Alcohol Dehydration Reaction

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Abstract

A Montmorillonite K10 catalyst was combined with 2-methylcyclohexanol, refluxed and distilled to generate an alkene. (Figure 1). Based off of the gas chromatography, our reactions did not occur. This could be due to a contaminant in our solutions.

Background

Alcohols, when in the presence of a strong acid, such as Montmorillonite K10, and heated at high temperatures, can produce an alkene. The reflux heating and distillation process is innate, as it allows for alcohols to dehydrate and form alkenes (Ma, 2020). We are attempting to separate the resultant isomers from the alcohol by removing the hydrogen from the β Carbon having the fewest hydrogens (Brooks et al., 2011) (Figure 1).

Figure 1: Elimination of H and OH from 2-methylcyclohexanol that yields two constitutional isomers

In order for a dehydration reaction to produce an alkene, elimination of H and OH from 2-methylcyclohexanol must occur. The introduction of the catalyst, Montmorillonite K10, and the heating process, protonates the OH group to make a good leaving group. The loss of the H20 group forms a carbocation and the removal of a β proton forms a π bond (Smith, 2017). The Montmorillonite K10, nontoxic clay, produces clean elimination products since there is no good nucleophile to react with the carbocation (Warnock et al., 2018). Gas chromatography was used to determine the percentages of different isomers in the product mixture to that of negative control groups.

Methods

First, a solution containing 2-methylcyclohexanol and Montmorillonite K10 was prepared and refluxed. The unreacted alcohol and catalyst were distilled. The products obtained were then analyzed via gas chromatography.

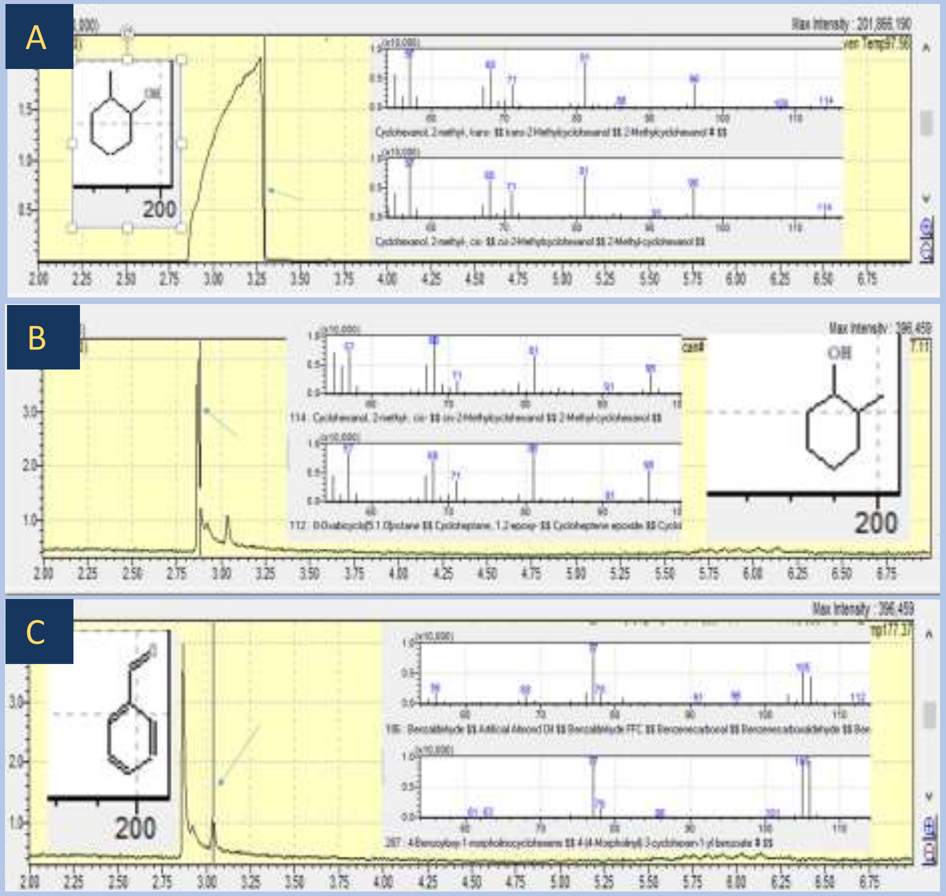

Figure 2. GC/MS readout for our A) control of methylcyclohexane, B) distillation at 70 degrees peak 1 and, C) peak 2.

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Results

The results derived from the experiment did not correlate with our prediction of creating 1-methylcyclohexene and methylenecyclohexane. The alcohol, 2-methylcyclohexanol, did not undergo alcohol dehydration following being added to a strong acid and heated at high temperatures. Both of our isomers obtained from distillation did not vary from the GCMS reading of the control, 2-methylcyclohexanol, (Figures 2,3,4,5,6).

Discussion

The suspected reason as to why our reaction did not occur, is because of the presence an external contaminant, or other unidentified error. There was a small difference between the molecular weights of the control and the products distilled from the mixture. We also derived a third product that was lost due to human error.

Conclusion/Future

Combining sufficient catalyst, Montmorillonite K10 and heating the mixture to a high temperature is integral to the formation of alkenes. For future experiments, obtaining one more product to compare to the control would be beneficial when determining the percentages of different isomers in the product mixture. The use of Montmorillonite K10, is a greener alternative because it is nontoxic, and a reusable catalyst (Warnock, et al., 2018).