Chem E- Car

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Abstract- *In light of the recent movement towards reducing fossil fuel consumption, the need for a suitable alternative energy source is greater than ever. To explore the utility of household products as unconventional yet efficient energy sources, a car powered entirely by chemical reactions was built. A shoebox-sized car was then built with both the battery and stopping mechanism implemented and tested at various distances and loads. Iodine clock reaction was also found to follow a first-order law, with a reaction time linearly proportional to the concentration of iodine. Ultimately, the car was able to stop at each intended distance through the iodine clock reaction. Although the aluminum batteries and iodine clock were implemented to power only a shoebox sized car, the scale-up of similar, widely available materials could possibly mean a future of globally accessible transportation.*

Keywords- Fuels, thermoelectric, see back effect

I. INTRODUCTION

The need for affordable and efficient alternative energy sources is a defining issue of the twenty-first century that is receiving growing attention from both the scientific community and the public alike. While hydrocarbons have driven a majority of the world's energy consumption for over a century, such sources are both unsustainable and environmentally detrimental. If the world's energy needs continue to grow at their current rate, fossil fuel reserves are estimated to deplete by 2052, followed by natural gas by 2060 and coal by 2088. The consequences of using these energy sources to the end will be unprecedented, both for the environment and the global economy. Thus, it is clear that the world needs to find a feasible alternative

While substantial advances in alternative energy have recently been made in the automobile industry, current alternative energy sources for powering vehicles are either expensive or not widely accessible to all. Ethanol fuels, for example, are not practical because they provide low mileage per gallon and require a large amount of organic material and land to produce, land that is increasingly difficult to provide. Currently, hydrogen fuel cars are very expensive and often require high running temperatures, reducing their longevity and efficacy. In addition, hydrogen fuel is difficult to safely transport for mass distribution because it needs to be compressed and purified. Because of the public's inaccessibility to many "green" technologies, the future depends on developing a less demanding way to encourage the use of alternative energy in vehicles.

The objective of this project is to investigate and employ common household products as nonconventional energy sources in a car powered entirely by chemical reactions. The car must also be able to travel variable distances and carry variable loads with no additional user input. In addition, the goal is to gain a better understanding of how chemical reactions can be calibrated to automate processes and how engineers optimize what is available to achieve the intended goal. The project began by conceptualizing, building, and optimizing a battery system and stopping mechanism before finally building the actual car and testing it.

II. EASE OF USE

The thermoelectric effect is the direct conversion of temperature differences to electric voltage and vice versa. A thermoelectric device creates voltage when there is a different temperature on each side. Conversely, when a voltage is applied to it, it creates a temperature difference. At the atomic scale, an applied temperature gradient causes charge carriers in the material to diffuse from the hot side to the cold side.
This effect can be used to generate electricity, measure temperature or change the temperature of objects. Because the direction of heating and cooling is determined by the polarity of the applied voltage, thermoelectric devices can be used as temperature controllers.

The term "thermoelectric effect" encompasses three separately identified effects: the Seebeck effect, Peltier effect, and Thomson effect. This separation derives from the independent discoveries of French physicist Jean Charles A thanase Peltier and Baltic German physicist Thomas Johann Seebeck. Joule heating, the heat that is generated whenever a current is passed through a resistive material, is related, though it is not generally termed as thermoelectric effect. The Peltier–Seebeck and Thomson effects are thermodynamically reversible,[1] whereas Joule heating is not.

The Seebeck effect is the conversion of heat directly into electricity at the junction of different types of wire. It is named for the Baltic German physicist Thomas Johann Seebeck, who in 1821 discovered that a compass needle would be deflected by a closed loop formed by two different metals joined in two places, with a temperature difference between the joints. This was because the electron energy levels in each metal shifted differently and a voltage difference between the junctions created an electrical current and therefore a magnetic field around the wires. Seebeck did not recognize there was an electric current involved, so he called the phenomenon "thermomagnetic effect." Danish physicist Hans Christian Ørsted rectified the oversight and coined the term "thermoelectricity"

Thermoelectric generators are all solid -state devices that convert heat into electricity. Unlike traditional dynamic heat engines, thermoelectric generators contain no moving parts and are completely silent. Such generators have been used reliably for over 30 years of maintenance-free operation in deep space probes such as the Voyager missions of NASA.[1] Compared to large, traditional heat engines, thermoelectric generators have lower efficiency. But for small applications, thermo electrics can become competitive because they are compact, simple (inexpensive) and saleable. Thermoelectric systems can be easily designed to operate with small heat sources and small temperature differences. Such small generators could be mass produced for use in automotive waste heat recovery or home co-generation of heat and electricity. Thermo electrics have even been miniaturized to harvest body heat for powering a wristwatch.

CIRCUITS:

Circuit configuration is essential to maximizing voltage and current output as differently designed circuits have various electrical properties. Series circuits allow electrons to flow in only one direction, while parallel circuits allow electrons to flow in multiple directions. Electron flow is severed when one component of a series circuit fails. Because the car photoreceptor, motor, and power source are wired in series, the circuit is broken when the photoreceptor no longer receives light (see Diagram 1).

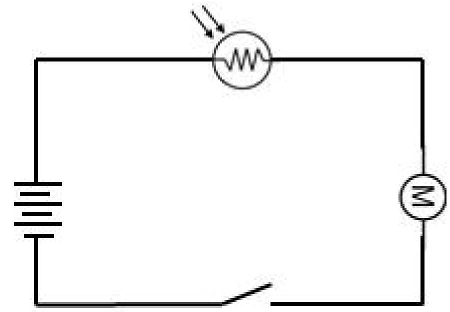


Diagram 1

Three definitions that require an understanding of basic circuitry are as follow:

1. Voltage (V) is the measure of potential difference between two points, in volts (V)
2. Current (I) accounts for the amount of electrons that flow in the wire, in amperes (A)
3. Resistance (R) measures any hindrance of movement for the electrons, in ohms (Ω)
   Mathematically, voltage, current, and resistance are related by Ohm's Law: $V = IR$.

Power (Watts) is defined as $P = IV$ for ohmic circuits.

In a series circuit, the total resistance equals the sum of the individual resistances of the components. Current is uniform throughout a series circuit and voltage drops split proportionally. Note that since current (I) is constant through a series circuit for resistors, V and R are directly proportional. Therefore, higher resistors experience greater voltage drops than lower resistors.

In a parallel circuit, total resistance is the reciprocal of the sum of the reciprocals of each individual resistance. When wired in parallel, the components experience equivalent voltage drops and split current proportionally. Since voltage is constant over resistors in parallel, I and R are inversely proportional to each other. This means that higher resistors let less current pass through them than lower resistors when in parallel.

IODINE CLOCK REACTION:

The iodine clock reaction is a classic example of a chemical clock; a mixture of reactants in which sudden property changes occur when concentration rises past a certain threshold. Clock reactions are often used by educators to help students visualize reaction kinetics, as changes in temperature and concentration (and thus reaction rate) are directly seen as color change.

The basic reaction is:

$$H_2O_2(aq) + 2I^-(aq) + 2H^+(aq) \rightarrow I_2(aq) + 2H_2O(l)$$

As soon as the iodine is formed, it reacts with the thiosulfate to form tetrathionate ions and recycles the iodide ions by the fast reaction:

$$2S_2O_{32}-(aq) + I_2(aq) \rightarrow S_4O_{62}-(aq) + 2I-(aq)$$

As soon as all the thiosulfate is used up, free iodine (or, strictly, I3- ions) remains in solution and reacts with the starch to form the familiar blue-black complex.The time for the blue colour to appear can be adjusted by varying the amount of thiosulfate in solution X so a ‘clock’ of any desired time interval can be produced Here End point is the solution turns to black or dark blue colour suddenly. When the iodine clock solution turns black, the photoresistor yields stop the flow of electricity through the transistor .This breaks the circuit and shuts down the motor.

ROLE OF IODINE CLOCK IN STOPPING MECHANISM:

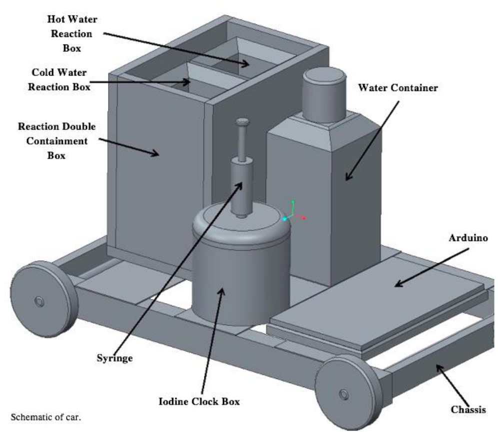
The car circuit contains a motor, photoreceptor and batteries. When the car first starts, a flashlight shines through a glass beaker containing the iodine clock onto the photoreceptor, switching it “on” and keeping the circuit closed. At this point, the beaker is clear as the iodine clock reaction has not reached completion. As the iodine clock reaction progresses, the car continues to move until the glass beaker suddenly turns dark, preventing light from reaching the photoreceptor and breaking the circuit. Because reaction time is a function of iodine concentration and can be easily measured, the iodine clock can be effectively calibrated to control the time and distance that the car travels for.

DESIGN:

The vehicle we designed consists of separate processes for propulsion and stopping. Energy to propel the vehicle is taken from the transfer of heat between a container of boiling water and a separate container of ethanol and dry ice. The resulting heat flux is converted into electricity by a grid of thermoelectric panels which power the motor. The iodine clock reaction serves as the timed chemical process that stops the car after the reaction has reached completion. The reaction takes place while contained in a vessel, with a syringe connected to the top for injecting potassium iodide (KI) solution into a mixture of 1.0 M hydrochloric acid (HCl), 3% hydrogen peroxide (H_2O_2), 0.5%starch solution, and 0.025 M sodium thiosulfate solution ($Na_2S_2O_3$). (3) The mixture exists as a clear liquid at the start of the reaction before turning to a deep blue/black upon reaction completion. A small LED shines from one end of the vessel through the flask containing the reaction into a set of two photoresistors on the other side.

The thermoelectric generators, motor, and photo resistors were all connected through an Arduino microcontroller. The change in color of the iodine clock solution results in a change in the photo resistor’s internal resistance. The resistance value is sent as an input signal to an analog pin on the Arduino.

The motor is controlled through the assistance of a TIP 120 Darlington Transistor. Transistors have three pins: a collector, base, and emitter. The transistor effectively functions as a switch by changing the amount of power that flows from the collector to the emitter based off of the state of the base pin. When the iodine clock solution turns black, the photoresistor yields a value below the allowable level and a digital output signal is sent to stop the flow of electricity through the transistor .This breaks the circuit and shuts down the motor. The duration of the iodine clock reaction is dependent on the concentration of KI used in the reaction, allowing for the manipulation of how far the vehicle can travel at a constant velocity.



Schematic of car.

Chassis:A chassis consists of an internal vehicle frame that supports a manmade object in its construction and use, can also provide protection for some internal parts. An example of a chassis is the underpart of a motor vehicle, consisting of the frame on which the body is mounted.

Iodine Clock Box: It is a box where the stopping mechanism of the car happens through the iodine clock reacton.

Syringe: Syringe is a device which is used to inject potassium iodide.

Hot water reaction Box: It is a box in which hot liquid is taken generally we use water at room temperature.

Cold water reaction Box: It is a box in which cold liquid is taken generally we use liquid at very low temperature.

OPERATION OF THE CAR:

Mainly the operation of the car divided into two part

1.Starting Mechanism
2.Stopping mechanism

Starting Mechanism:

To make an engine start it must be turned at some speed, so that it sucks fuel and air into the cylinders, and compresses it. The powerful electric starter motor does the turning. Its shaft carries a small pinion (gear wheel) which engages with a large gear ring around the rim of the engine flywheel.

TYPE-1:

Here we use thermoelectric for converting heat flux into the electricity. Our primary experiment helped to characterize the operating conditions and performance of the thermo electrics. Eight thermo electrics were sandwiched between a hot and a cold sink. The hot sink utilized in this experiment was boiling water (~100 ˚C) and the cold sink was a mixture of dry ice and ethanol (~ -72 ˚C). A multimeter was used to determine the current and voltage output of each thermoelectric, and those with similar performance were paired and connected in various series and parallel configurations. Additionally, after these connections were established current and voltage measurements were collected over a period of 10 minutes to verify that the thermo electrics functioned as a constant power source. Here we use the electricity produced from the thermo electrics to run DC motors which is used as propulsion.

TYPE-2:

All batteries were made using cheap and easily accessible household products. While parameters such as battery dimension, carbon mass and consistency, and circuitry were modified between design iterations, the following describes the final “CD case design” that proved to be the most successful.

Each CD case contained four cells which were made simultaneously. See Figures 1 and 2 for schematics of one cell. Two 9-10 cm long pieces of copper wire were then cut with one being taped onto the CD case (-).

Next, a 11 x11 cm piece of aluminum foil and paper towel were cut out and each folded into 5.5 x 11 cm pieces, and placed on top of the first copper wire (-). The folded paper towel was then soaked with 5 ml of salt water solution (concentration varied by trial) and placed on top of the aluminum foil again.

The second copper wire (+) was placed on the wetted paper towel and covered with the pre-prepared carbon. The carbon was only spread on either the right or left half of the paper towel, leaving the other side blank. Depending on whether pH was manipulated, 2 ml of vinegar or bleach were then sprinkled on top of the carbon to decrease and increase pH respectively. Finally, the entire cell was folded in half to 5.5 x 5.5 cm and secured in the CD case with binder clips.

After each cell’s voltage and current was measured, the cells were then wired in varied combinations of series and parallel circuits to maximize voltage and current respectively. The cells were connected in series by connecting the positive wires (inside paper towel and graphite) to the negative wires (touching aluminum foil). The cells were connected in parallel by connecting positive to positive and negative to negative wire(see Figures 3 and 4).

It was important to ensure that the crushed carbon was uniformly moist because the salt solution proactively balances charge.[9] Whenever the crushed carbon dried out, the cell had to be wetted in order to sustain voltage production. It was also important to ensure that the copper wires spanned the width of the battery so that surface area for conducting electron flow was maximized.

Previous designs were similar to the one described above, but used plastic sheets and clamps instead of binder clips, making them much heavier and impractical for implementation in the car.

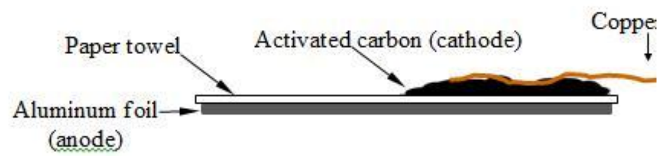


Figure 1 (side view diagram of open cell)

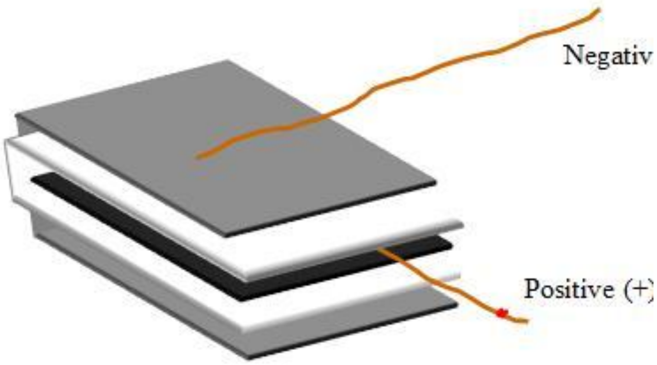


Figure 2 (layered diagram of folded cell)

TYPE 3-

The concept of our ChemCar is based on a jet propulsion system connected with a pressure vessel. To pressurize the reaction chamber we use hydrogen peroxide which decomposes to oxygen and water in presence of iron .The resulting oxygen gas increases the pressure inside the vessel. When the gas passes through a nozzle, its kinetic energy creates a thrust which drives the car forward. The decomposition of hydrogen peroxide has been chosen as the driving reaction because it generates environmentally friendly products, i.e., water and oxygen

Gearing:

From the previous experiments we were able to determine that our thermo electrics function as an approximately constant power source, which in turn causes the car to travel at a constant speed. However, this speed is also dependent on load and gear ratio. Out of these parameters, gear ratio is the most significant because it helps to balance the speed and torque for our car (8). Several AA batteries connected in series were used to simulate a power source equivalent to the thermo electrics and various gear ratios were tested under three different weight conditions (no load, half load, and full load). The time taken for the car to travel a distance of 10 meters was collected and used to determine the velocity of the vehicle under those conditions. In addition, a multimeter was used to determine the voltage and current supplied to the motor during each trial.

Stopping mechanism:

Iodine clock reaction

Type 1

A well-mixed solution of extremely fine crushed Vitamin C tablet and 60 ml of warm water was first prepared. 5 ml of this solution was then transferred to a second beaker (labeled Beaker B) containing 60 ml of warm water and 4-6 ml of iodine (increments of 0.1 ml were tested in each successive trial). The solution turned clear upon adding the Vitamin C and was also allowed to cool to room temperature. Finally, 60 ml of warm water, 15 ml of hydrogen-peroxide and 2.5 ml of liquid starch were added to a third beaker (labeled Beaker C), well stirred and allowed to cool to room temperature. Beaker B was added to Beaker C and the time required for color change was recorded. Trials were conducted in this fashion for varied amounts of iodine in order to observe the resultant changes in reaction rate.

Type2

The final parameter determined was the calibration of the iodine clock. The reaction consisted of 3 different solutions: a KI solution, a sodium thiosulfate-starch solution, and a catalyst solution. A 0.1 KI stock solution was made by adding 1.66 grams of granular KI to 100 mL of water. Several 10 mL solutions were made from this stock solution and served as the KI solution for the reaction (3). Table 1 below shows the respective volumes of KI and water used to make each concentration.

Table 2: Formulation of KI Solution

Concentration of KI Solution (M)	Volume of KI Stock (mL)	Volume of Water (mL)
0.05	5.01	4.99
0.03	7.01	2.99
0.02	8.00	2.00
0.01	9.00	1.00
0.0075	9.25	0.75
0.005	9.50	0.50

The sodium thiosulfate-starch solution consisted of 1 mL of a 0.025 M sodium thiosulfate solution (0.310 g of granular sodium thiosulfate in 50 mL of water) and 10 mL of a stock 0.5% starch solution. The catalyst solution consisted of 10 mL of a 3% H_2O_2 and 6 drops of 1M HCl.

For each trial, the catalyst and sodium starch solutions were mixed well in a flask on a stir plate. The KI solution was then injected into the flask and the time taken for the solution to change from clear to black was recorded, and three trials were conducted for each KI concentration.

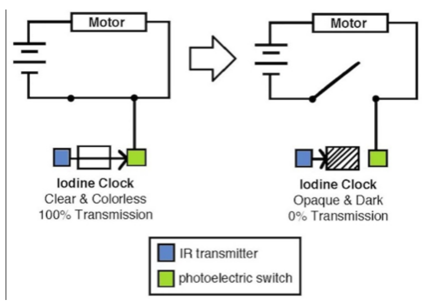
The basic reaction is:

$$H_2O_2(aq) + 2I^-(aq) + 2H^+(aq) \rightarrow I_2(aq) + 2H_2O(l)$$

As soon as the iodine is formed, it reacts with the thiosulfate to form tetrathionate ions and recycles the iodide ions by the fast reaction:

$$2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$$

As soon as all the thiosulfate is used up, free iodine (or, strictly, I_3^- ions) remains in solution and reacts with the starch to form the familiar blue-black complex.
The time for the blue colour to appear can be adjusted by varying the amount of thiosulfate in solution X so a ‘clock’ of any desired time interval can be produced



DETAILED EXPERIMENTAL PROCEDURE:

- Mainly we have divided this into two solutions solution A&B.

Solution A:-

- Here 10ml of 2M sulfuric acid is prepared .
- Further 10ml of 3% of H_2O_2 is added And this is diluted with 100ml of water

Solution B:-

- 0.2g of sodium thiosulfate is mixed with 100ml of water and 20 ml of sample is used
- 0.9g of KI is mixed in 5ml of water.
- 4ml of starch soln is added to it and diluted with 100ml of water

ADVANTAGES:

- Reduce the volume and toxicity of pollutants allowed to enter the air, waterways, and soil;
- Significantly reduce the negative environmental impact of industrial facilities, power plants, and transportation vehicles; and
- Allow greater reuse of post-consumer and post-industrial waste streams.
- Modernize disease diagnosis and treatment options,
- Improve the safety and efficacy of drug-delivery mechanisms, and
- Achieve better therapeutic outcomes.

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