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DEHYDROGENATION OF HYDROCARBONS CONTAINING AN ALKYLCYCLOPENTANE RING

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This invention relates to the production of an aromatic hydrocarbon by the conversion of a hydrocarbon containing a cyclopentane ring. More particularly, the process relates to the conversion of an alkylcyclopentane hydrocarbon into an aromatic hydrocarbon having one less carbon atom in the side chain than in the side chain of the charged alkylcyclopentane hydrocarbon.

An object of this invention is to convert an alkylcyclopentane hydrocarbon into an aromatic hydrocarbon.

Another object of this invention is to convert ethylcyclopentane into toluene.

One embodiment of this invention relates to a process for producing an alkyl aromatic hydrocarbon which comprises dehydrogenating an alkylcyclopentane hydrocarbon in the presence of a dehydrogenation catalyst and of an acid-acting material to form an alkyl aromatic hydrocarbon and recovering said alkyl aromatic hydrocarbon.

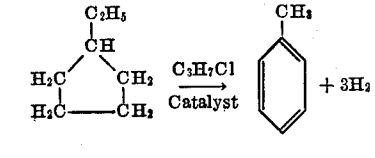
Another embodiment of this invention relates to a process for producing an alkyl aromatic hydrocarbon which comprises dehydrogenating an alkylcyclopentane hydrocarbon in the presence of an alkyl halide to form an alkyl aromatic hydrocarbon and recovering said alkyl aromatic hydrocarbon.

A further embodiment of this invention relates to a process for producing an alkyl aromatic hydrocarbon which comprises dehydrogenating an alkylcyclopentane hydrocarbon in the presence of a hydrogen halide to form an alkyl aromatic hydrocarbon and recovering said alkyl aromatic hydrocarbon.

A still further embodiment of this invention relates to a process for producing an alkyl aromatic hydrocarbon which comprises dehydrogenating an alkylcyclopentane hydrocarbon in the presence of an alkyl chloride to form an alkyl aromatic hydrocarbon and recovering said alkyl aromatic hydrocarbon.

This process for producing aromatic hydrocarbons and alkyl aromatic hydrocarbons is applicable particularly to the treatment of alkylcyclopentane hydrocarbons but it may be used also on polycyclic hydrocarbons containing an alkyl cyclopentane group and is utilizable even on polycyclic hydrocarbons containing a cyclopentane fused ring such as is present in ethylindan, ethylperhydroindan, and the like. Thus the dehydrogenation of ethylindan in the presence of propyl chloride and of a platinum-alumina catalyst gives a substantial yield of 1-methyl naphthalene.

We have found that an alkylcyclopentane hydrocarbon in the presence of an acid-acting material undergoes dehydrogenation to aromatic hydrocarbons when passed over an active dehydrogenation catalyst such as platinized alumina, platinum on silica, and the like, whereas in the absence of the acid-acting material substantially no dehydrogenation occurs. Thus ethylcyclopentane when contacted with platinized alumina at a temperature of 330° C. underwent substantially no reaction but a mixture of 95% of ethylcyclopentane and 5% of normal propyl chloride gave a 20% yield of toluene when passed over a platinum-alumina catalyst at a temperature of 330° C. Such a conversion of ethylcyclopentane into toluene is represented by the following equation which indicates that propylchloride functions as a catalyst.



In this treatment, the mixture of alkylcyclopentane and alkyl chloride or other added acid-acting material is passed over the catalyst at a rate corresponding to an hourly liquid space velocity of from about 0.1 to about 2. The catalyst is generally maintained at a temperature of from about 275° to about 400° C. in order to effect active dehydrogenation in the presence of platinum-alumina, platinum-charcoal and other supported platinum catalysts. The addition of platinum to other dehydrogenation catalyst such as chromia-alumina, chromia-molybdenum oxide and the like is generally beneficial in promoting isomerization and dehydrogenation to form alkylated aromatic hydrocarbons.

Although the acid-producing material or acidic material employed in this process to promote isomerization and dehydrogenation may be added continuously or intermittently together with the hydrocarbon charging stock, a dehydrogenation catalyst may also be prepared in which a stable acid-acting compound is present therein as well as material which promotes dehydrogenation. Thus, the presence of small amounts of silica-alumina mixed with a dehydrogenation catalyst will promote both dehydrogenation and isomerization. Also the addition of a small amount of hydrofluoric acid to alumina forms an acid-type catalyst suitable for promoting the dehydrogenation and isomerization reactions of this process.

Aromatic and alkyl aromatic hydrocarbons formed by this process are useful as solvents and intermediates in organic synthesis as in the production of dyes, medicinals, insecticides, etc. Some of the lower boiling polyakylated aromatic hydrocarbons have high antiknock qualities and are accordingly valuable components of gasolines.

The invention is further illustrated by the following example but it is to be understood that the broad scope of the invention is not limited thereto.

Platinum-alumina catalyst, (H. Pines, R. C. Olberg and V. N. Ipatieff, J. Amer. Chem. Soc. 70, 533 (1948)) was prepared by heating platinum, 12.0 grams on a steam-bath with aqua regia, until solution was complete. The excess acid was removed by evaporating the solution almost to dryness and then adding a 100 cc. portion of water and again evaporating down; this procedure was repeated ten times. The chloroplatinic acid was dissolved in 200 cc. of distilled water and suction filtered to remove any contaminants. The clear filtrate was added to 150 cc. (120 grams) of 10–12 mesh alumina so that the liquid completely covered the alumina. The solution was evaporated on a steam-bath with thorough stirring. When dry the catalyst had a uniform yellow-orange color. It was heated in a vertical furnace at 100° C. in an atmosphere of hydrogen for several hours. The temperature was then raised to 200° C. and the heating continued for several more hours. Finally it was heated at 254° C. for two hours prior to use for dehydrogenation. The reduced catalyst had a uniform gray color.

Platinum-alumina catalyst containing about 7% by weight of platinum and prepared as indicated above was supported in a Pyrex tube and maintained at a temperature of 330° C. while a mixture of 95% by weight of ethylcyclopentane and 5% by weight of normal propyl chloride was passed therethrough at an hourly liquid space velocity of 0.2. Gases formed in this dehydrogenation treatment consisted essentially of hydrogen and relatively small amounts of methane. The liquid product recovered was equivalent to 95% by volume of the ethylcyclopentane charged and was found to contain 20% by weight of toluene. As the unconverted ethylcyclopentane which was separated from the toluene was suitable for recycling to the process, the toluene yield was 85% based upon the amount of ethylcyclopentane converted.

We claim as our invention:

1. A process for producing an aromatic hydrocarbon which comprises dehydrogenating a hydrocarbon containing an alkylcyclopentyl group in the presence of a platinum-containing dehydrogenation catalyst and an alkyl halide to form a hydrocarbon containing an aryl group and recovering the resultant aromatic hydrocarbon.

2. A process for producing an alkyl aromatic hydrocarbon which comprises dehydrogenating an alkyl cyclopentane hydrocarbon in the presence of a platinum-containing dehydrogenation catalyst and an alkyl halide to

form an alkyl aromatic hydrocarbon and recovering said alkyl aromatic hydrocarbon.

3. A process for producing an alkyl aromatic hydrocarbon which comprises dehydrogenating an alkyl cyclopentane hydrocarbon in the presence of a platinum-containing dehydrogenation catalyst and an alkyl chloride to form an alkyl aromatic hydrocarbon and recovering said alkyl aromatic hydrocarbon.

4. A process for producing an alkyl aromatic hydrocarbon which comprises dehydrogenating an alkylcyclopentane hydrocarbon in the presence of a platinum-containing catalyst and of an alkyl chloride at a temperature of from about 275° to about 400° C. to form an alkyl aromatic hydrocarbon, and recovering said alkyl aromatic hydrocarbon.

5. A process for producing toluene which comprises dehydrogenating ethylcyclopentane in the presence of a platinum-alumina catalyst and of propyl chloride at a temperature of from about 275° to about 400° C. and recovering the resultant toluene.

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