Gravitational or centrifugal forces produce different potential changes in different metals

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Abstract

In the quest to find various energy solutions, concentration difference batteries have been widely studied, but concentration differences and potential differences caused by gravity have rarely been studied. The initial purpose of this research is to investigate whether centrifugal force or gravity can be used to generate potential differences to create new and useful energy devices. The Nernst equation [1] infers that changes in chemical potential in different gases vary with changing height. Additionally, different metal solids can exhibit different chemical potential changes under Earth's gravity. The resistance of metal is very low, and because the energy output is inversely proportional to the resistance, voltage differences in metals could be significant, which may provide a large energy output. Therefore, an experiment was designed using aluminum and lead connected in series with a cumulative height difference of 176 m, and the potential difference caused by gravity was measured. It is conjectured that the vibrational energy from hot electrons can be converted into electrical energy at a constant temperature, surpassing the limitations of Carnot's theorem [2]. Thus, if an experiment works in a gravity field, then it should also work in a centrifugal force field. In a centrifugal force field, when the rotation speed is doubled, the output energy is increased by 16 times. Therefore, if centrifugal forces can be used to convert thermal energy into electrical energy in an economically efficient way, it may be a new energy conversion method that is suitable for different occasions, which may address energy dilemmas.

Keywords: metal, gravity, centrifugal force, potential difference, Carnot's theorem, thermodynamics

Symbols:

P_{high} Pressure at the high place,

P_{low} Pressure at the low place,

M Molecular weight of the gas,

G Gravity,

V Volume,

ρ Density

h Height difference between the high and low places,

N Number of moles of gas molecules,

R Universal gas constant,

T Absolute temperature,

ΔV_{Cl_2} Potential difference between the high and low places in the chlorine gas pipe,

ΔV_{F_2} Pressure of the potential difference between the high and low parts of a fluorine gas pipe.

n Number of electrons exchanged in the chemical reaction,

F Faraday's constant,

$P_{Cl_2(1)}$ Pressure at the lower part of the chlorine gas pipe,

$P_{Cl_2(2)}$ Pressure at the high position in the chlorine gas pipe,

$P_{F_2(1)}$ Pressure at the lower part of the fluorine gas pipe,

$P_{F_2(2)}$ Pressure at the upper part of the fluorine gas pipe,

M_{Cl_2} Molecular weight of chlorine gas,

M_{F_2} Molecular weight of fluorine gas,

m_{Pb} Lead atomic weight,

m_{Al} Aluminum atomic weight.

1 Introduction

Gravity can cause gas concentrations to change with height, and the Nernst equation [1] infers that changes in chemical potential in different gases vary with changing height. Additionally, different metal solids can exhibit different chemical potential changes under Earth's gravity. An experiment was designed using aluminum and lead connected in series with a cumulative height difference of 176 m, and the potential difference caused by gravity was measured.

Once a voltage difference exists, current and energy can be output to a load impedance; when there is a current output, there must be an exchange process of electrons or holes; and high-energy electrons or electric holes have the greatest chance of becoming exchanged charged particles. During the exchange process, energy is output to the load impedance, and the energy of the charged particles will decrease. This process can transmit energy while maintaining the same temperature throughout the system. It is conjectured that the vibrational energy from hot electrons can be converted into electrical energy at a constant temperature, surpassing the limitations of Carnot's theorem [2], which says that the maximum energy output rate of a heat engine cannot be greater than the temperature difference divided by the absolute temperature. The resistance of metal is very low, and because energy output power is inversely proportional to resistance, when the resistance is very low, a high large energy output can result. In a centrifugal force field, when the rotation speed is doubled, the output energy is increased by 16 times. Therefore, the voltage problem can be overcome by increasing the rotational speed. This results in the change to potential energy in the metal becoming significant. Such an approach can be a new energy conversion method that provides stable energy in locations with no light or when there is no sunlight.

2 Materials and methods

1. 1 mm diameter 99.99% pure lead wire,
2. 1 mm diameter 99.99% pure aluminum wire,
3. 0.5 mm diameter 99.9% pure copper wire,
4. In the connection method, the lead wires are connected from bottom to top with lengths exceeding 2 m, and the aluminum is connected from top to bottom with same length of lead wires, alternately connecting many groups of them in series by copper wires.
5. The potential difference of an entire section of series metal wire is measured, both in the normal direction and placed upside down, and the voltage values are compared under these two conditions.

3 Theoretical derivation

3.1 Gravity causes pressure differences

Under Earth's gravity, the air density at ground level is relatively high, while the air density at high altitudes is relatively low. In the ideal gas law, $PV = NRT$ [3], where P is the pressure, V is volume, N is number of moles of gas molecules, R is the universal gas constant, and T is the absolute temperature. Thus, we can obtain the gas density $\rho = NM/V = PM/RT$, where M is the mass per moles. Then, the dh height causes pressure change $dP = -\rho G dh = -P(MG/RT)dh$, where G is the gravity. For pure gas, under gravity,

the pressure difference between high altitude and low altitude can be expressed by the following formula (1):

$$ln\left(\frac{P_{high}}{P_{low}}\right) = -\frac{MGh}{RT} \quad \ldots\ldots\ldots (1)$$

where P_{high} is the pressure at the high place and P_{low} is the pressure at the low place.

3.2 Pressure differences can cause chemical potential differences

After obtaining the relationship between height and pressure difference, we can use the Nernst equation to obtain the relationship between height and chemical potential difference.

Now, assume that there are two tubes. A tube of height h is filled with chlorine gas, the other tube of the same height is filled with fluorine gas, and electrodes are connected to the upper and lower ends of the tubes, as shown in Fig. 1. Since chlorine and fluorine are both highly reactive gases, the chemical potential of each gas at each electrode is shown. The reason why chlorine and fluorine are chosen for explanation is that the chemical properties of chlorine and fluorine are very similar. In terms of chemical potential performance, the value of the electron exchange number will be the same. Because of Earth's gravity, when the temperature is constant, the gas concentrations at different heights will be different. According to the Nernst equation [1], the potential difference between the upper and lower ends of the chlorine and fluorine gas pipes can be expressed by formulas (2) and (3).

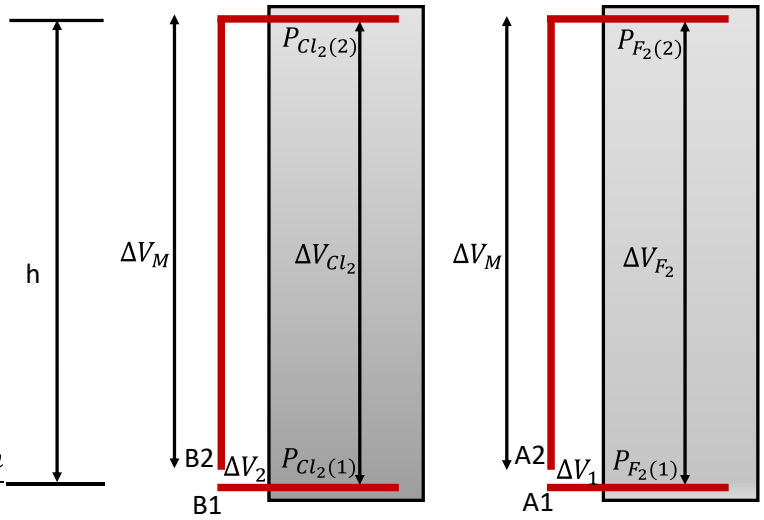
$$\Delta V_{Cl_2} = -\frac{RT}{nF} ln\left(\frac{P_{Cl_2(2)}}{P_{Cl_2(1)}}\right) = \frac{M_{Cl_2} Gh}{nF} \quad \ldots\ldots\ldots (2)$$

$$\Delta V_{F_2} = -\frac{RT}{nF} ln\left(\frac{P_{F_2(2)}}{P_{F_2(1)}}\right) = \frac{M_{F_2} Gh}{nF} \quad \ldots\ldots\ldots (3)$$

where ΔV_{Cl_2} is the potential difference between the high and low places in the chlorine gas pipe and ΔV_{F_2} is

the potential difference between the high and low parts of the fluorine gas pipe. n is the number of electrons exchanged in the chemical reaction, F is Faraday's constant, $P_{Cl_2(1)}$ is the pressure at the lower part of the chlorine gas pipe, $P_{Cl_2(2)}$ is the pressure at the high position in the chlorine gas pipe, $P_{F_2(1)}$ is the pressure at the lower part of the fluorine gas pipe, $P_{F_2(2)}$ is the pressure at the upper part of the fluorine gas pipe, $M_{Cl_2} = 70.903\ g/mol$ [4] is the molecular weight of chlorine gas, $M_{F_2} = 37.997\ g/mol$ [4] is the fluorine gas molecular weight, G is the Earth's gravity, h is the height difference between the high and low places, R is the universal gas constant, and T is the absolute temperature.

$$PV = NRT$$
$$\rho = NM/V = PM/RT$$
$$\rho G dh = -dP$$
$$dP = -\rho G dh = -P(MG/RT)dh$$
$$\frac{dP}{P} = -\frac{MG}{RT}dh$$
$$d(lnP) = -\frac{MG}{RT}dh$$
$$ln\left(\frac{P_{F_2(2)}}{P_{F_2(1)}}\right) = -\frac{M_{F_2}Gh}{RT}$$
$$\Delta V_{F_2} = -\frac{RT}{nF}ln\left(\frac{P_{F_2(2)}}{P_{F_2(1)}}\right) = \frac{M_{F_2}Gh}{nF}$$
$$\Delta V_{Cl_2} = -\frac{RT}{nF}ln\left(\frac{P_{Cl_2(2)}}{P_{Cl_2(1)}}\right) = \frac{M_{Cl_2}Gh}{nF}$$



$$M_{F_2} = 38.0\ g/mol \neq M_{Cl_2} = 70.9\ g/mol \Rightarrow \Delta V_{F_2} \neq \Delta V_{Cl_2} \Rightarrow \Delta V_1 = \Delta V_{F_2} - \Delta V_M \neq \Delta V_{Cl_2} - \Delta V_M = \Delta V_2$$
$$I = (net\ voltage\ difference)/(total\ path\ impedance)$$
$$P = (net\ voltage\ difference)^2/(total\ path\ impedance)$$

Fig. 1 Schematic diagram of gravity causing the concentration difference ratio of chlorine and fluorine to be different when the height difference is the same, and the potential difference is also different

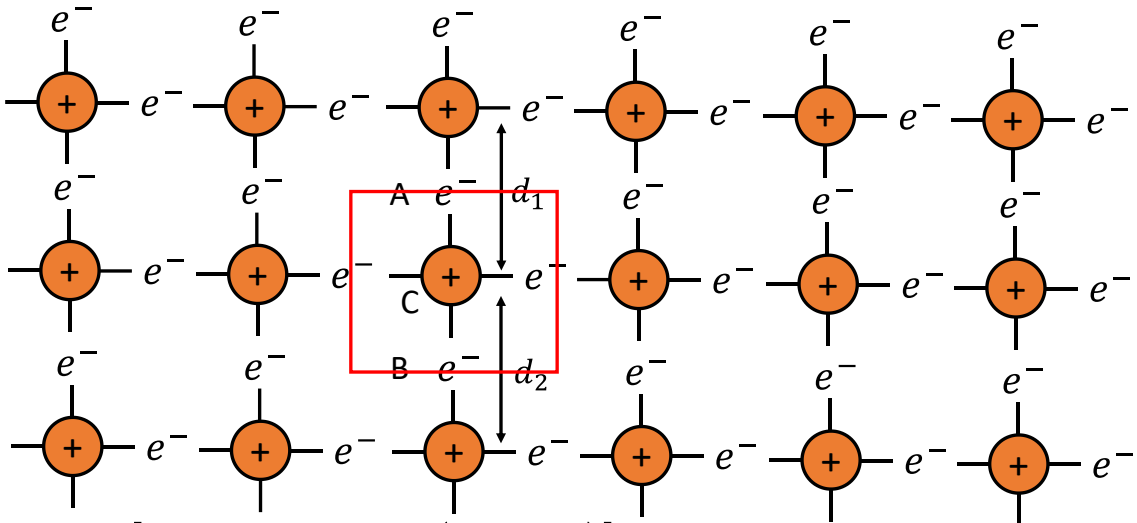
When the upper and lower electrodes are connected, if the metal wire does not produce a potential difference due to gravity, then a small current can flow in the wire. This current is due to the exchange of electrons between the gas and the electrode. During the exchange process, the gas loses some of its kinetic

energy, which is also a kind of heat energy. During the thermal motion of molecules, a new balance of charge and pressure is achieved. If the metal wire also produces a potential difference due to gravity, when the two groups are made of the same material, then the potential difference of the metal wire is fixed. Since the molecular weights of chlorine and fluorine are different, from the second and third formulas, we know that $M_{F_2} = 37.997\, g/mol \neq M_{Cl_2} = 70.903\, g/mol \Rightarrow \Delta V_{F_2} \neq \Delta V_{Cl_2} \Rightarrow \Delta V_1 = \Delta V_{F_2} - \Delta V_M \neq \Delta V_{Cl_2} - \Delta V_M = \Delta V_2$ and at least one group of electrical circuits in the picture can generate a potential difference and generate current $I = (net\ loop\ \ voltage\ difference)/(total\ path\ impedance) \neq 0$ and output power $P = (net\ \ loop\ voltage\ difference)^2/(total\ path\ impedance) > 0$.

3.3 Gravity can also cause metal chemical potential differences

There is not enough evidence to prove whether gravity creates a potential difference within metal, but If gravity can cause different chemical potential differences in different gases, then can it also produce different chemical potential differences between different metals? The resistance value of metal is very low, and the output power is inversely proportional to the resistance value. Therefore, if gravity or centrifugal force can also cause a potential difference in metal, under specific methods, mechanisms, and designs, the output power can be greatly increased. In metals, there is also a small gap in the distance between the electrons at the upper and lower ends of the nucleus due to the weight of the nucleus. As shown in Fig. 2, the electrons below the electron cell have to bear the weight of one more atom, which makes the distance between the atoms below (d_2) smaller than the distance between the atoms above (d_1), with a value $d_2 \cong d_1 - (mG/4r^2) \times (2r)/Y = d_1 -$

$mG/2rY < d_1$, where m is the atom weight, r is the atom radius, G is the gravity, and Y is the Young's modulus of materials. As shown in Fig. 2, in the electron packet, the average height of positive charges is $d_2/2$, and the average height of negative charges is $(d_1 + 5d_2)/12$. Then, the positive charge in the electron packet is directed downward about $(d_1 - d_2)/12$. Based on charge balance, the electron density is higher at the lower end of the metal and lower at the higher end. At this time, the thermal vibration should exhibit a driving force to evenly distribute the electrons, so the interaction and tug-of-war between the charge force and the thermal diffusion force should also produce a potential difference between the upper and lower ends. Moreover, when the nucleus is heavier, the voltage difference should also be larger. To verify this conjecture, an experiment was conducted using lead, which has a heavy atomic nucleus as $m_{Pb} = 207.04g/N_0$ [4], and aluminum, which has a relatively light atomic nucleus as $m_{Al} = 26.98g/N_0$ [4], where $N_0 = 6.023 \times 10^{23}$, and the potential difference was successfully measured. This potential difference can enable electrical energy output; that is, the thermal energy of hot electrons can be converted into electrical energy. Since thermal energy is converted into electrical energy without a temperature difference, the experimental results also exceed the limitations of Carnot's theorem [2], which says that the maximum energy output rate of a heat engine cannot be greater than the temperature difference divided by the absolute temperature.



$$\overline{h_{e^-}} = \frac{1}{3}\left[\frac{1}{2}\times 0 + 2\times\frac{1}{2}d_2 + \frac{1}{2}\times\left(\frac{1}{2}d_2 + \frac{1}{2}d_1\right)\right] = \frac{d_1 + 5d_2}{12}$$

$$\overline{h_+} = d_2/2\,\frac{d_2}{2}$$

$$d_2 \cong d_1 - (4mr^2)\times(2r)/Y = d_1 - (2mr)/Y < d_1$$

$$d_1 > d_2 \Rightarrow \overline{h_{e^-}} > \overline{h_+}$$

Fig. 2 Schematic diagram of the height difference between positive and negative charges produced in metal due to gravity

4 Experimental verification

4.1 Experimental steps

1. As shown in Fig. 3, 88 lead wires with a length greater than 2 m and a diameter of 1 mm and 88 aluminum wires with the same length and a diameter of 1 mm are connected in series with 0.5 mm diameter copper wires. In the connection method, the lead is connected from bottom to top, and the aluminum is connected from top to bottom, alternately connecting them in series. As a result, the lead path from bottom to top is more than 176 m, and the aluminum path from top to bottom is the same

length as the lead path. The blue wire represents lead wire, the green wire represents aluminum wire, and the red wire represents copper wire.

2. Since very long metal wires induce electromagnetic fields in the environment and generate noise, a 1 μF capacitor is connected in parallel for filtering. The connection method is shown in Fig. 3.

3. The device listed in the preceding paragraph is placed in a room 6 m long, 3.6 m wide and 3.6 m high. To ensure that what is measured is the gravity potential difference rather than the temperature potential difference, a forced convection fan was used to ensure that all experiments were conducted at a constant temperature.

4. A Keysight 34465A digital multimeter (Keysight Technologies, Santa Rosa, CA, United States) with a voltage resolution of 0.1 μV was used for the measurements. Every working day, this method was employed to evaluate the change in the potential in the current direction with time without moving the sample; the recording continued for three hours. Then, the sample orientation was changed from normal to upside down, and after the signal stabilized for 5 minutes, the change in potential over time was measured. The recording was continued for six hours, keeping the time direction unchanged until the next working day.

5. Comparison of the potential values under normal and “upside-down” orientations to confirm whether gravity induces varying potential differences in different wiring directions.

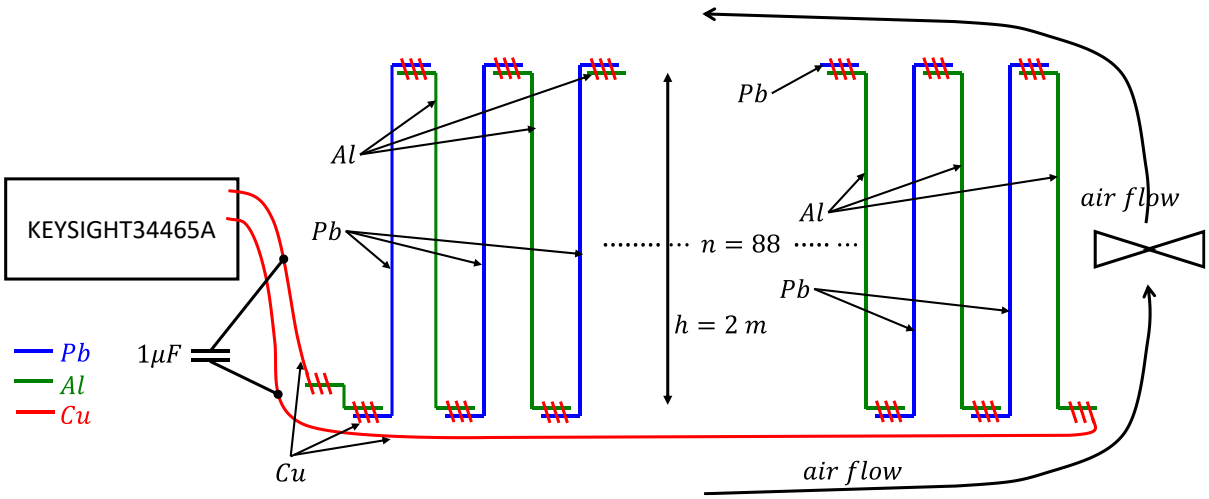


Fig. 3 Schematic diagram of the experimental device. Lead is connected from bottom to top, and aluminum is connected from top to bottom in an alternating order, and then the voltage difference from the front to the end is measured by Keysight 34465A digital multimeter

5 Results

5.1 Experimental results

After continuous measurements for 10 working days (two weeks), the data were sorted, and the results were obtained as shown in Fig. 4 by sorting the voltage and sustain time results from low to high voltage. The accumulated time as a percentage of the total time is marked on the horizontal axis, and the voltage value of this time percentage is used as the vertical axis value. The results indicate that when lead goes from bottom to top and aluminum goes from top to bottom, the voltage value is approximately 0.3 mV higher than when lead goes from top to bottom and aluminum goes from bottom to top. Therefore, it can be deduced that the voltage difference caused by gravity inside lead is different from the voltage difference caused by gravity inside

aluminum.

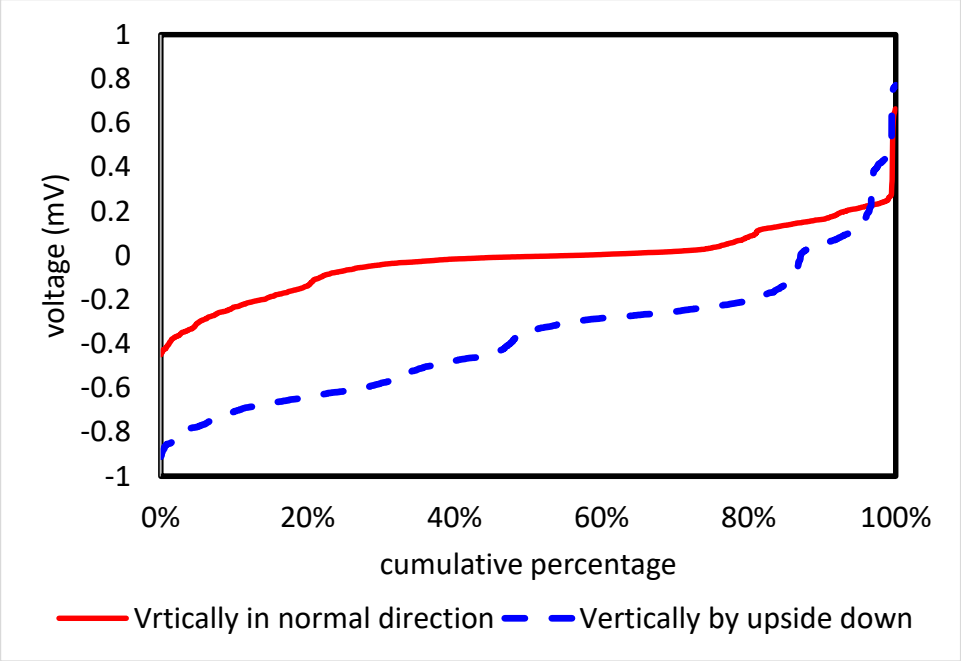


Fig. 4 Plot of voltage versus cumulative percentage in the normal and upside-down orientations

6 Discussion

In the study of batteries, it is well known that concentration differences cause potential differences, and it is also known that gravity makes the air at high altitudes thinner; combining these two well-known phenomena, it can be deduced that gravity can also make the chemical potentials of gases different at different heights. However, no research in this area has been seen. Due to the different chemical potential differences caused by gravity on different gases, it is also conjectured that gravity may produce different chemical potential differences for different solids, which makes it possible to invent batteries based on gravity or centrifugal force. Moreover, the reason why metal is chosen as the research target is that the output power of electrical energy is directly proportional to the square of the voltage and inversely proportional to the resistance value. The voltage

can be solved by increasing the rotation speed. As for the resistance part, because metal has a resistance close to zero, the output may be very large. Therefore, if this potential difference can be seen in metal, it means that it is possible to develop many new mechanisms of energy conversion from here, and it is also possible to solve many energy problems, such as solar panels cannot generate electricity when there is no sunlight. Wind power generation is also intermittent and cannot provide stable power supply. Additionally, there are many applications that may come into play.

In order to verify this conjecture, the first thing been considered is to use a centrifuge to create strong centrifugal force for testing. However, because the voltage value is very low, it is not easy to exclude the influence of the rotating brush on the voltage reading. Thus, we use the earth's gravity as a test. The first thing to overcome in this experiment is that there may be a temperature difference between high and low places. The measured voltage may come from the temperature difference rather than the chemical potential difference caused by gravity. Therefore, forced air convection is used to maintain the entire experimental field at the same temperature value. Another problem to overcome is the noise caused by ubiquitous radio waves. To overcome this problem, it is important that lead and aluminum are insulated and run side by side. But even if such wiring is done, the noise cannot be completely eliminated because the line is very long. Therefore, it is necessary to use capacitors to filter out most of the noise; then record for a long time and use the law of large numbers to minimize the impact of noise elimination. Additionally, the timing of experiments is also very important to avoid the impact of uneven timing. In the future, we can consider operating the experiment in a large iron box to reduce the influence from electric fields, magnetic fields, and electromagnetic waves.

With careful experimental design and operation, although there was still noise interference, the potential difference between the normal direction and the upside-down direction was measured. This means that it is possible to achieve energy conversion based on this principle. Because it converts thermal energy into electrical energy without a temperature difference, it exceeds the limitations of Carnot's theorem. Carnot's theorem says that the maximum rate at which a heat engine can convert heat into electrical energy, potential energy, or other mechanical energy is the temperature difference divided by the absolute temperature. But the entire system here is maintained at the same temperature; that is, when the temperature difference is zero, there is still heat energy that can be converted into electrical energy. Carnot's theorem must be met when a molecule or atom is randomly distributed and moving randomly. The method here is to use the directionality of gravity or centrifugal force to make the movement of molecules or atoms directional and not completely scattered so it can exceed the limitations of Carnot's theorem. This phenomenon can also open up many new fields of scientific research. Thus, it could be a significant discovery.

7 Conclusion

Increasing the rotation speed can increase the voltage difference, and using metal can access small resistance; combining these two items can increase energy conversion efficiency. Lead and aluminum are metals with very low electrical resistance. This measurement shows that the voltage difference caused by gravity inside lead is different from the voltage difference caused by gravity inside aluminum. That is, under a gravity field or a centrifugal force field, different metals, one of which is in the direction of the force field and the other is in the

opposite direction of the force field, can be connected in series to convert thermal energy into electrical energy without a temperature difference. This result exceeds the limitations of Carnot's theorem. From these results, many kinds of new heat engines could be invented. In the centrifugal force field, if the rotation speed is doubled, then both the centrifugal force and the voltage difference are increased by a factor of four. When the resistance is fixed and the voltage is increased by a factor of 4, the output energy is increased by a factor of 16. Therefore, increasing the rotational speed can greatly increase the energy conversion efficiency. It is very likely that centrifugal force can be used to convert thermal energy into electrical energy in an economically beneficial way. There may also be a more efficient material combination than the combination of lead and aluminum. This provides a new use for metals. Starting from this discovery, there is still a lot of more valuable research that can be done to facilitate the production of environmentally friendly energy.

Declarations

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Competing interests

The author declares that there are no conflicts of interest.

***Availability of data and material*:** Not applicable

***Authors' contributions*:**

Kuo Tso Chen designed the study, performed the experiments, analyzed the data, and wrote the manuscript.

Ethics approval

I confirm that the manuscript has been approved by the author for publication. I would like to declare that the work described herein is original research and that it has not been published previously.

***Code availability*:** Not applicable

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