CLAIMS

What is claimed is:

1. A process for making cyclohexylbenzene, the process comprising:

(1A) feeding a gas material comprising hydrogen gas and a liquid material comprising benzene into a hydroalkylation reactor;

(1B) distributing the liquid material to the upper surface of a bed of a solid hydroalkylating catalyst inside the hydroalkylation reactor such that in any given continuous area of 10.0 centimeters by 10.0 centimeters inside a first horizontal cross-section of the bed 1.0 centimeter below the upper surface of the bed, the average quantity of liquid benzene passing through the given continuous area per second Qbz0 is in a range from 60% to 140% of Qbz1, where Qbz1 is the average quantity of liquid benzene passing through the whole first horizontal cross-section, expressed in terms of quantity of liquid benzene per 100 square centimeters per second; and

(1C) contacting liquid benzene and hydrogen gas with the catalyst under hydroalkylation conditions to produce a hydroalkylation reaction effluent comprising cyclohexylbenzene;

wherein in step (1A) at least a portion of the gas material and at least a portion of the liquid material are fed into the hydroalkylation reactor above the bed, and in step (1B) the liquid material is distributed through a fluid distributing device between an inlet of the benzene liquid and the upper surface of the bed.

2. The process of claim 1, wherein Qbz0 is in a range from 80% to 120% of Qbz1.

3. The process of claim 1 or 2, wherein the distribution of liquid benzene in the bed is such that in any given continuous area of 10.0 centimeters by 10.0 centimeters inside (i) a horizontal cross-section of the bed 20.0 centimeters below the upper surface of the bed; and/or (ii) a horizontal cross-section of the bed 50.0 centimeters below the upper surface of the bed, the average quantity of liquid benzene passing through the given continuous area per second Qbz3 is in a range from 60% to 140% of Qbz4, where Qbz4 is the average quantity of liquid benzene passing through the

whole given horizontal cross-section, expressed in terms of quantity of liquid benzene per 100 square centimeters per second.

4. The process of claim 3, wherein Qbz3 is in a range from 80% to 120% of Qbz4.

5. The process of any of the preceding claims, wherein ~~in step (1A), at least a portion of the gas material and at least a portion of the liquid material are fed into the hydroalkylation reactor above the bed, and~~ in step (1C), the hydroalkylation reaction effluent exits the hydroalkylation reactor at a location in proximity to the bottom of the bed.

~~6. The process of any of the preceding claims, wherein in step (1B), a fluid distributing device is used between an inlet of the benzene liquid and the upper surface of the bed~~.

~~7~~6. The process of claim ~~6~~1, wherein the fluid distributing device produces a plurality of liquid droplets each having a volume of at most 1.0 cubic centimeter in a space between the upper surface of the bed and the fluid distributing device, and the distribution of the liquid droplets in a second horizontal cross-section 1.0 centimeter above the upper surface of the bed is such that in any given continuous area of 10.0 centimeters by 10.0 centimeters of the second horizontal cross-section, the number of the liquid droplets passing through the given continuous area Nav0 is in a range from 60% to 140% of Nav1, where Nav1 is the average number of the liquid droplets passing through the whole second horizontal cross-section per 100 square centimeters, expressed in terms of number of droplets per 100 square centimeters per second.

~~8~~7. The process of claim ~~5~~6, wherein Nav0 is in a range from 80% to 120% of Nav1.

~~9~~8. The process of any of claims 6 to ~~8~~7, wherein the fluid distributing device distributes the gas material fed into the hydroalkylation reactor such that in any given

continuous area of 10.0 centimeters by 10.0 centimeters within at least one of (i) the first horizontal cross-section of the bed, (ii) a horizontal cross-section 20.0 centimeters below the upper surface of the bed; and (iii) a horizontal cross-section 50.0 centimeters below the upper surface of the bed, the quantity of the gas material passing through the given continuous area per second Qgas0 is in a range from 60% to 140% of Qgas1, where Qgas1 is the average quantity of the gas material passing through the whole given horizontal cross-section, expressed in terms of quantity per 100 square centimeters per second.

~~10~~9. The process of claim ~~9~~8, wherein Qgas0 is in a range from 80% to 120% of Qgas1.

~~11~~10. The process of any of the preceding claims, wherein the bed is packed such that the upper surface of the bed is flat and horizontal.

~~12~~11. The process of any of the preceding claims, wherein the bed is packed such that the distribution of a catalytically active component of the catalyst within the bed is uniform at at least one of the following locations: (i) the first horizontal cross-section; (ii) a horizontal cross-section 20.0 centimeters below the upper surface of the bed; and (iii) a horizontal cross-section 50.0 centimeters below the upper surface of the bed.

~~13~~12. The process of any of the preceding claims, wherein the distribution of the temperature of the catalyst in at least one given cross-section of (i) the first horizontal cross-section; (ii) a horizontal cross-section 20.0 centimeters below the upper surface of the bed; and (iii) a horizontal cross-section 50.0 centimeters below the upper surface of the bed is such that in any given continuous area of 10.0 centimeters by 10.0 centimeters in the given cross-section, the average temperature of the catalyst Tav0 is in a range from Tav1 – 10°C to Tav1 + 20°C, where Tav1 is the average temperature of the catalyst across the whole given cross-section.

~~14~~13. The process of claim ~~13~~12, wherein Tav0 is in a range from Tav1 – 5°C to Tav1 + 10°C.

~~15~~14. The process of any of the preceding claims, wherein the catalyst comprises a solid acid component and a hydrogenating metal component.

~~16~~15. The process of claim ~~15~~14, wherein the acid component comprises a molecular sieve of the MCM-22 type, and the hydrogenating metal component comprises at least one metal in the Group 8, 9, or 10 of the Periodic Table of Elements.

~~17~~16. The process of any of the preceding claims, wherein the molar ratio of the hydrogen gas in the gas material to the benzene in the liquid material fed into the hydroalkylation reactor in step (1A) is in a range from 0.01 to 15.0.

~~18~~17. The process of claim ~~17~~16, wherein the molar ratio of the hydrogen gas in the gas material to the benzene in the liquid material fed into the hydroalkylation reactor in step (1A) is in a range from 0.10 to 1.0.

~~19~~18. The process of any of the preceding claims, wherein the distribution of the ratio of hydrogen gas to benzene passing through at least one given cross-section of (i) the first horizontal cross-section; (ii) a horizontal cross-section 20.0 centimeters below the upper surface of the bed; and (iii) a horizontal cross-section 50.0 centimeters below the upper surface of the bed is such that in any given continuous area of 10.0 centimeters by 10.0 centimeters in the given cross-section, the average of the ratio Rav0 is in a range from 60% to 140% of Rav1, where Rav1 is the average of the ratio across the whole given cross-section.

~~20~~19. The process of claim ~~19~~18, wherein Rav0 is in a range from 90% to 110% of Rav1.

2120. The process of any of the preceding claims, wherein the hydroalkylation reaction effluent comprises bi-phenyl at a concentration of at most 100 ppm, based on the total weight of the hydroalkylation reaction effluent.

2221. The process of any of the preceding claims, wherein the hydroalkylation reaction effluent comprises bi-phenyl at a concentration of at most 20 ppm, based on the total weight of the hydroalkylation reaction effluent.

2322. The process of any of the preceding claims, wherein the hydroalkylation reaction effluent comprises bicyclohexane at a concentration of at most 2.0 wt%, based on the total weight of the hydroalkylation reaction effluent.

2423. The process of any of the preceding claims, wherein the hydroalkylation reaction effluent comprises bicyclohexane at a concentration of at most 0.5 wt%, based on the total weight of the hydroalkylation reaction effluent.

2524. A process for making phenol and/or cyclohexanone, the process comprising:

(2A) producing cyclohexylbenzene according to the process of any of the preceding claims;

(2B) oxidizing at least a portion of the cyclohexylbenzene to obtain an oxidation reaction product comprising cyclohexylbenzene hydroperoxide; and

(2C) cleaving at least part of the cyclohexylbenzene hydroperoxide to obtain a cleavage effluent comprising phenol and cyclohexanone.