Alcohol Dehydration

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Abstract

The objective of this lab was to successfully carry out an elimination reaction in attempt to create a greener alternative through the synthesis of alkenes. This process was accomplished by the use of a reflux reaction in attempt two remove an Oxygen and two Hydrogen from 2-Methylcyclohexanol and Cyclohexanol in order to create the greener alternative being sought after.

Background

Elimination reactions are commonly used when the desired experiment requires a removal of a pair of atoms or groups of atoms from the starting molecule. This is typically done through the use of acids, bases, metals, or refluxing. For this experiment, an elimination reaction was used in the dehydration of alcohol. In order to carry out the reaction, a solid acid, montmorillonite KSF clay, was used. Montmorillonite KSF clay is non-toxic and reusable, which makes it a greener alternative. (2) The clay catalyst is also heat resistant which gives the clay the ability to attract cations which are then pulled off of any positive cation containing molecule. When this occurs, water can be stripped away from the molecule and a double bond will be formed in between the two carbon molecules in 2-methylcyclohexanol (Fig. 2) These products can be analyzed via gas chromatography-mass spectrometry or the GCMS. Gas chromatography vaporizes the produced mixtures and carries them through a separation column where gas, like helium, is inserted. The intermolecular forces that the compounds have with the chemistry inside the column determine the reading. The final detector in the system is the Mass Spec, which takes the size of the molecules into account.

Fig. 1 shows the reaction between 2-methylcycohexanol and our clay catalyst

Procedure 1

2-Methylcyclohexanol and montmorillonite KSF clay were mixed in a round bottom flask and refluxed for ninety minutes. Then, the products from the reflux were distilled from the remaining alcohol and remaining catalyst. The products of this reaction were then ran through the GCMS to determine the composition of certain isomers within the product. Step two of the experiment was not completed per instructor direction.

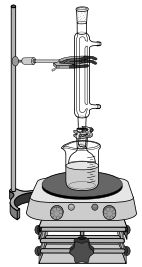

Fig. 2 Reflux setup

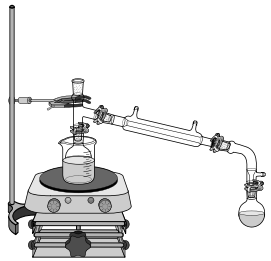

Fig. 3 Distillation setup

Results

The GCMS is used in order to separate chemical mixtures in order to identify their components at a molecular level. In this experiment, each collected sample was ran through the GCMS and compared to target readings from our own sample and the library database. From this, unknown compounds were found in each sample and were able to be determined **(Fig. 4-6).** Each individual peak shown from the GCMS represents a different organic compound. After looking at the readings, similar compounds were present in the different samples which are shown by similar peaks within **Fig. 5** and **Fig. 6**. However, they were not our desired results and did not show enough similarities in order to draw the conclusion that the experiment was successful.

Conclusion

The results of this experiment proved to be inconclusive. From our data from the GSMS it seems that we were unsuccessful in the dehydration of 2-Methyl Cyclohexanol and Cyclohexanol. The starting solution of 2-methylcyclohexane and montmorillonite KFS clay underwent an alcohol dehydration that was followed by a reflux and distillation. The GSMS did not pick up on any significant differences in the molecular weight or concentrations between the original product and the two products after the distillation was ran. Because of there being no significant differences in molecular weight or concentration it is concluded that no dehydration reaction took place. This could be due to cross contamination between the samples or potential glassware contamination. Another factor that could have potentially affected this was the burning of the clay catalyst during the reflux reaction. For future experiments I would recommend trying another dry catalyst option to see if that improves GSMS results. However, if the clay does work, running the standard dehydration is an option for a control.

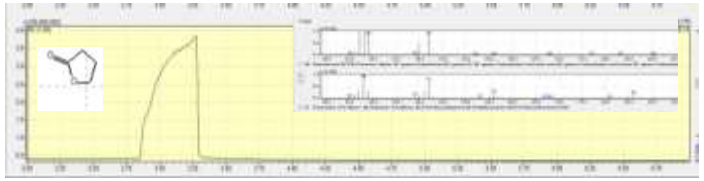

Fig. 4 Reflux product

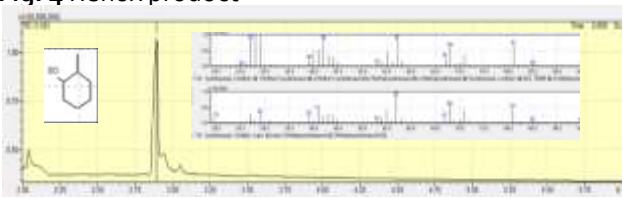

Fig. 5 2-Methylcyclohexane

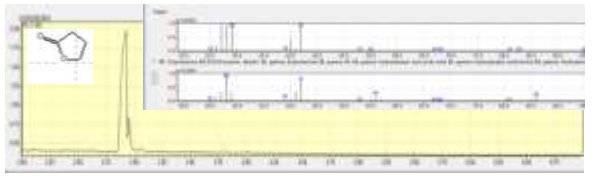

Fig. 6 Distilled Product

References

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2. Uddin, Faheem. "Montmorillonite: An Introduction to Properties and Utilization." *IntechOpen*, IntechOpen, 12 Sept. 2018, www.intechopen.com/books/current-topics-in-the-utilization-of-clay-in-industrial-and-medical-applications/montmorillonite-an-introduction-to-properties-and-utilization.