

# Pulse Chemisorption with AutoChem II 2920: Isopropylamine on Zeolites

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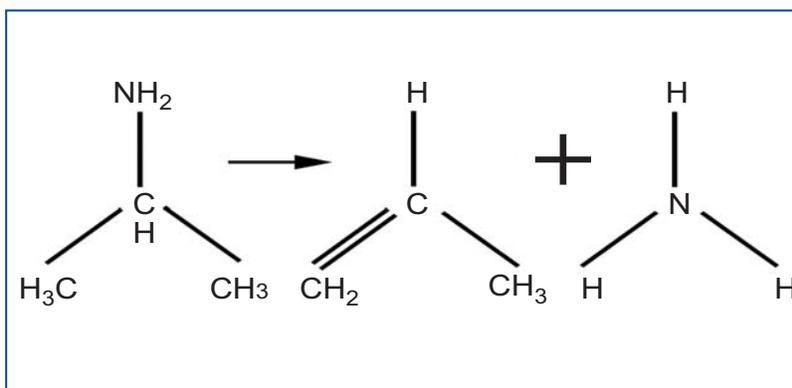
## Introduction

Several ZSM-5 zeolite samples were analyzed using the AutoChem II 2920. By pulsing isopropylamine onto the zeolites, the concentration of acid sites can be determined for a particular zeolite. This is very important for catalytic reactions. For example, the reaction that occurred during these analyses proceeded through an intermediate due to an acid-base reaction between the amine and the zeolite, followed by a specific type of E2 elimination, known as the Hoffman elimination. Due to the second order kinetics involved in this reaction, a high concentration of acid sites would allow the reaction to proceed much more quickly.

## Preparation

While there was no preparation of the sample as far as degassing is concerned, it could be said that the sample was 'prepared' by heating. The ZSM-5 samples contained various cations, including ammonium ( $\text{NH}_4^+$ ). These cations were not as desirable for the analysis as the hydrogen cation ( $\text{H}^+$ ). Since samples containing the hydrogen cation are more expensive, the sample can be converted to the hydrogen cation

*The Hoffman elimination reaction:*



## Materials:

*The samples used are listed below.*

Zeolite Type	$\text{SiO}_2 / \text{Al}_2\text{O}_3$
ZSM-5-30	30
ZSM-5-55	50
ZSM-5-80	80

by heating the sample to high temperature. These samples were 'prepared' by first being heated to 500 °C and then cooling back to 200 °C.

## Analysis

The preparation part of the analysis was followed by the pulse chemisorption step of the analysis. During this step, there

were twenty loop injections of isopropylamine occurring at four-minute intervals. The last part of the analysis involved a temperature-programmed desorption (TPD). At this step in the analysis, the mass spectrometer began scanning for propylene, the product of interest. Data were collected during a temperature ramp to 500 °C.

### Data

These graphs show how the intensity of the TCD signal changes for various zeolite samples. Notice that a direct proportionality exists between the peak intensities and the concentration of aluminum oxide ( $\text{Al}_2\text{O}_3$ ), and an inverse proportionality exists between the peak intensity and the silica-to-aluminum oxide ratio ( $\text{SiO}_2/\text{Al}_2\text{O}_3$ ).

### Legend:

ZSM-5-30	<span style="color: red;">█</span>
ZSM-5-55	<span style="color: green;">█</span>
ZSM-5-80	<span style="color: blue;">█</span>

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