Claims

1. A modified Y-type zeolite, which is characterized by having
a unit cell size of 2.420-2.440nm;
as percent by weight of the modified Y-type zeolite, a phosphorus content of 0.05-6%, a RE_2O_3 content of 0.03-10%, and an alumina content of less than 22%; and
a specific hydroxyl nest concentration of less than 0.35mmol/g and more than 0.05mmol/g,

$$\text{said specific hydroxyl nest concentration} = \frac{[(M_{500^\circ C}-M_{200^\circ C})-(17/9)\times(M_{800^\circ C}-M_{500^\circ C})]\times 1000}{36\times(1-M_{200^\circ C})\times C} \quad \text{(Unit:mmol/g)}$$

wherein $M_{200^\circ C}$, $M_{500^\circ C}$ and $M_{800^\circ C}$ respectively represent the weight loss percents of a sample measured at 200°C, 500°C and 800°C, and C is the crystallinity of the sample.

2. The modified Y-type zeolite according to claim 1, wherein said unit cell size is 2.428-2.438nm; as percent by weight of the modified Y-type zeolite, the phosphorus content is 0.1-4.5%, the RE_2O_3 content is 0.1-4.5%, the alumina content is less than 21%; the specific hydroxyl nest concentration is less than 0.3mmol/g and more than 0.10mmol/g.

3. A process for preparing the modified Y-type zeolite according to claim 1, wherein the modified Y-type zeolite is obtained by using a NaY zeolite as starting material and through three exchange steps in which a rare earth-containing substance and a phosphorus-containing substance are used and three hydrothermally treating steps, wherein, the introduction of phosphorus and rare earth is done by the exchange step;
wherein independently in each exchange step, the zeolite is added to a phosphorus-containing exchanging solution or a rare earth-containing exchanging solution;
wherein phosphorus is introduced at any exchange step; and
wherein rare earth is introduced at any exchange step except the first exchange step;
wherein said process further comprises: a dealumination agent is introduced at any

exchange step except the first exchange step.

4. The process according to claim 3, wherein said phosphorus-containing substance is selected from the group consisting of orthophosphoric acid, phosphorous acid, pyrophosphoric acid, ammonium phosphate, diammonium hydrogen phosphate, ammonium dihydrogen phosphate, aluminum phosphate, and any mixture thereof.

5. The process according to claim 3 or claim 4, wherein said rare earth-containing substance is selected from the group consisting of lanthanum oxide, cerium oxide, lanthanum nitrate, cerium nitrate, lanthanum chloride, cerium chloride, a mixed rare earth nitrate, a mixed rare earth chloride, and any mixture thereof.

6. The process according to any one of claims 1 to 5, wherein said dealumination agent is selected from the group consisting of ethylene diamine tetraacetic acid, oxalic acid, citric acid, sulfosalicylic acid, fluorosilicic acid, hydrochloric acid, sulphuric acid, nitric acid, ammonium oxalate, ammonium fluoride, ammonium fluorosilicate, ammonium fluoroborate, and any mixture thereof.

7. The process according toany one of claims 3 to 6, which further comprises: the exchange is conducted at 60-100°C, e.g. 70-90°C for at least 0.5 hour, e.g. 1-2 hours.

8. The process according to any one of claims 3 to 7, wherein each of the hydrothermally treating steps is independently conducted at 350-650°C, e.g. 550-600°C, in a condition of 1-100%, e.g. 70%-100% steam for at least 0.5 hour, e.g. 1-2 hours.

9. The process according to any one of claims 3 to 8, which is characterized in that said process comprises the following steps:

1) a NaY zeolite is mixed with an ammonium salt, an ammonium phosphate salt and water in a ratio of the NaY zeolite: the ammonium salt: the ammonium phosphate salt: water=1:[0.4-1]:[0-0.04]:[5-10] to obtain a slurry, the slurry is adjusted with an inorganic acid to a pH of 3.0-4.5, then the slurry is treated at 70-95°C for at least 0.5

hour, and then washed, wherein, the NaY zeolite is on the dry basis, the ammonium phosphate salt is based on the elemental phosphorus;

2) the product obtained in the step 1) is calcined at 350-650°C in a condition of 1-100% steam for at least 0.5 hour to obtain a firstly calcined zeolite;

3) the firstly calcined zeolite obtained in the step 2), phosphoric acid, an dealumination agent and water are mixed in a ratio of the firstly calcined zeolite: phosphoric acid: the dealumination agent: water=1:[0-0.04]:[0.02-0.3]:[5-10], the resulting mixture is adjusted with an inorganic acid to a pH of 2.3-3.5, then treated at 50-90°C for at least 0.5 hour, filtered and washed (washing temperature≥50°C), wherein, the firstly calcined zeolite is on the dry basis, and phosphoric acid is based on the elemental phosphorus;

4) the product obtained in the step 3) is calcined at 350-650°C in a condition of 1-100% steam for at least 0.5 hour to obtain a secondly calcined zeolite;

5) the secondly calcined zeolite obtained in the step 4) is mixed with a (mixed) rare earth chloride and water in a ratio of the secondly calcined zeolite: the rare earth chloride: water=1:[0.01-0.05]:[5-10], the resulting mixture is then treated at 70-90°C for at least 0.5 hour, filtered and washed (washing temperature≥50°C), wherein, the secondly calcined zeolite is on the dry basis, and the rare earth chloride is based on RE_2O_3;

6) the product obtained in the step 5) is calcined at 350-650°C, in a condition of 1-100% steam for at least 0.5 hour to obtain a modified Y-type zeolite.

10. A use of the modified Y-type zeolite according to claim 1 or 2 or the modified Y-type zeolite prepared by the process according to any one of claims 3 to 9 in catalytically cracking a heavy oil feedstock.