CLAIMS

1. A process for producing cyclohexylbenzene comprising:

(a) introducing hydrogen and benzene to a first hydroalkylation reaction zone containing a hydroalkylation catalyst;

(b) operating said first hydroalkylation reaction zone under at least partly liquid phase conditions sufficient to effect hydroalkylation of at least a portion of the benzene in the presence of said hydroalkylation catalyst to produce a first mixture exiting the first reaction zone comprising a liquid phase and a vapor phase;

(c) separating the first mixture into a first liquid effluent comprising cyclohexylbenzene and a portion of unreacted benzene and a first vapor effluent comprising a portion of the unreacted benzene;

(d) cooling at least a portion of the first vapor effluent to obtain a second liquid effluent containing at least a portion of the unreacted benzene; and

(e) recycling at least a portion of the second liquid phase stream to the first hydroalkylation reaction zone or to contact the first mixture or to mix with the first liquid effluent.

2. The process of claim 1, wherein the benzene contained in second liquid effluent is at least 1 wt% of the total weight of the first mixture.

3. The process of claim 1, wherein the benzene contained in the first liquid effluent is at least 3 wt% of the total weight of the first mixture.

4. The process of claim 1, wherein the benzene contained in the first liquid effluent is at least 10 wt% of the total weight of the first mixture.

5. The process of claim 1, further comprising:

(f) introducing at least a portion of the first liquid effluent and additional hydrogen to a second hydroalkylation reaction zone containing a hydroalkylation catalyst and connected in series with the first hydroalkylation reaction zone; and

(g) operating said second hydroalkylation reaction zone under at least partly liquid phase conditions sufficient to effect hydroalkylation of at least a portion

of the unreacted benzene in the first liquid effluent in the presence of said hydroalkylation catalyst to produce a third liquid effluent comprising cyclohexylbenzene.

6. The process of any of the preceding claims, wherein the cooling (d) is effected by passing the portion of the first vapor effluent through a heat exchanger, and the heat exchanger supplies heat to another portion of a process existing at the same location.

7. The process of claim 6, wherein said heat exchanger supplies heat to a reboiler for a benzene distillation column.

8. The process of claim 6, wherein said heat exchanger supplies heat to the feed to a dehydrogenation reactor for converting cyclohexane produced as a by-product of said operating steps (b) and (g) to benzene.

9. The process of any of the preceding claims 5 to 8, wherein each of said operating steps (b) and (g) is conducted at a temperature of about 100°C to about 250°C and a pressure of about 100 kPa to about 7,000 kPa.

10. The process of any of the preceding claims, wherein the hydroalkylation catalyst comprises at least one molecular sieve and at least one hydrogenation metal.

11. The process of claim 10, wherein the at least one molecular sieve is selected from zeolite beta, mordenite, zeolite X, zeolite Y, and a molecular sieve of the MCM-22 family.

12. A process for coproducing phenol and cyclohexanone, the process comprising producing cyclohexylbenzene by the process of any of the preceding claims, oxidizing the cyclohexylbenzene to produce cyclohexylbenzene hydroperoxide and cleaving the cyclohexylbenzene hydroperoxide to produce phenol and cyclohexanone.

13. A process for producing cyclohexylbenzene comprising:

(a) introducing hydrogen and benzene to a first hydroalkylation reaction zone containing a hydroalkylation catalyst;

(b) operating said first hydroalkylation reaction zone under at least partly liquid phase conditions sufficient to effect hydroalkylation of benzene in the presence of said hydroalkylation catalyst to produce a mixed liquid/vapor phase effluent comprising cyclohexylbenzene and unreacted hydrogen and benzene, wherein at least a portion of the unreacted benzene is in the vapor phase;

(c) removing said mixed phase first effluent from said first hydroalkylation reaction zone;

(d) cooling at least a portion of the mixed phase first effluent removed from said first hydroalkylation reaction zone by heat exchange with a feed to another portion of the process;

(e) introducing at least a portion of the cooled mixed phase first effluent to a second hydroalkylation reaction zone containing a hydroalkylation catalyst and connected in series with the first hydroalkylation reaction zone; and

(f) operating said second hydroalkylation reaction zone under at least partly liquid phase conditions sufficient to effect hydroalkylation of unreacted benzene in mixed phase first effluent in the presence of said hydroalkylation catalyst to produce a second effluent comprising cyclohexylbenzene.

14. The process of claim 13, wherein said heat exchanger supplies heat to a reboiler for a benzene distillation column.

15. The process of claim 13, wherein said heat exchanger supplies heat to the feed to a dehydrogenation reactor for converting cyclohexane produced as a by-product of said operating steps (b) and (f) to benzene.

16. The process of any of the preceding claims 13 to 15, wherein each of said operating steps (b) and (f) is conducted at a temperature of about 125°C to about 250°C and a pressure of about 100 kPa to about 7,000 kPa.

17. A process for coproducing phenol and cyclohexanone, the process comprising producing cyclohexylbenzene by the process of any of the preceding claims 13 to 16, oxidizing the cyclohexylbenzene to produce cyclohexylbenzene hydroperoxide and cleaving the cyclohexylbenzene hydroperoxide to produce phenol and cyclohexanone.