INFLUENCE OF TEMPERATURE ON THE SYNTHESIS OF THE ZEOLITES ZSM-5 AND FERRIERITE

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ABSTRACT

Both the zeolites ZSM-5 and ferrierite have found application as catalysts for a variety of industrial processes. Ferrierite, in particular, has been shown to be an active, selective and stable catalyst for the isomerisation of 1-butene to isobutene. The latter is then reacted with methanol to form methyl tertiary butyl ether (MTBE), which is currently used as an octane enhancer. As a consequence of the industrial significance of these zeolites, further knowledge on the reproducible synthesis of these zeolites is of crucial importance.

The zeolites ZSM-5 and ferrierite were prepared by methods described in the patent literature. The influence of the hydrothermal synthesis temperature on the crystallinity and morphology of the prepared samples was investigated under both static and stirred conditions for temperatures up to 180°C. The zeolite crystallinity was determined by X-ray diffraction (XRD) and the morphology by scanning electron microscopy (SEM).

For the zeolite ZSM-5 the results from the synthesis with and without stirring both give an S-shaped curve for the plot of percentage crystallinity versus synthesis temperature. The inflection point for the curve of the samples synthesized with stirring was reached at a lower temperature as well as the plateau of the curve, although the maximum percentage XRD crystallinity of the plateau was lower than that of the samples synthesized without stirring. The SEM study of the ZSM-5 zeolite samples synthesized without stirring show well formed polygon crystals for the samples with high percentage XRD crystallinities, while for the samples synthesized with stirring no specified crystals could be identified.

In both cases, with and without stirring, the results for the ferrierite zeolite have shown that the percentage XRD crystallinity increases to a maximum value with a corresponding increase in temperature up to 150°C after which it decreases with further increase in temperature. In the case of the synthesis with stirring, a higher maximum crystallinity is obtained. SEM results show the formation of rectangular crystals with “rose-like” intergrowth. These features were also observed to be randomly distributed in the amorphous material for samples of low percentage XRD crystallinity.