocarbons) of a catalyst comprised essentially of liquid hydrogen fluoride in which is dissolved not over 50 mol percent of boron trifluoride (based on the hydrogen fluoride) to provide a partial pressure of boron trifluoride of 5 to 550 pounds per square inch, and continuing the reaction under a pressure to maintain the hydrogen fluoride liquid thereby to form hydrocarbons intermediate said kerosene and said isopentane.

6. A process of averaging kerosene with another petroleum fraction containing butane and an appreciable amount of isopentane, at a temperature of not over 100° C. and in the presence of 5 to 300 volume percent (based on the liquid hydrocarbons) of a catalyst comprised essentially of liquid hydrogen fluoride in which is dissolved not over 50 mol percent of boron trifluoride (based on the hydrogen fluoride) to provide a partial pressure of boron trifluoride of 5 to 550 pounds per square inch, and continuing the reaction under a pressure to maintain the hydrogen fluoride liquid thereby to form hydrocarbons intermediate said kerosene and said isopentane.

7. A process of averaging gas oil with another petroleum fraction containing an appreciable amount of isopentane, at a temperature of not over 100° C. and in the presence of 5 to 300 volume percent (based on the liquid hydrocarbons) of a catalyst comprised essentially of liquid hydrogen fluoride in which is dissolved not over 50 mol percent of boron trifluoride (based on the hydrogen fluoride) to provide a partial pressure of boron trifluoride of 5 to 550 pounds per square inch, and continuing the reaction under a pressure to maintain the hydrogen fluoride liquid thereby to form hydrocarbons intermediate said gas oil and said isopentane.

8. A process of averaging a liquid petroleum fraction comprised primarily of normal hydrocarbons having at least six carbon atoms and boiling in the gas oil-kerosene range, with another petroleum fraction containing an appreciable amount of isopentane, at a temperature of not over 100° C. and in the presence of 5 to 300 volume percent (based on the liquid hydrocarbons) of a catalyst the catalytic ingredients of which are comprised essentially of liquid hydrogen fluoride in which is dissolved not over 50 mol percent of boron trifluoride (based on the hydrogen fluoride) to provide a partial pressure of boron trifluoride of 5 to 550 pounds per square inch, the activity of said catalyst being controllable by the regulation of the partial pressure of the boron trifluoride, and continuing the reaction under a pressure to maintain the hydrogen fluoride liquid, whereby substantial amounts of isobutane and branched chain hydrocarbons intermediate said reacting petroleum fractions are formed.

9. A process of averaging a liquid petroleum fraction comprised primarily of normal hydrocarbons having at least six carbon atoms and boiling in the gas oil-kerosene range, with another petroleum fraction containing butane and an appreciable amount of isopentane, at a temperature of not over 100° C. and in the presence of 5 to 300 volume percent (based on the liquid hydrocarbons) of a catalyst the catalytic ingredients of which are comprised essentially of liquid hydrogen fluoride in which is dissolved not over 50 mol percent of boron trifluoride (based on the hydrogen fluoride) to provide a partial pressure of boron trifluoride of 5 to 550 pounds per square inch, the activity of said catalyst being controllable by the regulation of the partial pressure of the boron trifluoride, and continuing the reaction under a pressure to maintain the hydrogen fluoride liquid, whereby substantial amounts of isobutane and branched chain hydrocarbons in the gasoline range are formed.

10. A process of averaging a kerosene fraction with at least one mol of isopentane per mol of kerosene, at a temperature of not over 100° C. and in the presence of 5 to 300 volume percent (based on the liquid hydrocarbons) of a catalyst the catalytic ingredients of which are comprised essentially of liquid hydrogen fluoride in which is dissolved not over 50 mol percent of boron

trifluoride (based on the hydrogen fluoride) to provide a partial pressure of boron trifluoride of 5 to 550 pounds per square inch, the activity of said catalyst being controllable by the regulation of the partial pressure of the boron trifluoride, and continuing the reaction under a pressure to maintain the hydrogen fluoride liquid, whereby substantial amounts of isobutane and branched chain hydrocarbons in the gasoline range are formed.

11. A process of averaging kerosene with at least one mol of isopentane per mol of kerosene and in the presence of butane, at a temperature of not over 100° C. and in the presence of 5 to 300 volume percent (based on the liquid hydrocarbons) of a catalyst the catalytic ingredients of which are comprised essentially of liquid hydrogen fluoride in which is dissolved not over 50 mol percent of boron trifluoride (based on the hydrogen fluoride) to provide a partial pressure of boron trifluoride of 5 to 550 pounds per square inch, the activity of said catalyst being controllable by the regulation of the partial pressure of the boron trifluoride, and continuing the reaction under a pressure to maintain the hydrogen fluoride liquid, whereby substantial amounts of isobutane and branched chain hydrocarbons in the gasoline range are formed.

12. A process of averaging a gas oil fraction with at least one mol of isopentane per mol of gas oil, at a temperature of not over 100° C. and in the presence of 5 to 300 volume percent (based on the liquid hydrocarbons) of a catalyst the catalytic ingredients of which are comprised essentially of liquid hydrogen fluoride in which is dissolved not over 50 mol percent of boron trifluoride (based on the hydrogen fluoride) to provide a partial pressure of boron trifluoride of 5 to 550 pounds per square inch, the activity of said catalyst being controllable by the regulation of the partial pressure of the boron trifluoride, and continuing the reaction under a pressure to maintain the hydrogen fluoride liquid, whereby substantial amounts of isobutane and branched chain hydrocarbons in the gasoline range are formed.

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