U.S. Pat. No. 7,176,340, US 2002/198422 and EP 1485334, and rare earth (RE) exchanged solid acid catalysts, as taught in U.S. Patent Application Publication 2008/0183025.

[0004] Another historical attempt at creating an active and stable solid acid alkylation catalyst includes U.S. Patent No. 3,851,004. The '004 reference elates to a process for the alkylation of hydrocarbons using zeolite-containing catalysts and more particularly to aromatic or isoparaffin alkylation processes wherein the reaction is catalyzed by a zeolitic molecular sieve catalyst in conjunction with a group VIII metal hydrogenation agent. However, the '004 reference specifically teaches that the addition of rare earth cations is not essential.

[0005] Other prior art attempts at creating an active and stable solid acid alkylation catalyst include U.S. Patent No. 8,163,969, U.S. Patent Application Publication 2010/0234661, and U.S. Patent Application Publication 2011/0313227. These references are herein incorporated by reference. These prior attempts disclose rare earth exchanged molecular sieves (e.g., Y-zeolites) in such solid acid alkylation catalysts.

[0006] There remains a need for a stable and active solid acid alkylation catalyst. The present invention provides an improved alkylation process utilizing a solid-acid catalyst comprising a cerium rich rare earth containing zeolite and a hydrogenation metal.

SUMMARY

[0007] It has been discovered that the use of cerium rich rare earth containing exchanged molecular sieves (e.g., Y-zeolites) in such solid acid alkylation catalysts, compared to low in cerium rare earth provided improved alkylation activity and stability of the catalyst.

[0008] In one embodiment of the disclosure there is provided a solid catalyst comprising a hydrogenation metal and a solid acid in the form of a cerium rich rare earth containing molecular sieve, wherein the catalyst is at least characterized by a porosity of less than 0.20 ml/g in pores below 100 nm in diameter, and a total porosity of greater than 0.30 ml/g.

[0009] Another embodiment of the disclosure provides a process for the alkylation of hydrocarbons comprising contacting a saturated hydrocarbon feedstock and one or more olefins with a catalyst of this disclosure at alkylation process conditions.

[0009a] In an aspect, there is provided a process for alkylating hydrocarbons wherein an alkylatable organic compound is reacted with an alkylation agent to form an alkylate in the presence of a catalyst with the catalyst being subjected intermittently to a regeneration step by being contacted with a feed containing a saturated hydrocarbon and hydrogen, said regeneration being carried out at 90% or less of the active cycle of the catalyst, with the active cycle of the catalyst being defined as the time from the start of the feeding of the alkylation agent to the moment when, in comparison with the entrance of the catalyst-containing reactor section, 20% of the alkylation agent leaves the catalyst-containing reactor section without being converted, not counting isomerization inside the molecule, wherein said catalyst comprises a hydrogenating function, solid acid constituent and one or more rare earth elements, said one or more rare earth elements comprising at least 0.1 wt % cerium calculated as fraction of the total catalyst weight.

[0009b] In another aspect, there is provided an alkylating catalyst comprising:

a. hydrogenation metal in the amount of 0.05 to 0.5 wt %

b. solid acid constituent in the form of a rare earth exchanged molecular sieve with 2-9 wt % of one or more rare earth elements, wherein the one or more rare earth elements comprises at least 5 wt % cerium calculated on the total of rare earth elements.

[0010] These and still further embodiments, features and advantages of the disclosure shall be made even more apparent by the followed detailed description, including the appended figures and claims.

BRIEF DESCRIPTION OF THE FIGURES

[0011] Figure 1 is a graph of olefin conversion over time

[0012] Figure 2 is a graph of C9+ compounds production over time

[0013] Figure 3 is a graph of olefin conversion over time

[0014] Figure 4 is a graph of C9+ compounds production over time

DETAILED DESCRIPTION OF THE INVENTION

[0015] All weight percentages mentioned related to the catalyst composition are based on dry catalyst (heated at 600°C for 1 hour). The rare earth wt% are calculated as rare earth oxides on a dry basis (600°C, 1 hour)

[0016] The water content of the catalyst ranges from about 1.5 wt% to about 6 wt%, in one embodiment it ranges from about 1.8 wt% to about 4 wt%, and in another embodiment it ranges from about 2 wt% to about 3 wt%. The water content of the catalyst is defined as its water content during use in the alkylation process and is measured by determining the water loss upon heating the catalyst to 600 °C including two hours at 600°C (LOI 600).

[0017] The catalyst further comprises a hydrogenation metal. Examples of suitable hydrogenation metals are the transition metals, such as metals of Group VIII of the Periodic Table, and mixtures thereof. Among these, noble metals of Group VIII of the Periodic Table are preferred. Platinum, palladium, and mixtures thereof are especially preferred. The amount of hydrogenation metal will depend on its nature. When the hydrogenation metal is a noble metal of Group VIII of the Periodic Table, the catalyst generally will contain in the range of about 0.01 to about 2 wt% of the metal. In one embodiment it ranges from about 0.1 to about 1 wt%, calculated as metal and based on the total weight of the catalyst.