Claims

1. A method of producing a supported catalyst, the method comprising:

(a) providing a bound zeolite base;

(b) washing the bound zeolite base with an aqueous solution comprising potassium to produce a potassium enriched zeolite support; and

(c) impregnating the potassium enriched zeolite support with a transition metal and a halogen to produce the supported catalyst;

wherein the concentration of potassium in the aqueous solution is in a range from 0.15 M to 0.45 M; and

wherein the supported catalyst has a surface area in a range from 100 m^2/g to 170 m^2/g and a micropore volume in a range from 0.015 cc/g to 0.05 cc/g.

2. The method of claim 1, wherein:

the aqueous solution comprises potassium chloride; and

the aqueous solution further comprises rubidium, cesium, or a combination thereof.

3. The method of claim 1, wherein the concentration of potassium in the aqueous solution is in a range from 0.2 M to 0.45 M.

4. The method of claim 1, wherein step (b) comprises from 2 to 8 washing cycles, and a ratio of the weight of the aqueous solution to the weight of the bound zeolite base in each washing cycle independently is in a range 1:1 to 5:1.

5. The method of claim 1, wherein:

the transition metal comprises platinum;

the halogen comprises fluorine and chlorine; and

the supported catalyst comprises:

from 0.2 wt. % to 5 wt. % platinum;

from 0.1 wt. % to 1.5 wt. % fluorine; and

from 0.1 wt. % to 1.5 wt. % chlorine;

based on the total weight of the supported catalyst.

6. The method of claim 1, wherein the supported catalyst has a surface area in a range from 100 m^2/g to 150 m^2/g and a micropore volume in a range from 0.02 cc/g to 0.045 cc/g.

7. The method of claim 1, wherein:

the supported catalyst is characterized by a benzene selectivity in a range from 0.92 to 0.98; and

the supported catalyst has a benzene selectivity greater than that of a catalyst obtained by washing the bound zeolite base with an aqueous solution that does not contain potassium, under the same catalyst preparation and aromatization reaction conditions.

8. The method of claim 1, wherein the bound zeolite base comprises a bound L-zeolite.

9. The method of claim 1, wherein step (b) is conducted at a washing temperature in a range from 15 °C to 65 °C.

10. The method of claim 1, wherein the concentration of potassium in the aqueous solution is in a range from 0.15 M to 0.35 M.

11. The method of claim 1, wherein the method further comprises drying and/or calcining the potassium enriched zeolite support prior to step (c).

12. The method of claim 1, wherein step (c) comprises mixing the potassium enriched zeolite support with a transition metal-containing compound comprising tetraamineplatinum (II) chloride, tetraamineplatinum (II) nitrate, platinum (II) acetylacetonate, platinum (II) chloride, ammonium tetrachloroplatinate (II), chloroplatinic acid, platinum (II) nitrate, or a combination thereof.

13. The method of claim 1, wherein step (c) comprises mixing the potassium enriched zeolite support with a chlorine-containing compound and/or a fluorine-containing compound.

14. The method of claim 1, wherein the method further comprises drying and/or calcining the supported catalyst after step (c).

15. The method of claim 1, wherein the supported catalyst comprises from 1 wt. % to 12.5 wt. % potassium, based on the total weight of the supported catalyst.

16. The method of claim 1, wherein step (b) enriches the bound zeolite base with from 0.03 moles to 1 mole of potassium per kg of the potassium enriched zeolite support.

17. The method of claim 1, wherein the potassium enriched zeolite support comprises from 0.03 wt. % to 0.2 wt. % sodium, based on the total weight of the potassium enriched zeolite support.

18. The method of claim 1, wherein:

the surface area of the supported catalyst is in a range from 105 m^2/g to 160 m^2/g; and

the micropore volume of the supported catalyst is in a range from 0.02 cc/g to 0.045 cc/g.

19. The method of claim 1, wherein the transition metal comprises platinum, and the supported catalyst has a platinum dispersion in a range from 50% to 65%.

20. A method of producing a supported catalyst, the method comprising:

(a) providing a bound zeolite base;

(b) washing the bound zeolite base with an aqueous solution comprising potassium to produce a potassium enriched zeolite support; and

(c) impregnating the potassium enriched zeolite support with platinum, fluorine, and chlorine to produce the supported catalyst;

wherein the aqueous solution comprises potassium chloride;

wherein the concentration of potassium in the aqueous solution is in a range from 0.15 M to 0.45 M; and

wherein the supported catalyst has a surface area in a range from 100 m^2/g to 170 m^2/g and a micropore volume in a range from 0.015 cc/g to 0.05 cc/g.

21. The method of claim 20, wherein:

the bound zeolite base comprises a bound L-zeolite;

the supported catalyst comprises, based on the total weight of the supported catalyst,

from 0.2 wt. % to 5 wt. % platinum,

from 0.1 wt. % to 1.5 wt. % fluorine, and

from 0.1 wt. % to 1.5 wt. % chlorine; and

the concentration of potassium in the aqueous solution is in a range from 0.2 M to 0.35 M.

22. A method of producing a supported catalyst, the method comprising:

(a) providing a bound zeolite base;

(b) washing the bound zeolite base with an aqueous solution comprising cesium to produce a cesium enriched zeolite support; and

(c) impregnating the cesium enriched zeolite support with a transition metal and a halogen to produce the supported catalyst;

wherein the concentration of cesium in the aqueous solution is in a range from 0.01 M to 5 M.

23. The method of claim 22, wherein:

the bound zeolite base comprises a silica-bound K/L-zeolite;

the transition metal comprises platinum; and

the halogen comprises chlorine, fluorine, or both.

24. The method of claim 22, wherein:

the aqueous solution further comprises potassium, rubidium, or a combination thereof; and

the supported catalyst comprises from 5 wt. % to 30 wt. % of a binder, based on the total weight of the supported catalyst.

25. The method of claim 22, wherein the supported catalyst comprises:

from 0.2 wt. % to 5 wt. % transition metal;

from 0.2 wt. % to 3 wt. % halogen; and

from 2 wt. % to 10 wt. % cesium;

based on the total weight of the supported catalyst.

26. The method of claim 22, wherein step (b) comprises from 2 to 8 washing cycles, each washing cycle conducted independently at a washing temperature in a range from 20 °C to 95 °C and for a time period in a range from 5 minutes to 2 hours.

27. The method of claim 26, wherein a ratio of the weight of the aqueous solution to the weight of the bound zeolite base in each washing cycle independently is in a range 0.4:1 to 10:1.

28. The method of claim 22, wherein the concentration of cesium in the aqueous solution is in a range from 0.01 M to 0.2 M.

29. The method of claim 22, wherein the cesium enriched zeolite support comprises:

from 0.03 wt. % to 0.35 wt. % sodium, based on the total weight of the cesium enriched zeolite support; and

from 0.1 moles to 0.9 moles of cesium per kg of the cesium enriched zeolite support.

30. The method of claim 22, wherein:

the supported catalyst is characterized by a benzene selectivity in a range from 0.92 to 0.98;

the supported catalyst has a benzene selectivity greater than that of a catalyst obtained by washing the bound zeolite base with an aqueous solution that does not contain an alkali metal, under the same catalyst preparation and aromatization reaction conditions; and

the supported catalyst has a platinum dispersion in a range from 50% to 65%.

31. The method of claim 22, wherein:

the transition metal comprises platinum;

the halogen comprises fluorine and chlorine; and

the supported catalyst comprises:

from 2 wt. % to 10 wt. % cesium; from 0.2 wt. % to 5 wt. % platinum;

from 0.1 wt. % to 1.5 wt. % fluorine; and from 0.1 wt. % to 1.5 wt. % chlorine; based on the total weight of the supported catalyst.

32. The method of claim 31, wherein the bound zeolite base comprises a bound L-zeolite.

33. The method of claim 32, wherein the supported catalyst has a surface area in a range from 100 m^2/g to 150 m^2/g and a micropore volume in a range from 0.02 cc/g to 0.045 cc/g.

34. The method of claim 31, wherein the concentration of cesium in the aqueous solution is in a range from 0.025 M to 0.25 M.

35. The method of claim 31, wherein the supported catalyst has a platinum dispersion in a range from 50% to 70%.