I. Class: AP Biology
Name: Keira Wardrip
Experiment: Creating Ethanol as a Biofuel
Date: December 14, 2023

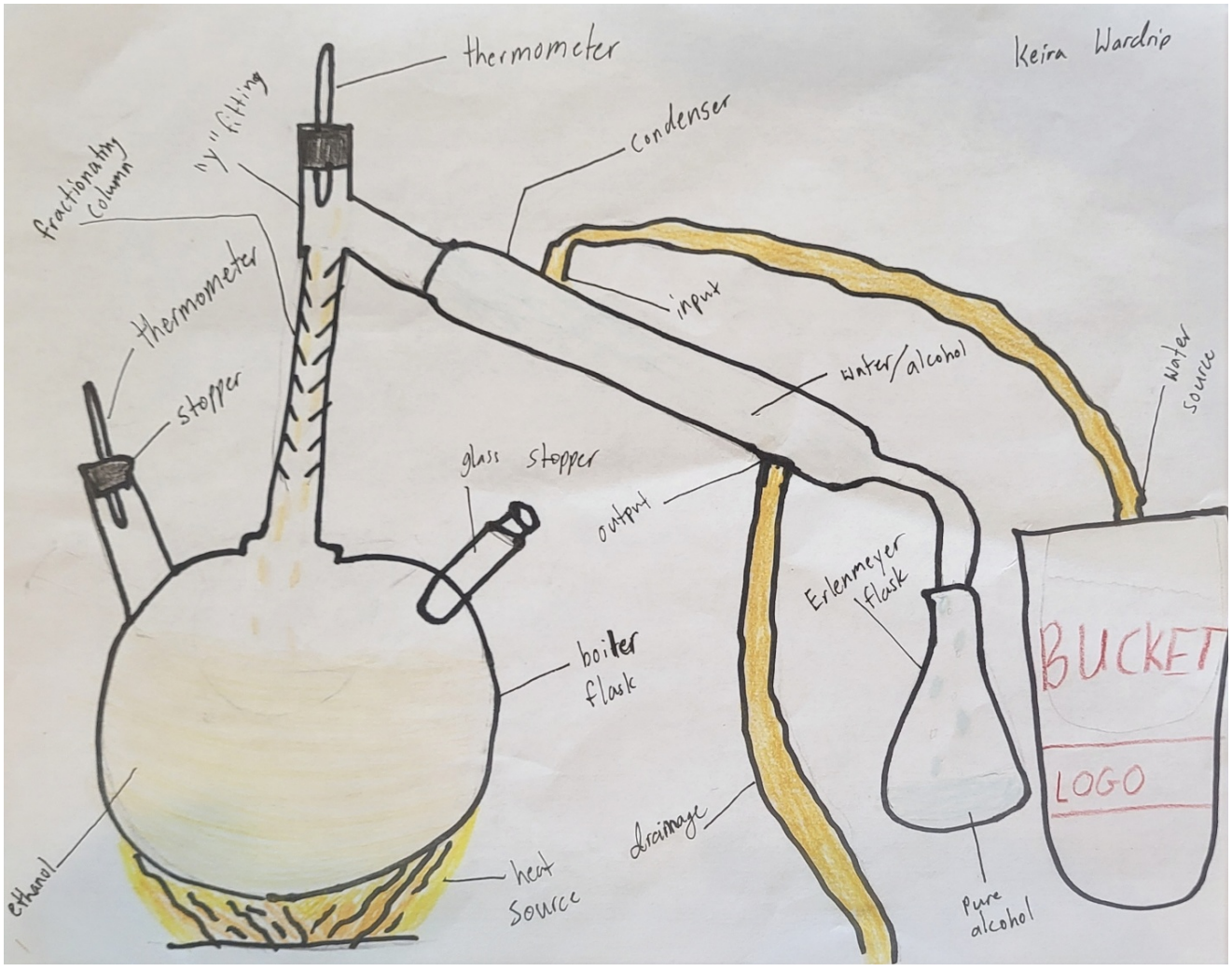
II. Problem Statement:
This lab distills ethanol to make pure alcohol to power a Stirling engine to make a small lightbulb turn on.

III. Materials and Procedures:

- Erlenmeyer flask (2)
- Glass tubing
- Heat source
- Rubber tubing
- Bucket (2)
- Water
- Thermometer (2)
- Condenser
- Stopper
- Boiler flask
- Fractionating column
- "y" fitting
- Elbow fitting
- Ethanol
- Clamps
- Stirling Engine
- K_2CO_2 (potassium carbonate)
- Large syringe
- Graduated cylinder
- Lighter
- Alcohol stove

First, the distillation apparatus was made. Next, we needed a syphon to get a consistent water flow for the distillation apparatus to work. We blew air into the rubber tubing connected to the syphon, then, because of the magic of physics and water, an infinite water supply was made. Next, 100 milliliters of ethanol were poured into the boiler flask. The flask was sitting on top of a burner, so once it reached the boiling point, no more than 95 degrees Celsius, the ethanol evaporated up the fractionating column, through the condenser, and into an Erlenmeyer flask as almost pure alcohol. A quarter of the alcohol's volume of

potassium carbonate is added to the alcohol, to make the alcohol pure, then vigorously shaken. To separate the alcohol from the potassium carbonate, it is poured into a graduated cylinder, and the calcium and water sink to the bottom, and pure alcohol floats on the top. The alcohol fuel on top of the cylinder is sucked up by a large syringe and put into a separate flask to hold it. The alcohol is put into the alcohol stove, lit on fire, then placed next to the Stirling engine's glass cylinder, turns the flywheel, which turns the lightbulb on.



IV. Results:

As the distilled alcohol traveled up the fractionating column, it turned gaseous, but as it hit the cool water of the condenser, the alcohol returned to its liquid state again. Once purified, collected, and lit on fire, the heat from the fuel caused the Stirling engine's flywheel to turn,

which pumped the piston, making the light bulb turn on. There are no chemical reactions in this experiment.

V. Conclusion:

Overall, this lab was a great demonstration of how to make ethanol into a biofuel. Though a lengthy process, the results and visuals clarified how substances are distilled, purified, and sometimes burned. If used at an industrial level, the entire process would be long and take a lot of work. Though expensive, the environmental effects of burning alcohol instead of gasoline would help the pollution problem. To conclude, this experiment was informative and helpful for understanding the process of making biofuel.

Ethanol Biofuels Lab Part 2

By Ayumi Torii

Lab Done: December 6, 2023

Lab Report: December 18, 2023

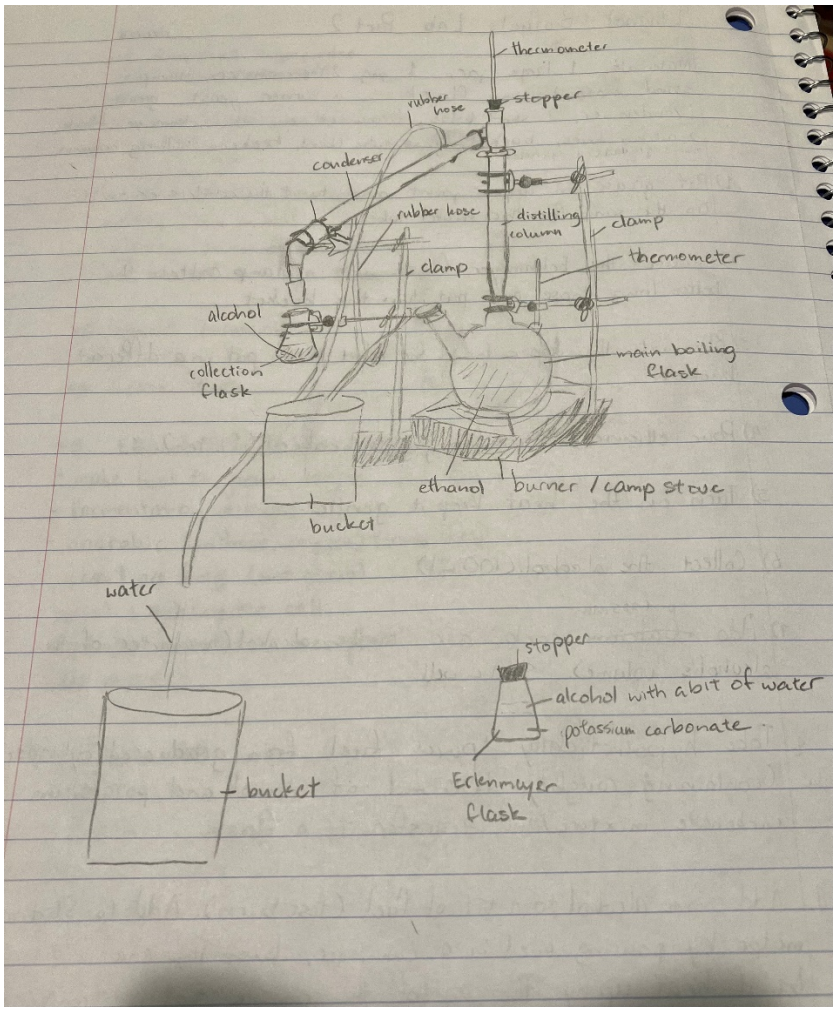
Ethanol Biofuels Lab Part 2

I. Ayumi Torii
Biology
6 December 2023
Ethanol Biofuels Lab Part 2

II. This lab will be exploring the second part of the biofuels lab: collecting the fuel and testing it with a Stirling engine (in the first part, the fuel was prepared for fermentation and fermented).

III. The materials necessary and procedure for this experiment are as follows:

1 large jar
Jug with fermented ethanol mixture from part 1
2 thermometers
2 clamps
1 main boiling flask
A burner
Yeast
Grease
1 condenser
1 short tube
2 joints
2 Erlenmeyer flasks
2 rubber hoses
2 buckets
1 bent glass tube
1 beaker
1 distilling column
100 mil graduated cylinder
Candle lighter
Potassium carbonate (K_2CO_3)
Cannister
Alcohol
Stirling engine



To finish distilling and test the fuel:

1. Set up the distilling apparatus as shown in the sketch. Put grease on the joint before twisting the condenser on it. Blow a bit into the upper hose before placing it in one of the buckets. Make sure that the Erlenmeyer flask is secured by the clamp.
2. Pour 1 liter of the ethanol (fermented) mixture from the jug into the beaker.
3. Turn on the burner and keep the heat gentle.
4. Collect 100 mil of alcohol in the Erlenmeyer flask.
5. Add about 25 mil of potassium carbonate (K_2CO_3) to the alcohol. Shake well. Pour the mixture into the graduated cylinder.
6. Transfer to a flask.
7. Add some alcohol to the mixture and test its flammability by lighting it with a candle lighter.
8. Pour a bit of the fuel into the cannister and light it, keeping it close to the glass cylinder of the Stirling engine. Record results and clean everything up.

IV. Results

The heat of the burning fuel powered the engine, proving the fuel to be a working fuel that can act as a source of energy.

Combustion of fuel:
C_2H_5OH (ethanol) + $3O_2$ (oxygen) → $2CO_2$ (carbon dioxide) + $3H_2O$ (water) + heat

V. Conclusions

Fuel made from ethanol can indeed be used as a source of power. Instead of being an unattainable fuel which has its existence taken for granted, it can be made at any house if the materials are there.

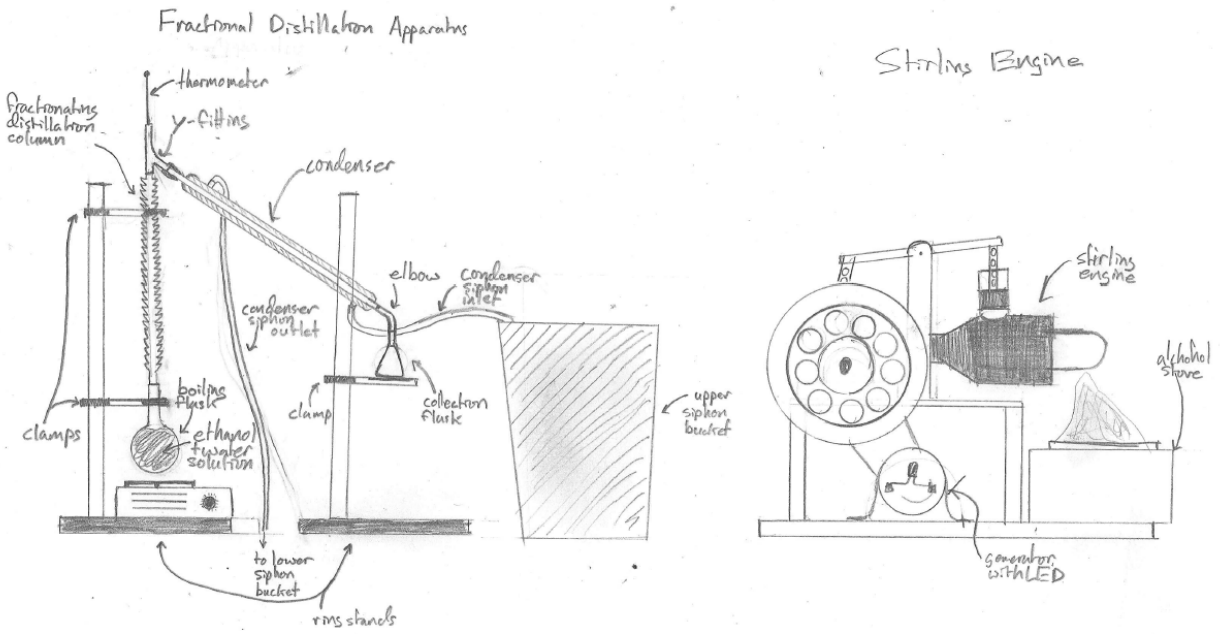
Ethanol Biofuels Lab Report

Patrick Chabot
11/18/2023
Biology

(II) Purpose: To concentrate ethanol through distillation and combust it to run a Stirling engine.

(III) Materials: Two ring stands, four clamps, large flask, one large flask, two 125 Erlenmeyer flasks, burner, fractionating column, Y fitting, Elbow, condenser, thermometer, two rubber stoppers, rubber tubing, two buckets, fermented ethanol and water solution, potassium carbonate, water, graduated cylinder, Stirling engine, alcohol stove, large syringe.

Method: Set up the apparatus according to the diagram. Fill the boiling flask with 2 Liters of fermented ethanol and water solution. Ferment in smaller batches if necessary. Start the siphon system by sucking on the end of the condenser outlet tube, and letting the outflow of water into the bottom bucket. Start the burner to heat the solution in the boiling flask. Monitor the temperature with the thermometer, and keep it below 95 degrees Celsius. Remove the collection flask and pour its contents into the graduated cylinder, using the syringe to draw off the ethanol at the top of the cylinder, depositing it into a flask. Repeat the process until the entirety of the original solution has been distilled. Pour a small amount of ethanol into the alcohol stove, light it, and put it under the cylinder bulb, and spin the flywheel to start the engine. Once started, the engine should power the generator in order to illuminate the light bulb.

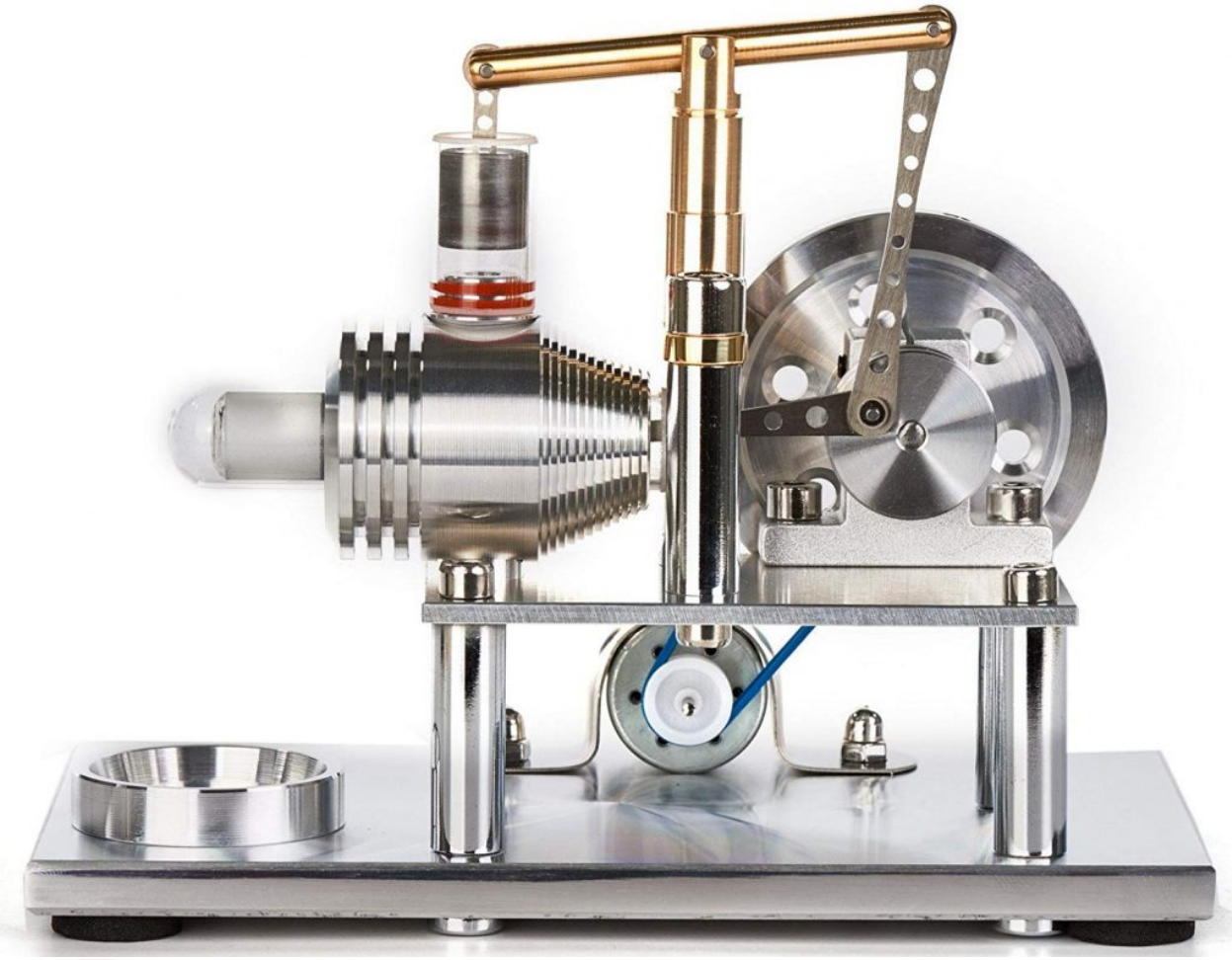


Chemical equation for the combustion of ethanol

$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

(IV) Using the distillation apparatus, the ethanol was concentrated, and then combusted in the alcohol stove. The heat produced was used to run the Stirling engine, which ran the generator, which in turn powered the light.

(V) I learned that using fermentation and distillation, it is possible to produce, from raw materials, a biofuel capable of running a small engine.



Ethanol Lab drawings.PDF