Claims

1. A modified Y-type molecular sieve, having a modifying metal content of 0.5-6.3 wt% calculated on the basis of an oxide of the modifying metal, and a sodium content of no more than 0.5 wt%, preferably 0.1-0.5 wt%, calculated on the basis of sodium oxide, on a dry basis and based on the weight of said modified Y-type molecular sieve, said modifying metal being magnesium and/or calcium; wherein the modified Y-type molecular sieve has a proportion of non-framework aluminum content to the total aluminum content of no more than 20%, 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 lattice collapse temperature of not lower than 1040 °C, 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 °C.

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 1040-1080 °C, for example 1045-1080 °C; 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, more preferably 2.4-4.2, as determined by pyridine adsorption infrared spectroscopy at 200 °C.

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 33% or more, for example 33-45%, after aging at 800 °C 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

58-75%, for example 58-70%.

5. The modified Y-type molecular sieve according to any of the preceding claims, wherein the modifying metal is magnesium, and the modified Y-type molecular sieve has a magnesium content of 0.5-4.5 wt%, for example 0.6-4.3 wt%, calculated on the basis of magnesium 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 8.4-12.6 calculated as SiO_2/Al_2O_3 molar ratio; or

the modifying metal is calcium, and the modified Y-type molecular sieve has a calcium content of 0.7-6.3 wt%, preferably 0.9-5.9 wt%, for example 1.5-6 wt%, calculated on the basis of calcium 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 8.0-12.6 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 532.55 eV, for example 532.39-532.52 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 magnesium salt and/or soluble calcium salt for ion exchange reaction, to obtain a Y-type molecular sieve comprising magnesium and/or calcium with reduced sodium content;

(2) subjecting the Y-type molecular sieve obtained in the step (1) to roasting at a temperature of 350-480 °C 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 °C 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 magnesium content of 0.5-7.0 wt% calculated on the basis of MgO, a sodium content of 4-8.8 wt%, for example 5.5-8.5 wt%, calculated on the basis of sodium oxide, and a lattice constant of 2.465-2.472 nm; or

preferably, the Y-type molecular sieve obtained in step (1) has a calcium content of 0.8-10 wt% calculated on the basis of CaO, a sodium content of 4-8.8 wt%, for example 5-7.5 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 magnesium salt and/or calcium salt and water are mixed at a weight ratio of the NaY molecular sieve : the soluble magnesium salt and/or calcium salt : H_2O of 1 : 0.005-0.28 : 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 magnesium salt, a soluble calcium salt, a solution of a soluble calcium salt and/or a soluble magnesium salt under stirring to conduct an ion exchange reaction;

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

preferably, the soluble magnesium salt is magnesium chloride and/or magnesium nitrate, and/or

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

11. The method according to any of claims 7 to 10, wherein in step (2), the roasting temperature is 380-470 °C, the roasting atmosphere is an atmosphere of 40-80% 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 °C.

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.