Claims

1. A modified Y-type molecular sieve, having a calcium content of 0.3-4 wt% calculated on the basis of calcium oxide, a rare earth content of 2-7 wt% calculated on the basis of rare earth oxide, and a sodium content of no more than 0.5 wt% calculated on the basis of sodium oxide, on a dry basis and based on the weight of said modified Y-type molecular sieve; wherein the modified Y-type molecular sieve has a total pore volume of 0.33-0.39 ml/g, a proportion of the pore volume of secondary pores having a pore size of 2-100 nm to the total pore volume of 10-25%, a lattice constant of 2.440-2.455 nm, a proportion of non-framework aluminum content to the total aluminum content of no more than 20%, a lattice collapse temperature of not lower than 1050 ℃, and a ratio of B acid to L acid in the total acid content of no less than 2.30, as determined by pyridine adsorption infrared spectroscopy at 200 ℃.

2. The modified Y-type molecular sieve according to claim 1, wherein the modified Y-type molecular sieve has a proportion of the pore volume of secondary pores having a pore size of 2-100 nm to the total pore volume of 15-21%, preferably 17-21%; and/or

the modified Y-type molecular sieve has a proportion of non-framework aluminum content to the total aluminum content of 13-19%, and a framework silica-alumina ratio, calculated as SiO_2/Al_2O_3 molar ratio, of 7.3-14.

3. The modified Y-type molecular sieve according to any of the preceding claims, wherein the modified Y-type molecular sieve has a lattice collapse temperature of 1050-1080 ℃ or 1050-1063 ℃; and/or

preferably, the modified Y-type molecular sieve has a ratio of B acid to L acid in the total acid content of 2.3-5.0, 2.4-4.2, or 2.4-3.5, as determined by pyridine adsorption infrared spectroscopy at 200 ℃.

4. The modified Y-type molecular sieve according to any of the preceding claims, wherein the modified Y-type molecular sieve has a relative crystalline retention of 35% or more, for example 36-45% or 35-48%, after aging at 800 ℃ under atmospheric pressure in a 100% steam atmosphere for 17 hours; and/or

preferably, the modified Y-type molecular sieve has a relative crystallinity of

58-68%.

5. The modified Y-type molecular sieve according to any of the preceding claims, wherein the modified Y-type molecular sieve has a calcium content of 0.5-3.5 wt% calculated on the basis of calcium oxide, a rare earth content of 2.5-6.5 wt% calculated on the basis of rare earth oxide, a sodium content of 0.2-0.5 wt% calculated on the basis of sodium oxide, a lattice constant of 2.442-2.452 nm, and a framework silica-alumina ratio of 8-12.6 calculated as SiO_2/Al_2O_3 molar ratio.

6. The modified Y-type molecular sieve according to any of the preceding claims, wherein the modified Y-type molecular sieve has an O1s electron binding energy of no greater than 532.70 eV, for example 532.55-532.65 eV.

7. A method for preparing a modified Y-type molecular sieve, comprising the steps of:

(1) contacting a NaY molecular sieve with a solution of a soluble calcium salt and a soluble rare earth salt for ion exchange reaction, to obtain a Y-type molecular sieve comprising calcium and rare earth with reduced sodium content;

(2) subjecting the Y-type molecular sieve obtained in the step (1) to roasting at a temperature of 350-480 ℃ in an atmosphere of 30-90 vol% of steam for 4.5-7 hours, and optionally drying, to obtain a Y-type molecular sieve with reduced lattice constant; and

(3) contacting the Y-type molecular sieve with reduced lattice constant with gaseous silicon tetrachloride for reaction at a weight ratio of $SiCl_4$ to the Y-type molecular sieve with reduced lattice constant, on a dry basis, of 0.1 : 1 to 0.7 : 1, and a reaction temperature of 200-650 ℃ for a reaction time of 10 minutes to 5 hours, to obtain the modified Y-type molecular sieve.

8. The method according to claim 7, wherein the Y-type molecular sieve obtained in step (1) has a lattice constant of 2.465-2.472 nm, a sodium content of no more than 8.8 wt% calculated on the basis of sodium oxide;

preferably, the Y-type molecular sieve obtained in step (1) has a calcium content of 0.3-10 wt%, for example 0.9-9 wt%, calculated on the basis of calcium oxide, a rare earth content of 2-8 wt%, for example 2.1-7 wt%, calculated on the basis of rare earth oxide, a sodium content of 4-8.8 wt%, for example 5.0-8.5 wt%, calculated on the basis

of sodium oxide, and a lattice constant of 2.465-2.472 nm.

9. The method according to claim 7 or 8, wherein in step (1), the NaY molecular sieve, the soluble calcium salt, the soluble rare earth salt and water are mixed at a weight ratio of the NaY molecular sieve : the soluble calcium salt : the soluble rare earth salt : H_2O of 1 : 0.009-0.28 : 0.005-0.09 : 5-15 for ion exchange.

10. The method according to any of claims 7 to 9, wherein the step (1) further comprises mixing the NaY molecular sieve with water, and adding thereto a soluble calcium salt and/or a solution of a soluble calcium salt, and a soluble rare earth salt and/or a solution of a soluble rare earth salt under stirring to conduct an ion exchange reaction;

the conditions for the ion exchange reaction include: an exchange temperature of 15-95 ℃ and an exchange time of 30-120 minutes;

preferably, the solution of the soluble calcium salt and the solution of the soluble rare earth salt are aqueous solutions of the soluble calcium salt and the soluble rare earth salt, and/or

preferably, the soluble calcium salt is calcium chloride and/or calcium nitrate, and the soluble rare earth salt is a rare earth chloride and/or a rare earth nitrate.

11. The method according to any of claims 7 to 10, wherein in step (2), the roasting temperature is 380-460 ℃, the roasting atmosphere is an atmosphere of 40-80 vol% steam, and the roasting time is 5-6 hours;

preferably, the Y-type molecular sieve with reduced lattice constant obtained in step (2) has a lattice constant of 2.450-2.462 nm and a water content of no more than 1 wt%.

12. The method according to any of claims 7 to 11, wherein the step (3) further comprises washing the resulted modified Y-type molecular sieve with water under conditions including: a ratio of molecular sieve : H_2O of 1 : 5-20, a pH of 2.5-5.0, and a washing temperature of 30-60 ℃.

13. A modified Y-type molecular sieve obtained by the method according to any of claims 7-12.

14. A catalytic cracking catalyst, comprising 10-50 wt%, on a dry basis, of a modified Y-type molecular sieve, 10-40 wt% of an alumina binder calculated on the

basis of alumina, and 10-80 wt%, on a dry basis, of a clay, based on the weight of the catalytic cracking catalyst; wherein the modified Y-type molecular sieve is a modified Y-type molecular sieve according to any of claims 1-6 and 13.

15. Use of a modified Y-type molecular sieve according to any of claims 1 to 6 and 13 in catalytic cracking of hydrocarbon oils, comprising contacting a hydrocarbon oil with a catalytic cracking catalyst comprising the modified Y-type molecular sieve according to any of claims 1 to 6 and 13.