~~Amended~~ Claims

1. A rare earth-containing Y zeolite, which has a rare earth content as rare earth oxide of 10-25wt%~~, e.g. 11-23wt%~~; a unit cell size of 2.440-2.472nm~~, e.g. 2.450-2.470nm~~; a crystallinity of 35-65%~~, e.g. 40-60%~~; a Si/Al atom ratio in the skeleton of 2.5-5.0; and a product of the ratio of the strength I_1 of the peak at $2\theta=11.8\pm0.1°$ to the strength I_2 of the peak at $2\theta=12.3\pm0.1°$ in the X-ray diffraction spectrogram of the zeolite and the weight percent of rare earth as rare earth oxide in the zeolite of higher than 55.

2. The rare earth-containing Y zeolite of claim 1, which has a rare earth content as rare earth oxide of 11-23wt%; a unit cell size of 2.450-2.470nm; and a crystallinity of 40-60%.

~~2~~3. The rare earth-containing Y zeolite of claim 1, which has a crystallinity retention after 17 hours of aging treatment at 800°C in a condition of 100% steam of greater than 45%.

~~3~~4. A process ~~for~~ of preparing a rare earth-containing Y zeolite, which has a rare earth content as rare earth oxide of 10-25wt%; a unit cell size of 2.440-2.472nm; a crystallinity of 35-65%; a Si/Al atom ratio in the skeleton of 2.5-5.0; and a product of the ratio of the strength I_1 of the peak at $2\theta=11.8\pm0.1°$ to the strength I_2 of the peak at $2\theta=12.3\pm0.1°$ in the X-ray diffraction spectrogram of the zeolite and the weight percent of rare earth as rare earth oxide in the zeolite of higher than 55, which comprises the following steps:

(1) a NaY zeolite and a rare earth solution or a mixed solution of ammonium salt and rare earth solution are contacted to obtain a rare earth- and sodium-containing Y zeolite;

(2) the rare earth- and sodium-containing Y zeolite obtained in step (1), after being filtered and washed with water, and dried, is subjected to a first

calcination to obtain a rare earth- and sodium-containing Y zeolite;
(3) then either the rare earth- and sodium-containing Y zeolite obtained in step (2) is contacted with an ammonium salt solution, and then mixed with a rare earth solution without filtration, and the mixture is adjusted to a pH of 6-10, or the rare earth- and sodium-containing Y zeolite obtained in step (2) is contacted with a mixed solution of ammonium salt and rare earth solution, and then the mixture is adjusted to a pH of 6-10, to obtain a rare earth- and sodium-containing Y zeolite;
(4) the rare earth- and sodium-containing Y zeolite obtained in step (3), after being filtered and washed with water, and dried, is subjected to a second calcination to obtain the target rare earth-containing Y zeolite.

45. The process according to claim ~~3~~4, wherein the ammonium salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof.

~~5~~6. The process according to claim ~~3~~4, wherein in step (1),
the weight ratio of the rare earth solution ~~(~~as rare earth oxide~~)~~ to the NaY zeolite ~~(~~on the dry basis~~)~~ is 0.06-0.14~~, e.g. 0.07-0.12~~, the weight ratio of the ammonium salt ~~(~~as ammonium chloride~~)~~ to the rare earth solution ~~(~~as rare earth oxide~~)~~ is 0-10~~, e.g. 0-5, such as 0.2-3~~, said ammonium salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof, the pH is adjusted to 3.0-5.0, the weight ratio of water:zeolite is controlled to 5-30~~, e.g. 7-15~~, said contact is conducted at room temperature ~~(such as 18-26°C)~~ to 100°C~~, e.g. 70-95°C~~ for at least 0.3 hour~~, e.g. 0.5-3 hours, such as 0.5-1.5 hours~~.

7. The process according to claim 4, wherein in step (1),
the weight ratio of the rare earth solution as rare earth oxide to the NaY

zeolite on the dry basis is 0.07-0.12, the weight ratio of the ammonium salt as ammonium chloride to the rare earth solution as rare earth oxide is 0.2-3, said ammonium salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof, the pH is adjusted to 3.0-5.0, the weight ratio of water:zeolite is controlled to 7-15, said contact is conducted at 70-95°C for at 0.5-1.5 hours.

~~6~~8. The process according to claim ~~3~~4, wherein in step (2),
said first calcination is conducted at 500-650°C~~, e.g. 530-630°C, such as 550-620°C~~, in a condition of 0-100% steam for at least 0.5 hour~~, e.g. 0.5-4.0 hours, 1.0-4.0 hours or 1.5-3.0 hours~~.

9. The process according to claim 4, wherein in step (2),
said first calcination is conducted at 550-620°C in a condition of 0-100% steam for 1.5-3.0 hours.

~~7~~10. The process according to claim ~~3~~4, wherein in step (3),
for the case of contacting the rare earth- and sodium-containing Y zeolite with the ammonium salt solution, the contact is conducted at room temperature to 100°C~~, e.g. 60-80°C~~ for at least 0.3 hour~~, e.g. 0.3-3.0 hours, 0.5-3 hours or 0.5-1.5 hours~~, wherein for the proportions of the rare earth- and sodium-containing Y zeolite and the ammonium salt solution, the weight ratio of the zeolite ~~(~~on dry basis~~)~~:ammonium salt:water is 1:(0.05-0.5):(5-30), ~~e.g. 1:(0.1-0.4):(8-15);~~ the rare earth solution is subsequently added in such an amount that the weight ratio of the rare earth element ~~(~~as rare earth oxide (RE_2O_3)~~)~~ in the rare earth solution to the rare earth- and sodium-containing Y zeolite ~~(~~on a dry basis of the zeolite~~)~~ is 0.01-0.2~~, e.g., 0.02-0.12~~; said ammonium salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof;

for the case of contacting the rare earth- and sodium-containing Y zeolite with the mixed solution of ammonium salt and rare earth solution, the contact is conducted at room temperature to 100°C~~, e.g. 60-80°C~~ for at least 0.3 hour~~, e.g. 0.3-3.0 hours, 0.5-3 hours or 0.5-1.5 hours~~, wherein for the proportions of the rare earth- and sodium-containing Y zeolite, the ammonium salt, and the rare earth solution, the weight ratio of zeolite ~~(~~on dry basis~~)~~:ammonium salt:rare earth oxide (RE_2O_3):water is 1:(0.05-0.5):(0.01-0.2):(5-30)~~, e.g. 1:(0.1-0.4):(0.02-0.12):(8-15)~~; said ammonium salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof.

~~8~~11. The process according to claim ~~7~~10, wherein in step (3), after the contact, the mixture is adjusted with an alkaline liquid to a pH of 6-10~~, e.g. 7-9, such as 7.5-8.2~~.

~~9~~12. The process according to claim ~~8~~11, wherein said alkaline liquid can be selected from the group consisting of aqueous ammonia, sodium silicate, sodium metaaluminate, sodium hydroxide and any mixture thereof.

13. The process according to claim 4, wherein in step (3),
for the case of contacting the rare earth- and sodium-containing Y zeolite with the ammonium salt solution, the contact is conducted at 60-80°C for 0.5-1.5 hours, wherein for the proportions of the rare earth- and sodium-containing Y zeolite and the ammonium salt solution, the weight ratio of the zeolite on dry basis:ammonium salt:water is 1:(0.1-0.4):(8-15), the rare earth solution is subsequently added in such an amount that the weight ratio of the rare earth element as rare earth oxide (RE_2O_3) in the rare earth solution to the rare earth- and sodium-containing Y zeolite on a dry basis of the zeolite is 0.02-0.12; said ammonium salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof;

for the case of contacting the rare earth- and sodium-containing Y zeolite with the mixed solution of ammonium salt and rare earth solution, the contact is conducted at 60-80°C for 0.5-1.5 hours, wherein for the proportions of the rare earth- and sodium-containing Y zeolite, the ammonium salt, and the rare earth solution, the weight ratio of zeolite on dry basis:ammonium salt:rare earth oxide (RE_2O_3):water is 1:(0.1-0.4):(0.02-0.12):(8-15); said ammonium salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof.

14. The process according to claim 13, wherein in step (3), after the contact, the mixture is adjusted with an alkaline liquid to a pH of 7.5-8.2.

15. The process according to claim 14, wherein said alkaline liquid can be selected from the group consisting of aqueous ammonia, sodium silicate, sodium metaaluminate, sodium hydroxide and any mixture thereof.

~~10~~16. The process according to claim ~~3~~4, wherein in step (4), said second calcination is conducted at 500-650°C, in a condition of 0-100% steam for 0.5-4 hours~~, e.g. 1-3 hours~~.

17. The process according to claim 4, wherein in step (4), said second calcination is conducted at 500-650°C, in a condition of 0-100% steam for 1-3 hours.

Claims

1. A rare earth-containing Y zeolite, which has a rare earth content as rare earth oxide of 10-25wt%; a unit cell size of 2.440-2.472nm; a crystallinity of 35-65%; a Si/Al atom ratio in the skeleton of 2.5-5.0; and a product of the ratio of the strength I_1 of the peak at $2\theta=11.8\pm0.1°$ to the strength I_2 of the peak at $2\theta=12.3\pm0.1°$ in the X-ray diffraction spectrogram of the zeolite and the weight percent of rare earth as rare earth oxide in the zeolite of higher than 55.

2. The rare earth-containing Y zeolite of claim 1, which has a rare earth content as rare earth oxide of 11-23wt%; a unit cell size of 2.450-2.470nm; and a crystallinity of 40-60%.

3. The rare earth-containing Y zeolite of claim 1, which has a crystallinity retention after 17 hours of aging treatment at 800°C in a condition of 100% steam of greater than 45%.

4. A process of preparing a rare earth-containing Y zeolite, which has a rare earth content as rare earth oxide of 10-25wt%; a unit cell size of 2.440-2.472nm; a crystallinity of 35-65%; a Si/Al atom ratio in the skeleton of 2.5-5.0; and a product of the ratio of the strength I_1 of the peak at $2\theta=11.8\pm0.1°$ to the strength I_2 of the peak at $2\theta=12.3\pm0.1°$ in the X-ray diffraction spectrogram of the zeolite and the weight percent of rare earth as rare earth oxide in the zeolite of higher than 55, which comprises the following steps:

(1) a NaY zeolite and a rare earth solution or a mixed solution of ammonium salt and rare earth solution are contacted to obtain a rare earth- and sodium-containing Y zeolite;

(2) the rare earth- and sodium-containing Y zeolite obtained in step (1), after being filtered and washed with water, and dried, is subjected to a first

calcination to obtain a rare earth- and sodium-containing Y zeolite;
(3) then either the rare earth- and sodium-containing Y zeolite obtained in step (2) is contacted with an ammonium salt solution, and then mixed with a rare earth solution without filtration, and the mixture is adjusted to a pH of 6-10, or the rare earth- and sodium-containing Y zeolite obtained in step (2) is contacted with a mixed solution of ammonium salt and rare earth solution, and then the mixture is adjusted to a pH of 6-10, to obtain a rare earth- and sodium-containing Y zeolite;
(4) the rare earth- and sodium-containing Y zeolite obtained in step (3), after being filtered and washed with water, and dried, is subjected to a second calcination to obtain the target rare earth-containing Y zeolite.

5. The process according to claim 4, wherein the ammonium salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof.

6. The process according to claim 4, wherein in step (1),
the weight ratio of the rare earth solution as rare earth oxide to the NaY zeolite on the dry basis is 0.06-0.14, the weight ratio of the ammonium salt as ammonium chloride to the rare earth solution as rare earth oxide is 0-10, said ammonium salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof, the pH is adjusted to 3.0-5.0, the weight ratio of water:zeolite is controlled to 5-30, said contact is conducted at room temperature to 100°C for at least 0.3 hour.

7. The process according to claim 4, wherein in step (1),
the weight ratio of the rare earth solution as rare earth oxide to the NaY zeolite on the dry basis is 0.07-0.12, the weight ratio of the ammonium salt as ammonium chloride to the rare earth solution as rare earth oxide is 0.2-3, said

ammonium salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof, the pH is adjusted to 3.0-5.0, the weight ratio of water:zeolite is controlled to 7-15, said contact is conducted at 70-95°C for at 0.5-1.5 hours.

8. The process according to claim 4, wherein in step (2),
said first calcination is conducted at 500-650°C in a condition of 0-100% steam for at least 0.5 hour.

9. The process according to claim 4, wherein in step (2),
said first calcination is conducted at 550-620°C in a condition of 0-100% steam for 1.5-3.0 hours.

10. The process according to claim 4, wherein in step (3),
for the case of contacting the rare earth- and sodium-containing Y zeolite with the ammonium salt solution, the contact is conducted at room temperature to 100°C for at least 0.3 hour, wherein for the proportions of the rare earth- and sodium-containing Y zeolite and the ammonium salt solution, the weight ratio of the zeolite on dry basis:ammonium salt:water is 1:(0.05-0.5):(5-30), the rare earth solution is subsequently added in such an amount that the weight ratio of the rare earth element as rare earth oxide (RE_2O_3) in the rare earth solution to the rare earth- and sodium-containing Y zeolite on a dry basis of the zeolite is 0.01-0.2; said ammonium salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof;
for the case of contacting the rare earth- and sodium-containing Y zeolite with the mixed solution of ammonium salt and rare earth solution, the contact is conducted at room temperature to 100°C for at least 0.3 hour, wherein for the proportions of the rare earth- and sodium-containing Y zeolite, the

ammonium salt, and the rare earth solution, the weight ratio of zeolite on dry basis:ammonium salt:rare earth oxide (RE_2O_3):water is 1:(0.05-0.5):(0.01-0.2):(5-30); said ammonium salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof.

11. The process according to claim 10, wherein in step (3), after the contact, the mixture is adjusted with an alkaline liquid to a pH of 6-10.

12. The process according to claim 11, wherein said alkaline liquid can be selected from the group consisting of aqueous ammonia, sodium silicate, sodium metaaluminate, sodium hydroxide and any mixture thereof.

13. The process according to claim 4, wherein in step (3),
for the case of contacting the rare earth- and sodium-containing Y zeolite with the ammonium salt solution, the contact is conducted at 60-80°C for 0.5-1.5 hours, wherein for the proportions of the rare earth- and sodium-containing Y zeolite and the ammonium salt solution, the weight ratio of the zeolite on dry basis:ammonium salt:water is 1:(0.1-0.4):(8-15), the rare earth solution is subsequently added in such an amount that the weight ratio of the rare earth element as rare earth oxide (RE_2O_3) in the rare earth solution to the rare earth- and sodium-containing Y zeolite on a dry basis of the zeolite is 0.02-0.12; said ammonium salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof;
for the case of contacting the rare earth- and sodium-containing Y zeolite with the mixed solution of ammonium salt and rare earth solution, the contact is conducted at 60-80°C for 0.5-1.5 hours, wherein for the proportions of the rare earth- and sodium-containing Y zeolite, the ammonium salt, and the rare earth solution, the weight ratio of zeolite on dry basis:ammonium salt:rare earth oxide (RE_2O_3):water is 1:(0.1-0.4):(0.02-0.12):(8-15); said ammonium

salt is selected from the group consisting of ammonium chloride, ammonium nitrate, ammonium carbonate, ammonium hydrogen carbonate and any mixture thereof.

14. The process according to claim 13, wherein in step (3), after the contact, the mixture is adjusted with an alkaline liquid to a pH of 7.5-8.2.

15. The process according to claim 14, wherein said alkaline liquid can be selected from the group consisting of aqueous ammonia, sodium silicate, sodium metaaluminate, sodium hydroxide and any mixture thereof.

16. The process according to claim 4, wherein in step (4), said second calcination is conducted at 500-650°C, in a condition of 0-100% steam for 0.5-4 hours.

17. The process according to claim 4, wherein in step (4), said second calcination is conducted at 500-650°C, in a condition of 0-100% steam for 1-3 hours.