METHOD FOR PREPARING ZEOLITE SSZ-35

TECHNICAL FIELD

[001] This disclosure relates generally to a method of making zeolite SSZ-35 using a N,N-diethyl-2,3-dimethylpiperidinium cation or a N,N-dimethyl-2-isopropylpiperidinium cation as a structure directing agent.

BACKGROUND

[002] Zeolites are a commercially important class of crystalline materials. They have distinct crystal structures with ordered pore structures which are demonstrated by distinct X-ray diffraction patterns. The crystal structure defines cavities and pores which are characteristic of the different species.

[003] Zeolites identified by the International Zeolite Associate as having the structure code STF are known. For example, the zeolite known as SSZ-35 is a known crystalline STF material. U.S. Patent No. 5,316,753 discloses the preparation of SSZ-35 using various conformationally constrained aza-polycylic ring systems as structure directing agents (SDAs), including 3,3-dimethyl-3-azonia-7-methyl-7-aza-bicyclononane, N-ethyl-N-methyl-9-azoniabicyclo[3.3.1]nonane, and 1,3,3,8,8-pentamethyl-3-azoniabicyclo[3.2.1]octane.

[004] Japanese Patent Publication No. 2002-137918 discloses the synthesis of SSZ-35 using a *cis*,*cis*,*cis*-N-methyl hexahydrojulolidinium cation as a structure directing agent.

[005] However, these SDAs are complex and costly, which makes the synthesis of SSZ-35 using these SDAs complex and costly. This cost can limit the usefulness of SSZ-35 in commercial processes. Thus, it would be desirable to find a way to synthesize SSZ-35 without having to use these SDAs.

[006] It has now been found that SSZ-35 can be prepared using a N,N-diethyl-2,3-dimethylpiperidinium cation or a N,N-dimethyl-2-isopropylpiperidinium cation as a substitute for these complex and costly SDAs.

SUMMARY

[007] In one aspect, there is provided a method for preparing zeolite SSZ-35, comprising:

(a) preparing a reaction mixture containing: (1) at least one source of silicon oxide; (2) one or more sources of one or more oxides selected from the group consisting of oxides of boron, aluminum, and mixtures thereof; (3) at least one source of an element (M) selected from

Groups 1 and 2 of the Periodic Table; (4) hydroxide ions; (5) a structure directing agent (Q) selected from the group consisting of a N,N-diethyl-2,3-dimethylpiperidinium cation and a N,N-dimethyl-2-isopropylpiperidinium cation; and (6) water; and

(b) maintaining the reaction mixture under crystallization conditions sufficient to form crystals of the zeolite, wherein the crystallization conditions include autogeneous pressure and a temperature between 125°C and 200°C and the reaction mixture comprises, in terms of mole ratios, the following:

SiO_2/X_2O_3	20 to 60
M/SiO_2	0.03 to 0.40
Q/SiO_2	0.05 to 0.40
OH/SiO_2	0.15 to 0.40
H_2O/SiO_2	20 to 50

wherein X is selected from the group consisting of B, Al, and mixtures thereof

[007a] In one aspect, there is provided a method of preparing zeolite SSZ-35 by contacting under crystallization conditions (1) at least one source of at least one oxide of a tetravalent element; (2) optionally, one or more sources of one or more oxides selected from the group consisting of oxides of trivalent elements, pentavalent elements, and mixtures thereof; (3) hydroxide ions; and (4) a structure directing agent selected from the group

CLAIMS

1. A method for preparing zeolite SSZ-35, comprising:

(a) preparing a reaction mixture containing: (1) at least one source of at least one oxide of a tetravalent element; (2) optionally, one or more sources of one or more oxides selected from the group consisting of oxides of trivalent elements, pentavalent elements, and mixtures thereof; (3) at least one source of an element selected from Groups 1 and 2 of the Periodic Table; (4) hydroxide ions; (5) a structure directing agent selected from the group consisting of a N,N-diethyl-2,3-dimethylpiperidinium cation and a N,N-dimethyl-2-isopropylpiperidinium cation; and (6) water; and

(b) maintaining the reaction mixture under crystallization conditions sufficient to form crystals of the zeolite.

2. The method of claim 1, wherein the zeolite is prepared from a reaction mixture comprising, in terms of mole ratios, the following:

TO_2/X_2O_n	≥ 10
M/TO_2	0.01 to 0.50
Q/TO_2	0.05 to 0.50
OH/TO_2	0.10 to 0.70
H_2O/TO_2	15 to 100

wherein:

(1) T is selected from the group consisting of tetravalent elements from Groups 4-14 of the Periodic Table, and mixtures thereof;

(2) X is selected from the group consisting of trivalent and pentavalent elements from Groups 3-13 of the Periodic Table, and mixtures thereof;

(3) *n* equals the valence state of X;

(4) M is selected from the group consisting of elements from Groups 1 and 2 of the Periodic Table; and

(5) Q is a structure directing agent selected from the group consisting of a N,N-diethyl-2,3-dimethylpiperidinium cation and a N,N-dimethyl-2-isopropylpiperidinium cation.

3. The method of claim 2, wherein T is selected from the group consisting of Si, Ge, and mixtures thereof.

4. The method of claim 2, wherein X is selected from the group consisting of B, Al, Ga, In, and mixtures thereof.

5. The method of claim 2, wherein T is Si and X is B.

6. The method of claim 2, wherein T is Si and X is Al.

7. The method of claim 2, wherein the zeolite is prepared from a reaction mixture comprising, in terms of mole ratios, the following:

TO_2/X_2O_n	20 to 60
M/TO_2	0.03 to 0.40
Q/TO_2	0.05 to 0.40
OH/TO_2	0.15 to 0.40
H_2O/TO_2	20 to 50.

8. The method of claim 1, wherein the structure directing agent is a N,N-diethyl-2,3-dimethylpiperidinium cation.

9. The method of claim 1, wherein the structure directing agent is a N,N-dimethyl-2-isopropylpiperidinium cation.

10. The method of claim 1, wherein the zeolite has a composition, as-synthesized and in its anhydrous state, in terms of mole ratios, as follows:

TO_2/X_2O_n	≥ 10
Q/TO_2	0.01 to 0.10
M/TO_2	0 to 0.04

wherein:

(1) T is selected from the group consisting of tetravalent elements from Groups 4-14 of the Periodic Table, and mixtures thereof;

(2) X is selected from the group consisting of trivalent and pentavalent elements from Groups 3-13 of the Periodic Table, and mixtures thereof;

(3) *n* equals the valence state of X;

(4) Q is a structure directing agent selected from the group consisting of a N,N-diethyl-2,3-dimethylpiperidinium cation and a N,N-dimethyl-2-isopropylpiperidinium cation; and

(5) M is selected from the group consisting of elements from Groups 1 and 2 of the Periodic Table.

11. The method of claim 10, wherein the zeolite has a composition, as-synthesized and in its anhydrous state, in terms of mole ratios, as follows:

TO_2/X_2O_n	20 to 60
Q/TO_2	0.01 to 0.10
M/TO_2	0 to 0.04.

12. The method of claim 10, wherein T is Si and X is B.

13. The method of claim 10, wherein T is Si and X is Al.

CLAIMS

1. A method for preparing zeolite SSZ-35, comprising:

(a) preparing a reaction mixture containing: (1) at least one source of silicon oxide; (2) one or more sources of one or more oxides selected from the group consisting of oxides of boron, aluminum, and mixtures thereof; (3) at least one source of an element (M) selected from Groups 1 and 2 of the Periodic Table; (4) hydroxide ions; (5) a structure directing agent (Q) selected from the group consisting of a N,N-diethyl-2,3-dimethylpiperidinium cation and a N,N-dimethyl-2-isopropylpiperidinium cation; and (6) water; and

(b) maintaining the reaction mixture under crystallization conditions sufficient to form crystals of the zeolite, wherein the crystallization conditions include autogeneous pressure and a temperature between 125°C and 200°C and the reaction mixture comprises, in terms of mole ratios, the following:

SiO_2/X_2O_3	20 to 60
M/SiO_2	0.03 to 0.40
Q/SiO_2	0.05 to 0.40
OH/SiO_2	0.15 to 0.40
H_2O/SiO_2	20 to 50

wherein X is selected from the group consisting of B, Al, and mixtures thereof.

2. The method of claim 1, wherein X is B.

3. The method of claim 1, wherein X is Al.

4. The method of claim 1, wherein the structure directing agent is a N,N-diethyl-2,3-dimethylpiperidinium cation.

5. The method of claim 1, wherein the structure directing agent is a N,N-dimethyl-2-isopropylpiperidinium cation.

6. The method of claim 1, wherein the zeolite has a composition, as-synthesized and in its anhydrous state, in terms of mole ratios, as follows:

SiO_2/X_2O_3	20 to 60
Q/SiO_2	0.01 to 0.10
M/SiO_2	0 to 0.04.

7. The method of claim 6, wherein X is B.

8. The method of claim 6, wherein X is Al.