Electromotive Force Generated in All Materials under Temperature Difference

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Abstract

In this research, we investigate the thermoelectric effects of general materials. The results of this showed that an electromotive force was generated under a temperature difference between two points in materials. As no material has infinite electric resistance, an electromotive force is expected to be generated under a temperature difference in all materials. In conclusion, the thermoelectric effect generates an electromotive force.

This electromotive force causes an electric current to flow, thereby generating a magnetic field.

This magnetic field generates the Earth's magnetic field, triboelectricity, sunspots, and kinetic energy of celestial bodies.

This temperature differential electromotive force also generates lightning and creates an ionosphere that reflects radio waves.

Keywords: Thermoelectric effects, Temperature difference electromotive force, Friction electricity, Earth magnetism, sunspots

1. Introduction

The thermoelectric effect of two metals was discovered by T. J. Seebeck, a German physicist.[1]

This research shows the thermoelectric effect of non-metallic materials (e.g. soil and water) in which an electromotive force is generated under a temperature difference through the migration of electric charges. An electromotive force (voltage) was generated in all the materials used in the experiment under a temperature difference. As no material with infinite electric resistance exists, an electromotive force is expected to be generated under a temperature difference in all materials.

Under a temperature difference between two points of all materials, an electromotive force is generated because electric charges migrate.

This electromotive force causes an electric current to flow, thereby generating a magnetic field (Framing’s left-hand rule).

Such a thermoelectric effect of material explains the induction of static electricity by friction, the generation of geomagnetic fields, the electromotive force of lightning, the release of electromotive force through spark discharge between clouds, the generation of sunspots and the relevant magnetic field, the reverse rotation of planets, the release of electromotive force through spark discharges in volcano eruptions, the release of electromotive force through spark discharge in large fires, the generation of electromotive force through spark discharge in nuclear explosions and the formation of the ionosphere that reflects electromagnetic waves.

Materials generate an electromotive force in the presence of a temperature difference between two points. The electromotive force is not easily measured in materials having a high electric resistance where the charge transfer is minimal or in materials having almost no electric resistance, such as metals, where the positive (+) charges and the negative (−) charges are immediately offset. However, despite the difference in magnitude, all materials generate an electromotive force in the presence of a temperature difference.

2. Electromotive force generated in materials under a temperature difference

Under a temperature difference between two points of all materials, an electromotive force (voltage) is generated as electric charges are migrated.

This electromotive force causes an electric current to flow and generate a magnetic field (Framing's left-hand rule).

In this research, a temperature difference was generated between two points of a material such as soil and the potential difference was measured.

Figure 1 shows the temperature difference and charge transfer state of materials.

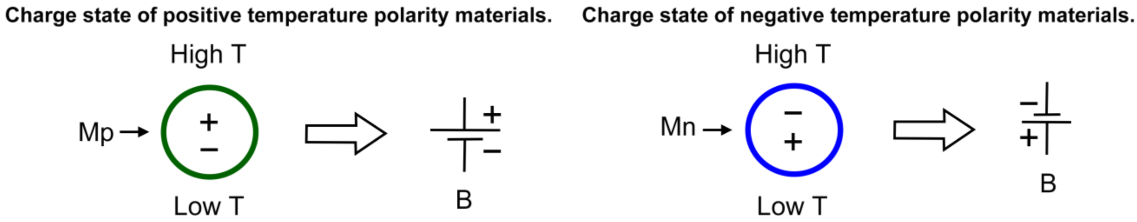

Figure 1. Temperature difference and charge states of materials.

Mp: Positive temperature polarity materials (Water, Iron, etc.),

Mn: Negative temperature polarity materials (Soil, Ice, etc.)

+: Positive charge, −: Negative charge, B: Battery.

The materials that are charged positively on the high-temperature side are defined as "positive temperature polarity materials" and those that are charged negatively on the high-temperature side are defined as "negative temperature polarity materials."

For example, water and iron, are positively charged on the high-temperature side and negatively charged on the low-temperature side. (Table 1).

Contrarily, the negative temperature polarity materials, such as soil and ice, are negatively charged on the high-temperature side and positively charged on the low-temperature side (Table 1).

Water, a positive temperature polarity material, is positively charged on the high-temperature side and negatively charged on the low-temperature side. However, when water is frozen and turns into ice below 0°C, it becomes a negative temperature polarity material with the reversal of the charge polarity.

Because water and ice have opposite temperature polarities, when the cloud (water) is turned into ice particles (hail), charges are transferred owing to the reversal of charge polarity.

The reversal of the charge polarity also occurs when ice particles melt and turn into rain (water).

This is related to the occurrence of lightning.

2.1 Negative temperature polarity experiment

When the temperature of the soil increased, as shown in Figure 2, the voltage was gradually increased from −46.9 mV > −57.5 mV > −70.6 mV > −85.9 mV > −93.5 mV > −110 mV > −126.3 mV.

This shows that an electromotive force is always generated if there is a temperature difference, even in non-metallic materials.

Figure 2 shows the voltage was measured by increasing the temperature of the soil by using an electric heater.

Figure 2. Soil temperature difference experiment.

As a result of this experiment, negative temperature polarity materials were soil, ice and stainless steel (Table 1).

2.2 Positive temperature polarity experiment

Figure 3 is a picture of the positive temperature polarity experiment (Water, Water obtained by melting snow, and Snow).

(a) Water (850 mV), (b) Water (978 mV), and (c) Snow (864 mV)

Figure 3. Temperature difference experiment on positive temperature polar materials.

Experiment on positive temperature polar materials.

a) Water (850 mV) is drinking water; (b) Water (978 mV) is water from melted snow; and (c) Snow (864 mV) is snow.

However, Ice had a negative temperature polarity (Table 1).

This seems to be related to the bonding structure of H_2O {(a) Water, (b) Water obtained by melting snow, and (c) Snow and Ice}.

2.3 Electromotive force measurements

Table 1 shows the experimental results of measuring the magnitude and direction of the electromotive force according to 16 types of temperature difference.

As shown in Table 1, in the case of soil measurement, the high-temperature side was charged negatively and the low-temperature side was charged positively. Therefore, soil is a negative temperature polarity material.

Ice had a negative temperature polarity (Table 1).

This seems to be related to the bonding structure of H_2O {(a) Water, (b) Water obtained by melting snow, and (c) Snow and Ice}.

3. The cause of triboelectricity is the temperature difference caused by friction heat

Figure 4 compares the current theory of triboelectricity with this research.

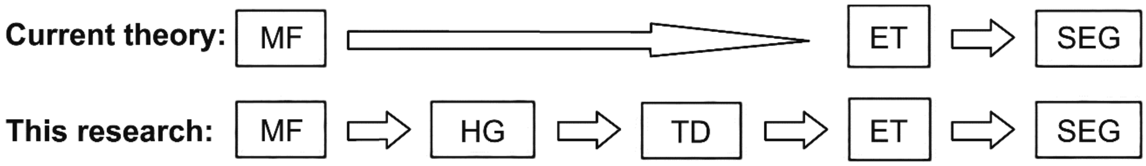

Figure 4. Comparison of current theory with this research.

MF: Material friction (Hair, etc.), HG: Heat generation, TD: Temperature difference,

ET: Electron transfer, SEG: Static electricity generation

The current theory of triboelectricity (the triboelectric effect [2]) is static electricity caused by the movement of electrons owing to friction.[2]

According to the results of this research, it is argued that frictional electricity is the static electricity caused by electron migration owing to temperature difference, as the temperature of the portion subject to friction is increased by the heat generated owing to the friction.Therefore, it is necessary to revise school textbooks.

4. The cause of the strong magnetic field when sunspots occur

The temperature of the sunspot part of the sun is approximately 3000°C-4000°C, and the temperature around it is approximately 6000°C.[3]

The temperature difference between the sunspot and the surrounding area is "2000°C–3000°C**.**"
Therefore, when a sunspot occurs, a large amount of current flows around the sunspot and a strong magnetic field is generated.

5. Evidence that a temperature difference creates an electromotive force

The following is evidence that a temperature difference creates an electromotive force.

1) When a sunspot occurs, a strong magnetic field is generated due to the temperature difference.
2) Lightning occurs when there is a large temperature difference in the atmosphere.
3) Static electricity of triboelectric generated by frictional heat.
4) Earth's magnetic field caused by global temperature difference.
5) Spark emission owing to temperature difference during volcanic eruption.
6) In case of a large fire, sparks are generated owing to the temperature difference.
7) In case of nuclear explosion, spark discharge owing to temperature difference.

6. Discussion

The results of this research show that an electromotive force was generated under a temperature difference between two points, even in non-metallic materials.

It is assumed that the kinetic energy of a celestial body also arises from the temperature difference.

When current generated due to temperature differences in celestial bodies flows through the celestial bodies, a magnetic field is generated across these bodies, and this magnetic field produces a force perpendicular both to that field and to the direction of the current flow (i.e. they are mutually perpendicular) [Fleming's left-hand rule: electric motor's principle].

The celestial body rotates due to the force of the magnetic field, and as it rotates, it functions as a generator (Fleming's right-hand rule), which continues to rotate as if the motor and generator are combined. Therefore, the kinetic energy of a celestial body is also generated by the temperature difference between its two points.

The results of this research show that an electromotive force was generated under a temperature difference between two points, even in non-metallic materials (e.g. soil and water).

This suggests that an electromotive force is generated by the migration of charges in the presence of a temperature different in materials.

Since there is no material of which electric resistance is infinite, an electromotive force is expected to be generated in the presence of a temperature difference between two points in all materials.

Data Availability: Data supporting the findings of this manuscript are available from the corresponding author upon reasonable request.
https://doi.org/10.21203.re.3.rs-1137728/v2

Code Availability: Custom codes that support the findings of this study are available at a dedicated Github repository (https://github.com/DongilSong/TemperatureDifference)

References

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Declarations

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Author Contribution: The author (Dong-il Song) confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

Competing Interest: Author declares that there are no competing interests.

Table 1. Experiment for measuring the magnitude and direction of the electromotive force caused by temperature difference.

Materials	Temperature difference (Low T–High T)	Electromotive force (Voltage)	Note
Soil (Figure 2)	22°C–34°C	−126.3mV	Increase the temperature with an electric heater
Soil–Ice	0°C–17°C	−600 mV	Soil (17 cm × 10 cm), Ice (7 cm × 5 cm)
Soil–Stainless steel–Ice	0°C–17°C	−300 mV	Soil (17 × 10 cm), Ice (7 cm × 5 cm), Stainless steel (9 cm)
Soil–stainless steel	10°C–17°C	−260 mV	Soil (17 × 10 cm), Stainless steel diameter (9 cm)
Stainless steel–Ice–Stainless steel	0°C–23°C	−250 mV	Stainless steel container, ice, Stainless steel lid
Stone–Ice–Stainless steel	low T–high T	−221 mV	Stone plate, Ice (12 cm × 17 cm × 3 cm), Stainless steel
Ice	low T–high T	−73.2 mV	Ice (10 cm × 5 cm)
Stainless steel–Ice–stainless steel	0°C–50°C	−60 mV	Stainless steel container, Ice, Stainless steel lid
Steam	low T–high T	+35 mV	Stainless steel−Steam (Stainless steel container 30 × 20 cm)
Stainless steel–Ice–Iron plate	0°C–50°C	+60 mV	Stainless steel container, Ice (12 × 17 × 2 cm), Iron (10 cm × 4 cm)
Stone–Steam–Stainless steel	low T–high T	+250 mV	Stone plate (30 cm × 3 cm), Stainless steel lid (26 cm)
Stainless steel–Water	15°C–20°C	+280 mV	Stainless steel container (30 cm, H = 20 cm)
Soil–Iron	10°C–17°C	+420 mV	Soil (17 cm × 10 cm), Iron plate (4 cm × 10 cm)
Water (Figure 3)	low T–high T	+850 mV	Water
Water (Figure 3)	0°C–10°C	+978 mV	Water obtained by melting snow
Snow (Figure 3)	0°C–10°C	+864 mV	Stainless steel-Snow-Iron