**Formal Report Guidelines and Examples**

A formal report will be required for most of the later laboratories. Point values for the sections below will vary by lab, but will remain the same proportionally.

*University Honor Statement (2 pts).* The University Honor Statement should be included on the first page.

*Introduction (5 pts)*. Write a paragraph or two describing the purpose of the laboratory, key principles, or important aspects of the experiment. Provide literature references as appropriate.

*Overall Reaction (3 pts)*. Use SymyxDraw to complete this portion of the report. The program is installed in the computer labs in the science building, and in the 24-hour computer lab in Hollenbeck Hall. Scanned and handwritten images are not acceptable. If you cannot access the above mentioned computers, be aware that SymyxDraw is freeware, and can be downloaded following your registration.

# ***Procedure (10 pts)*. Write out a detailed account of your procedure. *Always* use third-person past tense, *NEVER* first person, present or imperative tense! (Tell me what *was done*, not what you did or what I should do.) Proper grammar is expected. Include the exact amount of reagents used and exactly what *you* did, mistakes and all. Do not elaborate on why things were done or what affect any mistakes may have on your outcome.**

*Results (10 pts)*. Present your results (data) in the clearest, most efficient manner possible. Include all numerical data (units labeled), well-labeled calculations (*especially theoretical and percent yield*), and graphs. (Note: You may need to refer to your general chemistry textbook to review calculations for theoretical yield and percent yield. Do NOT calculate percent yield by dividing grams of product by grams of starting material.)

*Discussion/ Conclusion (10 pts)*. Restate the most important data from the *Results* section and how that led to your conclusions. Analyze the data. Cite evidence that your product is the correct one. Compare physical data to literature values (mp, bp, spectroscopic data, etc.). Estimate product purity. Discuss any errors that may have caused your results to deviate from what was expected. Summarize what you learned. Discuss more than just loss due to the physical limitations of the equipment. For instance, if you have less than a 100% yield there are more reasons than just "Some of the solid stuck to the flask and some passed through the filter paper."

Each section of the reports will be graded on a 5-10 (or equivalent) scale:

*10* – Clear and concise language with no major errors/omissions and no more than 1 or 2 minor errors/omissions. Full explanation of important principles.

*9* – May be occasionally unclear, contain grammatical errors, or contain several minor errors/omissions, but still easy to read. No major errors/omissions. Important principles explained, though perhaps not particularly well.

*8* – Contains several errors/omissions, possibly major. Difficult to decipher at times. Important principles explained, though perhaps not particularly well.

*7* – Contains numerous major errors/omissions. Difficult to follow due to errors and poor grammar.

*6* – Poorly written with little pertinent data.

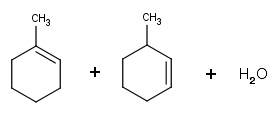
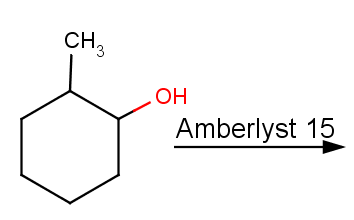
*5* – The lowest score possible for completed assignments is 50%. Late assignments will be demoted 10% per weekday down to a minimum of 50% of their original value.

**Sample “A” Report**

**Introduction:**

Alkenes can be formed from the dehydration of an alcohol by using an acid catalyst. This reaction is an E1 reaction most of the time where the –OH group reacts with a proton to form H2O that is then lost forming a carbocation. When an adjacent proton is removed, an alkene is formed. In this lab 2-methylcyclohexanol was dehydrated using Amberlyst 15 ion exchange resin as a catalyst and an alkene mixture of 1-methylcyclohexene and 3-methlycyclohexene was formed. According to Zaitsev’s Rule, the more substituted alkene, which would be 1-methylcyclohexene, should be the major product of the mixture because it is more stable. This will be verified using gas chromatography. An IR spectrum will also be used to verify that the product is an alkene and no longer has an –OH group.

**Reaction:**



**Procedure:**

Amberlyst 15 ion exchange resin (1.64g, 5.216 mmol) and 2-methylcyclohexanol (17.5 mL, 142.5 mmol) were combined in a 100 mL round-bottom flask. A stir bar was added and then a Clasien head, distillation adapter with a temperature probe and a condenser were attached. A 50 mL round-bottom flask cooled in an ice bath was then attached to collect the product. The reaction mixture was heated and the temperature did not exceed 100-110 °C. The reaction mixture was heated until about 5-10 mL of liquid remained in the distilling flask and then the heat source was removed.

The product mixture was poured into a clean separatory funnel and the aqueous layer was removed. The product layer was put into a small Erlenmeyer flask and was dried with anhydrous CaCl2 for about 10 minutes. The dried product was then filtered into a clean 50 mL round-bottom flask and distilled using a simple distillation apparatus. The 100 mL round-bottom receiving flask was cooled in an ice-water bath and the distillate was collected between 103-110 °C.

The product collected was massed and the percent yield was calculated. The product was then tested with Br2/cyclohexane test solution, gas chromatography, and IR spectroscopy.

**Results:**

The product was a clear liquid and had a mass of 3.48g (36.19 mmol).

The Br2/cyclohexane test resulted in a clear liquid.

Percent yield calculation:

3.48g product (1 mol / 96.17 g) = 36.19 mmol

% yield = (36.19 mmol / 140.397 mmol) \* 100% = 25.78%

A gas chromatography (attached) was analyzed to determine the percentage composition of the product.

Peak 1 (3-methylcyclohexene, bp 104 °C):

Height of peak: 0.9375 inches

Width at half height: 0.3125 inches

Area of peak: 1.89 cm2

(0.9375 in)(0.3125 in) = 0.292 in2

0.292 in2 (6.4516 cm2 / 1 in2) = 1.89 cm2

Peak 2 (1-methylcyclohexene, bp 110 °C):

Height of peak: 2.9375 inches

Width at half height: 0.375 inches

Area of peak: 7.11 cm2

(2.9375 in)(0.375 in) = 1.102 in2

1.102 in2 (6.4516 cm2 / 1 in2) = 7.11 cm2

The infrared spectrum of the product (attached) was obtained.

|  |  |
| --- | --- |
| **Band Position (cm-1)** | **Intensity** |
| 3043.4 – 3017.2 | moderate |
| 2921.8 | strong |
| 1439.5 | moderate |

**Discussion:**

The dehydration of 2-methylcyclohexanol using Amberlyst 15 ion exchange resin resulted in a product mixture containing 1-methylcyclohexene and 3-methylcyclohexene. By testing the product with Br2/cyclohexanetest solution, which resulted in a clear liquid, it was verified that there was an alkene in the solution, which means that the expected products were formed.

The percent yield of this reaction was 26%. This is a relatively low percent yield, which means that very little of the possible amount of product was actually produced. This could be because when doing the first distillation not all of the 2-methylcyclohexanol was allowed to be distilled.

The infrared spectrum confirmed that the dehydration of 2-methylcyclohexanol resulted in the formation of 1-methylcyclohexene and 3-methylcyclohexene. There was a moderate band at 3043.4 and 3017.2 cm-1, which shows a =C-H bond and the presence of a sp2 carbon. A broad band at 2921.8 cm-1 represented a C-H bond and a C=C was shown represented by a peak at 1439.5 cm-1. These peaks confirm that an alkene is present in the product mixture. There is no evidence of an O-H bond, which would result in a very broad peak at 3520-3100 cm-1, and this verifies that there is no alcohol present in the product.

The gas chromatography showed two peaks, which represent the presence of 1-methycyclohexene and 3-methylcyclohexene in the product. The first peak, which is 3-methylcyclohexene (boiling point is 104 °C), has an area of 1.89 cm2. The second peak, which is 1-methylcyclohexene (boiling point is 110-111 °C), has an area of 7.11 cm2. This shows that the product is 21% 3-methylcyclohexene and 79% 1-methylcyclohexene, which confirms that 1-methylcyclohexene is the major product of the dehydration of 2-methylcyclohexanol.

In the pre-lab, it was predicted that 1-methylcyclohexene would be the major product because of Zaitsev’s Rule. Elimination reactions often follow Zaitsev’s Rule, which is an observation that the most substituted alkene is the one that forms in an elimination reaction. The more substituted alkene is more stable because of hyperconjugation, or the distribution of electrons between the π bond and adjacent *p*-orbitals. 1-Methylcyclohexene is the more substituted alkene, so it should be the major project, which is observed in these results.

**Appendices:**

Gas Chromatography

IR Spectrum

Notebook pages

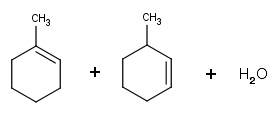
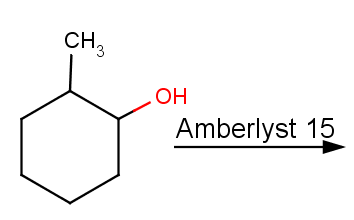
Calculations

**Sample “B” Report**

**Introduction:**

Alkenes can be formed from the dehydration of an alcohol by using a catalyst. This reaction is an E1 reaction most of the time where the –OH group reacts with a hydrogen to form H2O that is then lost and a carbocation is formed. When another hydrogen is removed, an alkene is formed. In this lab, the alcohol 2-methylcyclohexanol was dehydrated using Amberlyst 15 ion exchange resin as a catalyst and an alkene mixture of 1-methylcyclohexene and 3-methlycyclohexene was formed. According to Zaitsev’s Rule, the more substituted alkene, which would be 1-methylcyclohexene, should be the major product of the mixture. This will be verified with a gas chromatography. An IR spectrum will also be used to verify that the product is an alkene and no longer has an –OH group.

**Reaction:**



**Procedure:**

Amberlyst 15 ion exchange resin (1.64g, 5.216 mmol) and 2-methylcyclohexanol (17.5 mL, 142.5 mmol) were combined in a 100 mL round-bottom flask. A stir bar was added and then a Clasien head, distillation adapter with a temperature probe and a condenser were attached. A 50 mL round-bottom flask cooled in an ice bath was then attached to collect the product. The reaction mixture was heated and the temperature did not exceed 100-110 °C. The reaction mixture was heated until about 5-10 mL of liquid remained in the distilling flask and then the heat source was removed.

The product mixture was poured into a clean separatory funnel and the aqueous layer was removed. The product layer was put into a small Erlenmeyer flask and was dried with anhydrous CaCl2 for about 10 minutes. The dried product was then filtered into a clean 50 mL round-bottom flask and was distilled using the simple distillation apparatus used before. The receiving 100 mL round-bottom flask was cooled in an ice-water bath and the distillate was collected.

The product collected was weighed and the percent yield was calculated. The product was then tested with Br2/cyclohexane test solution and a gas chromatography and IR spectrum were collected and analyzed.

**Results:**

The product was a clear liquid and had a mass of 3.48g (36.19 mmol).

The Br2/cyclohexane test resulted in a clear liquid.

Percent yield calculation:

3.48g product (1 mol / 96.17 g) = 36.19 mmol

% yield = (36.19 mmol / 140.397 mmol) \* 100% = 25.78%

A gas chromatography (attached) was analyzed to determine the percentage composition of the product.

3-methylcyclohexene:

Height of peak: 0.9375 inches

Width at half height: 0.3125 inches

Area of peak: 1.89 cm2

(0.9375 in)(0.3125 in) = 0.292 in2

0.292 in2 (6.4516 cm2 / 1 in2) = 1.89 cm2

1-methylcyclohexene:

Height of peak: 2.9375 inches

Width at half height: 0.375 inches

Area of peak: 7.11 cm2

(2.9375 in)(0.375 in) = 1.102 in2

1.102 in2 (6.4516 cm2 / 1 in2) = 7.11 cm2

The infrared spectrum of the product (attached) was obtained.

|  |  |
| --- | --- |
| **Band Position (cm-1)** | **Intensity** |
| 3043.4 – 3017.2 | moderate |
| 2921.8 | strong |
| 1439.5 | moderate |

**Discussion:**

The dehydration of 2-methylcyclohexanol using Amberlyst 15 ion exchange resin resulted in a product mixture containing 1-methylcyclohexene and 3-methylcyclohexene. By testing the product with Br2/cyclohexanetest solution, which resulted in a clear liquid, it was verified that there was an alkene in the solution, which means that the expected products were formed.

The percent yield of this reaction was 25.78%. This is a relatively low percent yield, which means that very little of the possible amount of product was actually produced. This could be because when doing the first distillation not all of the 2-methylcyclohexanol was allowed to be distilled.

The infrared spectrum confirmed that the dehydration of 2-methylcyclohexanol resulted in the formation of 1-methylcyclohexene and 3-methylcyclohexene. There was a moderate band at 3043.4 and 3017.2 cm-1, which shows a =C-H bond and the presence of a sp2 carbon. A broad band at 2921.8 cm-1 represented a C-H bond and a C=C was shown represented by a peak at 1439.5 cm-1. These peaks confirm that an alkene is present in the product mixture. There is no evidence of an O-H bond, which would result in a very broad peak at 3520-3100 cm-1, and this verifies that there is no alcohol present in the product.

The gas chromatography showed two peaks, which represent the presence of 1-methycyclohexene and 3-methylcyclohexene in the product. The first peak, which is 3-methylcyclohexene (boiling point is 104 °C), has an area of 1.89 cm2. The second peak, which is 1-methylcyclohexene (boiling point is 110-111 °C), has an area of 7.11 cm2. This shows that the product is 21% 3-methylcyclohexene and 79% 1-methylcyclohexene, which confirms that 1-methylcyclohexene is the major product of the dehydration of 2-methylcyclohexanol.

In the pre-lab, it was predicted that 1-methylcyclohexene would be the major product because of Zaitsev’s Rule. Elimination reactions often follow Zaitsev’s Rule, which is an observation that the most substituted alkene is the one that forms in an elimination reaction. The more substituted alkene is more stable because of hyperconjugation, or the distribution of electrons between the π bond and adjacent p-orbitals. 1-methylcyclohexene is the more substituted alkene, so it should be the major project, which is observed in the results.

**Appendices:**

Gas Chromatography

IR Spectrum

Notebook pages

Calculations

**Sample “C” Report**

**Reaction**



**Introduction**

This experiment was designed to align with Zaitsev’s Rule for dehydration reactions. The E1 reaction of 2-methylcyclohexanol with Amberlyst 15 ion exchange resin formed two alkenes: 1-methylcyclohexene and 3-methylcyclohexene. According to Zaitsev’s Rule, the major product should be the more highly substituted alkene, 1-methylcyclohexene.

The experiment requires the use of two simple distillations to collect the appropriate condensate. Once both distillations are complete, the liquid product is analyzed by a Br2C6H12 or KMnO4 test to verify the presence of an alkene. The product is also analyzed via gas chromatography and IR spectroscopy in order to identify the structure and percentage of products formed.

**Procedure**

2-Methylcyclohexanol (16.00 g, 140.21 mmol) was poured into a 100 mL round-bottom flask. Amberlyst 15 ion exchange resin (1.60 g, 10.12 mmol) was added to the 100 mL round-bottom flask, along with a stir bar. A simple distillation apparatus was consructed using a Claisen head, distillation adapter, temperature probe, and condenser. The 50 mL round-bottom flask, also known as the collection flask, was cooled in an ice bath using a beaker of ice and wood blocks for support. The heat was set to 40 and the stirring plate was set to 1. The reaction then proceeded for one hour and did not exceed a temperature of 110 ˚C. The temperature rapidly

increased from 45 ˚C to 70 ˚C. The stopper on the Claisen head repeatedly “bumped” upwards,

and the Amberlyst beads “popped” up and stuck to the edge of the 100 mL round-bottom flask

and to the side of the Claisen head. It was assumed that the dehydration reaction had sufficiently completed when there was approximately 5-10 mL of liquid left in the distilling flask. The heating source was turned off, and lowered from the bottom of the 100 mL round-bottom flask. The water source and stirring mantle were also turned off. The 50 mL round-bottom flask was removed from the apparatus and the condensate was poured into a separatory funnel.

The aqueous layer that formed was placed into a waste beaker. The remaining product layer was poured into a small erlenmeyer flask. Anhydrous CaCl2 was then added to the flask. After approximately 10 minutes, the product layer was separated from the anhydrous CaCl2 and poured into a 50 mL round-bottom flask. This flask was then attached to the Claisen head of the simple distillation apparatus previously used in the experiment. The heat source and the stirring plate were raised near the bottom of the flask, and set to 40 and 1 respectively. The goal was to collect the distillate between 103-110 ˚C. Therefore, any distillate that formed prior to these temperatures was collected into a waste beaker. Once the temperature reached 103 ˚C, a 100 mL round-bottom flask was attached to the end of the vacuum adapter and cooled in an ice bath. After the addition of the 100 mL round-bottom flask, the temperature dropped significantly to about 65 ˚C. The heat setting was increased until the temperature reached 103 ˚C again. When the temperature began to significantly decrease a second time, and a small amount of liquid was left in the 50 mL round bottom flask attached to the Claisen head, the distillation was stopped. The round-bottom flask attached to the vacuum adapter was dried and weighed in order to determine the product weight. Three tests were then performed in order to analyze the product that formed: Br2C6H12 test solution, gas chromatography, and an IR spectroscopy. A few drops of the product were placed into a test tube that contained a small amount of Br2C6H12 test solution.

**Results**

**Theoretical Yield:**

16.0 g C7H14O \* 1 mol C7H14O \* 1 mol C7H12 \* 96.17 g C7H12  = 13.48 g C7H12

114.19 g C7H14O 1 mol C7H14O 1 mol C7H12

The mass of the product was 1.18 g.

**Percent Yield:**

1.18 g C7H12 \* 100% = 8.8%

13.48 g C7H12

Gas chromatography (graph attached) was used to calculate the percent composition of the products. The calculations are shown below.

**Percent Composition Calculations:**

**1-methylcyclohexene:**

Height= 1.5cm

Width at ½ Height= 1.0 cm

Area= 1.5 cm2

**3-methylcyclohexene:**

Height= 8.0 cm

Width at ½ Height= 1.1 cm

Area= 8.8 cm2

Total Area= 1.5 cm2 + 8.8 cm2 =10.3 cm2

**%Composition**

**1-methylcylcohexene:**

1.5 cm2/10.3 cm2 \* 100% = 14.6%

**%Composition**

**3-methylcyclohexene:**

8.8 cm2/10.3 cm2 \* 100% = 85.4%

IR Spectroscopy (graph attached) was used to identify the structure of the products formed. The results are presented below.

**IR Spectroscopy Results:**

|  |  |  |
| --- | --- | --- |
| **Bond Type** | **Wave Numbers** | **IR Spectroscopy Results** |
| C=C | 1400s | 1439.5 |
| C-H | 2972-2843 | 2914 |
| C-H | 3043 | 3043.5 |

**Br2C6H12 Test:**

The product of the reaction induced a color change in the Br2C6H12 test from brown to clear.

**Discussion**

The products that formed in this experiment were a direct consequence of Zaitsev’s Rule which states that the major product that forms is the more substituted alkene. The products of this experiment were 1-methylcyclohexene and 3-methylcyclohexene. The total mass of this mixture of products was 1.18 g, which lead to a percent yield of 8.75%. This is a low percentage value with regard to percent yield and was a result of some potential procedural errors. For instance, the distillations may have been prematurely stopped. The distillations were meant to continue until about 5-10 mL of liquid remained in the round-bottom flask connected to the Claisen head. The amount of liquid that remained in the flask could not be measured, but rather, had to be estimated. This could account for a lack of condensate that formed if more than the allotted amount of liquid was left in the flask. In the second distillation, the temperature dropped dramatically after the desired 103˚C-110˚C range was present; the result was a termination of the distillation. This may have led to a decrease in the amount of condensate formed, which could hinder the product yield. In addition, anhydrous CaCl2 was needed to dry the product layer

that formed as a result of the first distillation. The fear of accidently pouring the anhydrous

crystals into the round-bottom flask limited the amount of liquid that was transferred to the flask. In other words, some of the liquid product layer from the first distillation remained in the erlenmeyer flask, and was not used in the second distillation. This decreased the potential amount of product that could form.

Several tests were conducted to analyze the products that formed as a result of this dehydration experiment. The tests that were utilized include: Br2C6H12 test solution, IR spectroscopy, and gas chromatography.

The goal of the Br2C6H12 solution test was to prove that an alkene, 1-methylcyclohexene and/or 3-methylcyclohexene, was present in the product mixture, which should be the product(s) of a dehydration reaction. A color change from brown to clear indicated the presence of an alkene, but no change in color indicated that no alkene was present. The originally brown Br2C6H12 solution did in fact turn clear, which verified the presence of an alkene.

IR spectroscopy was also used to analyze the products that formed. It is important to note that there should not be O-H bonds present between 3520-3100 cm-1; this would indicate that some of the reactant, 2-methylcyclohexanol, remained in the product. As the IR spectrum demonstrates, no such bonds were present. Thus, no reactants were present in the product mixture. With that said, alkenes should form. C=C bonds and C-H bonds are indicative of an alkene structure—both of which were also present on the IR spectroscopy graph. The large dip in the graph that is visible around 2914 cm-1 corresponds to the expected literature range of 2972-2843 cm-1 for the presence of a C-H bond. In addition, the stretch present on the graph at 1439.5 cm-1 indicates the presence of a C=C bond as the accepted value for this structural trait is near 1450 cm-1. The last value of 3043 cm-1 is a critical value that also refers to alkene formation with a C-H bond. The IR spectrum clearly shows this structural feature with a stretch value of 3043.5cm-1. Thus, the IR spectroscopy graph reflects that 1-methylcyclohexene and 3-methylcyclohexene were products of this reaction, and were not inhibited by the presence of the alcohol that was used as the reactant.

The final test performed was gas chromatography. This test was used to identify the percent compositions of the products that formed. It is important to note that the more volatile substances, or those with the lower boiling point, are represented in the graph first. 3-methylcyclohexene has a boiling point of 105 ˚C, while 1-methylcyclohexene has a boiling point of 110 ˚C. The identity of the substances can be determined from this information; 3-methylcyclohexene is depicted by the first curve, and 1-methylcyclohexene by the second curve. The percent composition of each was calculated using the height and the width at half height. Using the calculated percent composition values, it was determined that 1-methylcyclohexene was the major product because more of this was formed in comparison to 3-methycyclohexene. The calculated percentages were 14.6% (1-methylcyclohexene) and 85.4% (3-methylcyclohexene).

Each of the tests performed aligned with Zaitsev’s Rule—the major product that formed was the

more substituted alkene. The energy of each product that formed was calculated in pre-lab. The results of the pre-lab also indicated that 1-methylcyclohexene was the major product. The Br2C6H12 test verified that an alkene (1-methylcyclohexene and/or 3-methylcyclohexe) was present, and that the presence of the reactant had not hindered the results. The IR spectroscopy results also concluded that no reactants remained in the product mixture, and that the bonds characteristic of alkenes—C-H and C=C—were present in the products. Lastly, gas chromatography solidified Zaitsev’s Rule; the more substituted alkene, 1-methylcyclohexene, was the major product by percent composition analysis of the GC graph.

**Appendices**

Gas Chromatography Graph

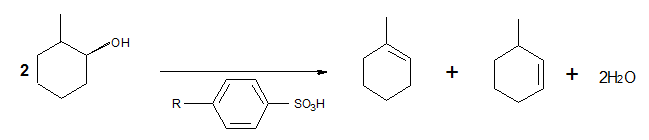
IR Spectroscopy Graph

Notebook Pages

**Sample “D” Report**

Dehydration of 2-methylcyclohexanol

**Introduction:** The purpose of this lab was to dehydrate 2-metylcyclohexanol to produce major product 1-methylcyclohexene (the more highly substituted alkene) and minor product 3-methylcyclohexene. Once the product was obtained it was analyzed using gas chromatography (which helped to determine which product was more prevalent), IR spectroscopy (showed the bonds that formed the products), and chemical tests (showed if the products were in fact alkenes). This lab was geared to aid in the understanding of how organic compounds react with one another.

**Overall Reaction:**

**Procedure:** Once the distillation apparatus was set up 16.00 g of 2-methylcyclohexanol was added to a 100 mL round bottomed flask (RBF) along with 1.6 g of Amberlyst 15 ion exchange resin. A stir bar was also added to prevent bumping during heating. A 50 mL RBF was attached at the end of the distillation apparatus to catch the product after it had gone through the condenser. The mixture in the 100 mL RBF was heated slowly until distillation began, at that time the temperature was kept below 95 oC. The mixture was heated until a minimal amount of fluid was left in the 100 mL RBF, at that time the heat was removed and the 50 mL RBF was removed from the end of the distillation apparatus. The condensate was poured into a separatory funnel, this allowed for removal of the aqueous layer from the product layer. The aqueous layer was discarded. The product layer was then moved to an erlenmeyer flask, CaCl2 was added to the product layer for drying. After drying was complete, roughly 10 minutes, CaCl2 was removed from the product. The product was then placed in a dry 100 mL RBF and subjected to distillation again using the same apparatus as mentioned previously. Again the distillation occurred until there was a minimal amount of product left in the heated 100 mL RBF. The condensate produced from this distillation was weighed, analyzed by gas chromatography, IR spectroscopy, and chemically tested for the presence of alkenes. KMnO4 was used to test for the presence of alkenes in the product, KMnO4 is naturally purple but when in the presence of alkenes it will turn a brownish color.

**Results:**

**Theoretical Yield:**

16 g 2-metylcyclohexanol X 1mol / 114.19 g/mol 2-metylcyclohexanol = 0.140 mol

0.140 mol 1-methylcyclohexene X 96.17g / 1 mol = 13.48 g 1-methylcyclohexene

**Percent Yield:**

Obtained g of 1-methylcyclohexene = 4.95 g

(4.95 / 13.48) X 100 = 36.72%

**GC Measurements:**

Area of first bump: 2cm2

Area of second bumb: 8.58cm2

**KMnO4 Test Results:**

Solution turned brown indicating the presence of alkenes

**IR Spectroscopy Peaks:**

Frequency Bond

3002.7 O-H Stretch

2924.1 O-H Stretch

1440.9 O-H

1376.6 C-C

796.1 C-H

.

**Discussion:** When product was mixed with KMnO4, the KMnO4 turned brown indicating that an alkene had been produced through distillation. Also the IR spectra showed no indication of any OH bonds present in the product, this meant the 2-methylcyclohexanol had been successfully dehydrated and had a high purity as well. The gas chromatography chart also showed that there was a higher amount of 1-methylcyclohexene then 3-methylcyclohexene present in the product because the first arch was much smaller than the second. It is possible to know which arch belongs to which organic compound because the compound with the lower boiling point will exit first which in this case is 3-methylcyclohexene.

The percent yield of this experiment was low because during the distillation process some of the starting compound must be left in the 100 mL RBF because of it is distilled to dryness an explosion an occur. Also during the distillation some of the joints in the apparatus became loose which could have allowed for vapors to escape from the system. Also when decanting when the product from the Erlenmeyer flask, after drying, some product was spilled on the desk top inside of the fume hood. All of these errors compounded onto each other to result in a percent yield of only 36.72%.

**Literature Cited**

Lab Manual for Dehydration of 2-methylcyclohexanol provided on the Organic Chemistry Moodle page.