CLAIMS

1. A process for producing phenol and/or cyclohexanone, said process comprising:

(a) contacting cyclohexylbenzene with an oxygen-containing gas under conditions effective to produce an oxidation effluent containing cyclohexylbenzene hydroperoxide;

(b) contacting at least part of said oxidation effluent containing cyclohexylbenzene hydroperoxide with a cleavage catalyst under conditions effective to produce a cleavage effluent containing phenol and cyclohexanone;

wherein at least one of said oxidation effluent and said cleavage effluent contains at least one by-product selected from phenylcyclohexanols and phenylcyclohexanones;

(c) contacting at least part of said at least one effluent containing said at least one by-product with hydrogen in the presence of a bifunctional catalyst comprising (i) an acid dehydration component comprising a molecular sieve of the MCM-22 family and (ii) a hydrogenating metal component under conditions effective to convert at least part of said by-product to cyclohexylbenzene.

2. The process of claim 1, wherein said hydrogenating metal component comprises at least one metal selected from Groups 6 to 12 of the Periodic Table of Elements.

3. The process of claim 1 or claim 2, wherein said hydrogenating metal component comprises palladium.

4. The process of any one of claims 1 to 3, wherein said bifunctional catalyst comprises from 0.1 wt% to 1.0 wt % of said hydrogenating metal component.

5. The process of any one of the preceding claims, wherein said conditions in said contacting step (c) comprise a temperature of 25°C to 200°C.

6. The process of any one of the preceding claims, wherein said conditions in said contacting step (c) comprise a hydrogen partial pressure of 15 kPa to 1000 kPa.

7. The process of any one of the preceding claims, wherein said at least one by-product comprises at least one of 2-phenyl-1-cyclohexanol, 3-phenyl-1-cyclohexanol, 4-phenyl-1-cyclohexanol, 2-phenylcyclohexanone, 3-phenylcyclohexanone, and 4-phenylyclohexanone.

8. The process of any one of the preceding claims, further comprising:

~~(e)~~(d) separating at least part of said cleavage effluent from said contacting step (b) into a first fraction containing phenol and cyclohexanone and a second fraction containing said at least one by-product; and

~~(f)~~(e) supplying said second fraction to said contacting step (c).

9. The process of claim 8, wherein said separating step ~~(e)~~ (d) is effected in a first distillation column.

10. The process of claim 9, wherein said second fraction is removed as a side stream from said first distillation column.

11. The process of claim 9 or claim 10, wherein at least part of the product produced in said contacting step ~~©~~ (c) is fed back to said first distillation column.

12. The process of any one of claims 8 to 11, wherein said cleavage catalyst in said contacting step (b) comprises sulfuric acid and said process further comprises:

~~(g)~~(f) neutralizing a residual sulfuric acid in said cleavage effluent with amines to produce amine salts in said cleavage effluent; and

~~(h)~~(g) removing at least part of said amine salts prior to said separating step ~~(e)~~ (d).

13. The process of claim 12, wherein said removing step ~~(h)~~ (g) is effected in a second distillation column.

14. The process of any one of the preceding claims, further comprising:

~~(i)~~(h) recycling at least part of said cyclohexylbenzene produced in said contacting step (c) to said contacting step (a).

15. The process of any one of the preceding claims, wherein said contacting step (a) is effected in the presence of a catalyst.

16. The process of any one of the preceding claims, wherein said contacting step (a) is effected in the presence of a cyclic imide catalyst.

17. The process of any one of the preceding claims, wherein said cyclohexylbenzene is produced by alkylation of benzene with cyclohexene.

18. The process of any one of the preceding claims, wherein said cyclohexylbenzene is produced by a reaction of benzene with hydrogen in the presence of a hydroalkylation catalyst.

19. A process for producing phenol and/or cyclohexanone, said process comprising:

(I) contacting benzene with hydrogen in the presence of a hydroalkylation catalyst under a hydroalkylation condition effective to produce a hydroalkylation effluent comprising cyclohexylbenzene;

(II) contacting at least part of said cyclohexylbenzene in said hydroalkylation effluent with an oxygen-containing gas under conditions effective to produce an oxidation effluent containing cyclohexylbenzene hydroperoxide;

(III) contacting at least part of said oxidation effluent containing cyclohexylbenzene hydroperoxide with a cleavage catalyst under conditions effective to produce a cleavage effluent containing phenol and cyclohexanone,

wherein at least one of said oxidation effluent and said cleavage effluent contains at least one by-product selected from phenylcyclohexanols and phenylcyclohexanones;

(IV) contacting at least part of said at least one effluent containing said at least one by-product with hydrogen in the presence of a bifunctional catalyst

comprising (i) an acid dehydration component comprising a molecular sieve of the MCM-22 family and (ii) a hydrogenating metal component under conditions effective to convert at least part of said by-product to cyclohexylbenzene.

20. The process of claim 19, further comprising:

~~(VI)~~(V) recycling at least part of said cyclohexylbenzene produced in step ~~(V)~~ (IV) to said contacting step (II).

21. The process of claim 19 or claim 20, further comprising:

~~(VII)~~(VI) separating at least part of said cleavage effluent produced in said contacting step (III) into a first fraction containing phenol and cyclohexanone and a second fraction containing said at least one by-product; and

~~(VIII)~~(VII) supplying at least part of said second fraction to said contacting step (IV).