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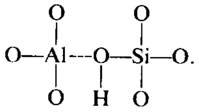
LETTERS TO THE EDITORS

The Removal of Aluminum from Zeolite Y

Dempsey (*1*), in explaining the results of Beaumont and Barthomeuf (*2*), stated, "Similarly the protons associated with the aluminum atoms of β faces will have properties different from those of α faces. We suggest that the former (β face) protons are the initial strongly acidic sites of Beaumont and Barthomeuf. On attempting to remove aluminum from the crystal structure, the aluminum atoms of α faces will be more vulnerable electrostatically (i.e., less strongly bound) than those of β faces (on account of the mutual repulsion between the aluminum atoms)."

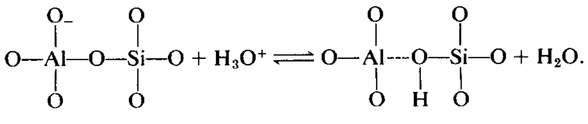
It has been proposed (*3*) that the first and necessary step in aluminum removal from zeolite Y involves the formation of the *hydrogen* form of the zeolite:



$$\begin{array}{ccccc} & O & & O & \\ & | & & | & \\ O— & Al & \cdots O— & Si & —O. \\ & | & | & | & \\ & O & H & O & \end{array}$$

The aluminum (atom or ion) shown as sharing an oxygen with a proton and a silicon (atom or ion) undergoes reaction with water whereby the aluminum is hydrolyzed from the tetracoordinate framework and becomes hexacoordinate.

It is important to realize that the technique (*2,3*) used by Beaumont and Barthomeuf first involves the exchange of hydronium ion (H_3O^+) into the zeolite. Then an equilibrium is established:



$$\begin{array}{cccccccccc} & O^- & & O & & & & O & & O \\ & | & & | & & & & | & & | \\ O— & Al & —O— & Si & —O + H_3O^+ \rightleftharpoons & O— & Al & \cdots O— & Si & —O + H_2O. \\ & | & & | & & & & | & | & | \\ & O & & O & & & & O & H & O \end{array} \quad (1)$$

The aluminums associated with weakly acidic sites are those lying on the right of Eq. (1); whereas, strongly acidic sites are those on the left. It seems unlikely that the β sites of Dempsey are, in fact, associated with protons. Accordingly, then, it is apparent that the tetracoordinate aluminums associated with weakly acidic or α sites are preferentially hydrolyzed, become hexacoordinate, and are removed from the tetracoordinate framework. Hence, Dempsey's proposal, based on electrostatic theory, that weakly bound aluminums are most vulnerable to aluminum removal is supported by chemical considerations. The chemistry of hydronium zeolite Y under study in this laboratory will be reported in the future.

REFERENCES

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