Sample Lab Report for

"Dehydration of 2-methylcyclohexanol: Study of C=C orientation in the products"

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Purpose:

To carry out the dehydration of 2-methylcyclohexanol and study the orientation of C=C in the final alkene products. Saytzev's rule will be tested.

Introduction:

Alcohols can be dehydrated by using an acid such as sulfuric or phosphoric acid. Water will be eliminated from the molecule and a C=C double bond will be formed. If the alcohol is not symmetric, then a mixture of products containing alkene isomers is possible. Russian chemist Saytzev predicted that for a reaction following E1 mechanism, the more substituted C=C is favored in the product. In the case of 2-methylcyclohexanol, that would mean that 1-methylcyclohexene should be formed as the major product. Therefore, in this experiment, we will carry out the dehydration of 2-methylcylclohexanol in H_3PO_4/H_2O, and analyze the distribution of alkene products on a GC. The result would allow us to test whether the Saytzev's rule holds in this case.

Experimental: (note: past tense and passive)

2 ml of cyclohexanol was mixed with 0.6 ml of 85% H_3PO_4 and the mixture was swirled to for 2-3 min to allow the reaction to complete. A distillation was then set up. The setting of the Variac was controlled so that the thermometer temperature of the vapor distilled was below 100 °C. The distillate was washed with $NaCO_3$ and water, before being dried over $CaSO_4$. 0.5 grams of colorless liquid product were obtained and kept in a vial. The product was analyzed by injecting 1 ul of sample into the GC.

The product was also tested for the presence of a C=C double bond. It was found that our product discolored the purple color of $KMnO_4$ upon its addition and it also discolored the brown color of Br_2/Cl_4.

Results and Discussion:

Based on the amount of product obtained, the % yield of this reaction is calculated as follows:

(show the calculation either with handwriting or typing. Let's assume a yield of 35%)

The yield is somewhat low; this could be due to the incomplete reaction or distillation. Washing and extraction may also cause the product to be lost. A longer reaction time may be helpful in converting the alcohol to alkenes in higher yield.

GC analysis showed that 1-methylcyclohexene eluted before 3-methylcyclohexene, with areas of (note: assuming 3000 and 1000 respectively). This gave a % ratio of 75% 1-methylcyclohexene and 25% 3-methylcyclohexene. Since 1-methylcyclohexene has a C=C that is more substituted, we can conclude that this result is consistent with the rule predicted by Saytzev.

The fact that $KMnO_4$ and Br_2 were discolored by the product indicated that the product does contain C=C bonds, which reacted with the two reagents therefore discoloring them. This confirmed that fact that C=C bond was formed by dehydrating the alcohol.

Conclusions:

It is evident that the dehydration of 2-methylcyclohexanol in H_3PO_4 gave 1-methylcyclohexene as the major product, as predicted by Saytzev (more substituted C=C being more stable). Both $KMnO_4$ and Br_2 tests are useful in the confirmation of C=C formation. Although the dehydration yield was low, the experimental goal was achieved.

(note: insert a page break and answer the questions on the next page. Although the text should be word processed, the structures or equations can be drawn by hand.)