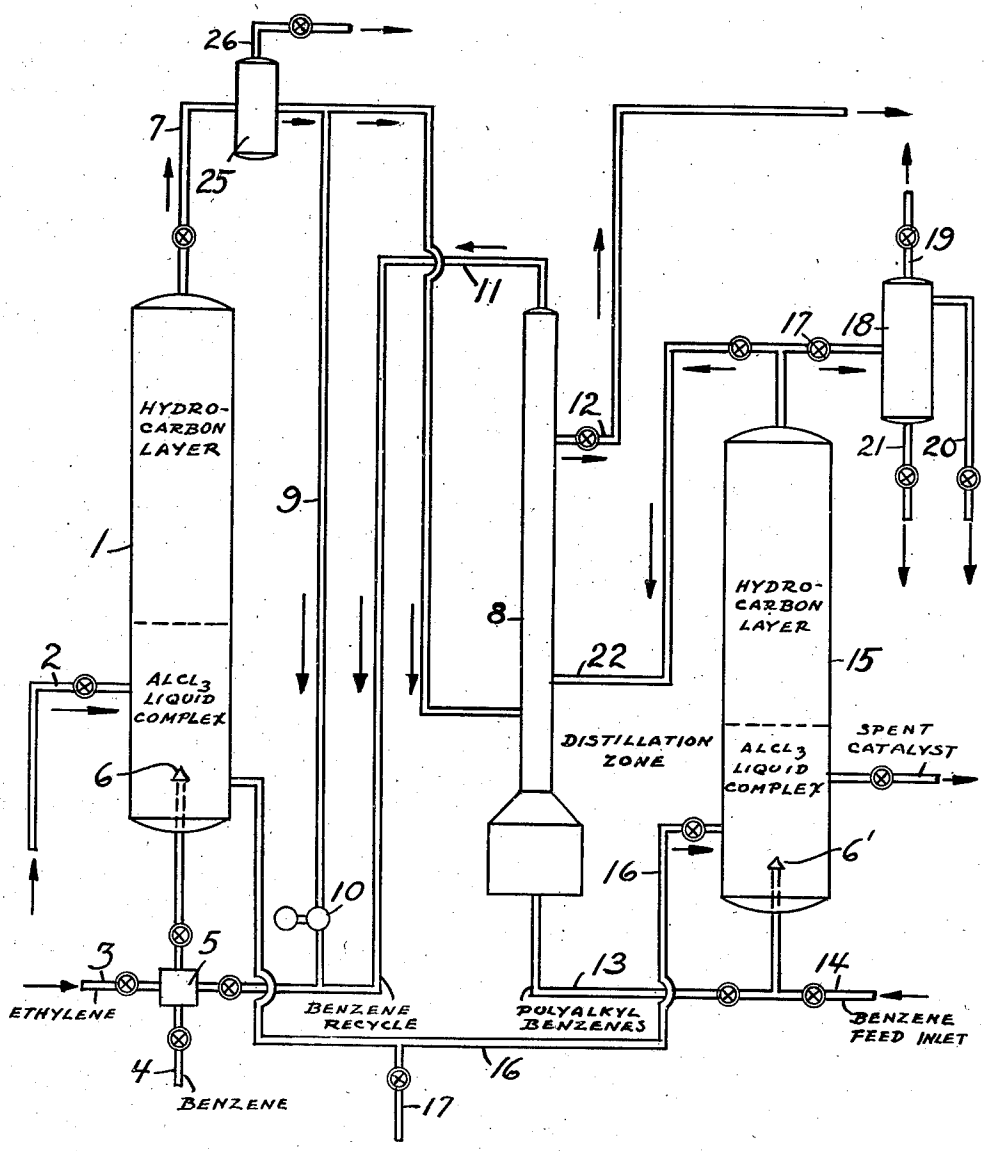
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PRODUCTION OF ETHYL BENZENE

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PRODUCTION OF ETHYL BENZENE

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The present invention is concerned with the manufacture of ethyl benzene. The invention is more particularly concerned with an improved process by which a maximum yield of mono-ethyl benzene may be readily secured with minimum formation of undesirable poly-ethyl benzenes. In accordance with the present process benzene is reacted with ethylene in an initial stage under conditions to form mono-ethyl benzene. The reaction product is separated and the mono-ethyl benzene recovered. The poly-ethyl benzenes are then contacted in a secondary stage with additional benzene in the absence of ethylene to form an additional yield of mono-ethyl benzene. By operating in this manner a maximum yield of the desired product is secured with a minimum formation of poly-ethyl benzenes.

It is well known in the art to react benzene and ethylene under suitable conditions in the presence of various catalysts to form ethyl benzene. The desired product comprises mono-ethyl benzene. However, in these reactions, it is relatively difficult to control the reaction so that poly-ethyl benzenes are not formed. I have, however, now discovered a process by which a maximum yield of mono-ethyl benzene may be secured with a minimum formation of undesirable poly-ethyl benzenes. My process may be readily understood by reference to the attached drawing illustrating one embodiment of the same.

Referring specifically to the drawing, it is assumed for the purpose of illustration, that the catalyst used comprises aluminum chloride and that the same is introduced into reaction zone 1 by means of line 2. The stream comprising ethylene is introduced into the system by means of line 3 while the stream comprising benzene is introduced into the system by means of line 4. The respective streams are passed through mixing zone 5 and introduced into zone 1 by means of jets or equivalent means 6. Temperature and pressure conditions within zone 1 are adapted to secure the maximum yield of mono-ethyl benzene. In general, the temperatures are in the range from about 100° F. to about 200° F. and the pressures are sufficient to maintain the constituents in a liquid phase. The reaction products are removed overhead from zone 1 by means of line 7 and passed to distillation zone 8. Under certain conditions it may be desirable to recirculate a portion of the overhead to reaction zone 1 by means of line 9 and pump 10. Unreacted ethylene may be removed from the overhead by passing the reaction products to gas liquid separator 25 in which the ethylene is separated and removed by means of line 26.

Temperature and pressure conditions in distillation zone 8 are adjusted to remove overhead by means of line 11, the unreacted benzene which is preferably recycled to zone 1. Ethyl benzene is removed as a side stream from distillation zone 8 by means of line 12 and handled as desired. The higher boiling constitutents comprising poly-alkyl benzenes are withdrawn from distillation zone 8 by means of line 13, combined with additional benzene which is introduced by means of line 14 and the combined stream then passed into reaction zone 15 by means of jets or equivalent means 6. For the purpose of description it is assumed that the catalyst in zone 15 comprises aluminum chloride. It is also assumed that the catalyst utilized in zone 15 is removed from zone 1 and introduced into zone 15 by means of line 16. Fresh catalyst may be introduced into zone 15 by means of line 17.

The temperature and pressure conditions maintained in zone 15 are in the general range from about 100° to about 500° F. The pressure conditions are sufficient to maintain the constituents in the liquid phase. The reaction product comprising ethyl benzene is removed overhead by means of line 17^1 and introduced into distillation zone 18. Temperature and pressure conditions are adjusted to remove benzene overhead from zone 18 by means of line 19 which benzene may be recycled to reaction zone 15. The benzene may also be recycled to reaction zone 1. The ethyl benzene is removed as a side stream by means of line 20 and preferably combined with the ethyl benzene removed by means of line 12. The higher boiling hydrocarbon constituents removed by means of line 21 may be recycled to zone 15 or withdrawn from the system. Under certain conditions, the entire reaction product from zone 15 may be introduced into zone 8 by means of line 22.

The process of the present invention may be widely varied. It is to be understood that the respective zones may comprise any suitable number and arrangement of units. The invention essentially comprises reacting benzene with ethylene in an initial stage, removing the reaction products and separating the same into mono-ethyl benzene and into higher poly-ethyl benzenes. The higher poly-ethyl benzenes are then reacted in a secondary stage with an additional quantity of benzene to form mono-ethyl benzene.

The catalyst employed in the respective stages

may comprise any of the conventional Friedel-Crafts catalysts such as aluminum chloride, iron chloride, zinc chloride, and the various metallic halides. The amount of benzene employed with respect to ethylene in the initial zone may vary considerably. However, in general I have found that it is preferred to use a molar excess of benzene as compared to ethylene. For example, I have found it desirable to employ from about 25% to about 100% molar excess of benzene to ethylene in the initial stage. In the secondary stage it is likewise desirable to employ a molar excess of benzene, usually in the range from about 50 to 100% excess, based upon the poly-ethyl benzenes.

The operating temperatures in the initial stage may vary considerably but are generally in the range from about 100° F. to about 200° F. Preferred temperatures are in the range from about 160° F. to about 170° F. The temperatures in the secondary stage are somewhat higher and are in the general range from about 100° F. to about 500° F. Preferred temperatures for utilization in the secondary stage are in the range from about 130° F. to about 250° F. In general, the pressures are sufficient to maintain the constituents in a liquid phase.

In order to illustrate my invention further, the following example is given which should not be construed as limiting the same in any manner whatsoever:

Example

Ethylene was reacted with benzene at a temperature of 160° F. and at atmospheric pressure. Approximately 27 moles of ethylene were introduced per 40 moles of benzene, utilizing one mole of aluminum chloride as catalyst. The reaction product secured comprised the following:

	Parts by weight
Unreacted benzene	1446
Ethyl benzene	1102
Poly-ethyl benzenes	878

The poly-ethyl benzenes were segregated and 500 parts by weight of the same containing 35 parts by weight of mono-ethyl benzene and 465 parts by weight of poly-ethyl benzenes were treated with 1000 parts by weight of benzene at 160° F. using aluminum chloride as the catalyst. The product obtained consisted of 558 parts by weight of mono-ethyl benzene, 196 parts by weight of poly-ethyl benzene and 734 parts by weight of unreacted benzene. Thus 57.8% of the poly-ethyl benzenes and 26.6% of the benzene were converted to mono-ethyl benzene in accordance with my process.

A particular adaptation of the present invention is in the case where an impure commercial benzene is used in the process. The fresh benzene is preferably introduced into reaction zone 15 and thus given a pretreatment with partially spent catalyst in addition to effecting the reaction between benzene and poly-ethyl benzenes. The purified benzene is then recycled to reaction zone 1. In an operation of this character the fresh catalyst is introduced into reaction zone 1 and only partially spent catalyst is employed in reaction zone 15. The reaction between benzene and poly-ethyl benzenes goes more readily than the reaction between benzene and ethylene, so that a less active catalyst and a benzene feed with some impurities may be used.

What I wish to claim as new and protect by Letters Patent is:

1. Improved process for production of mono-ethyl benzene which comprises reacting benzene with ethylene in the presence of a Friedel-Crafts catalyst in an initial stage, separating the reaction product from partially spent Friedel-Crafts catalyst and segregating poly-ethyl benzenes therefrom, reacting said poly-ethyl benzenes in a secondary stage with additional benzene in the presence of the partially spent Friedel-Crafts catalyst in the absence of ethylene, whereby additional mono-ethyl benzene is formed, separating the reaction product from said secondary stage and recovering the mono-ethyl benzene therefrom.

2. Process as defined by claim 1 in which said Friedel-Crafts catalyst comprises aluminum chloride.

3. Process as defined by claim 1 in which the temperature utilized in said secondary stage is from 30° to 50° F. higher than the temperature employed in said initial stage.

4. An improved process for the production of monoethyl benzene which comprises reacting benzene with ethylene in the presence of a Friedel-Crafts catalyst in an initial stage, separating the reaction product from the partially-spent catalyst and segregating poly-ethyl benzenes therefrom, reacting said poly-ethyl benzenes in a secondary stage with impure commercial benzene in the presence of said partially spent catalyst in the absence of ethylene, thereby converting part of the poly-ethyl benzenes to monoethyl benzene, separating the reaction product from said secondary stage, recovering the monoethyl benzene and unreacted benzene therefrom and supplying said unreacted benzene to the initial stage for reaction with ethylene.

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