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Heat, Electricity and Magnetic field

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***Abstract*— The knowledge of Heat is known from pre-historic period. It is also mentioned in many epics as a god. Its use is immense, without which nothing is imaginable. The very existence of us is questionable .probably it would have been impossible. The scientific study of heat started in 18th century in the Europe. Its advanced study led to development of Heat engines, which in turn led to vast development of Industries causing Industrial revolution in the Europe. Later, the discovery of Electricity led to power driven machines which accelerated further industrial revolution. There is strong link between them at the atomic level. The magnetic materials gets demagnetised due to application of heat. This indicates there is link between magnetism and heat. Magnetism is caused by spin motion of electron. The flow of electrons in a conductor causes heat. But, the heat does not get converted to electricity directly except by thermocouple. Here, I have shown that heat is directly linked to charges or voltages, distance between the charges and change in magnetic field or flux between them.**

***Index Terms*— Heat. Atoms, magnetic flux and electricity.**

I. INTRODUCTION

All the physical matters present will be under four states of matter. Its state can be changed by its temperature. Temperature is the measure of hotness or coldness of the body. Heat and Electricity are both a forms of energy. Electricity is closely linked to heat as it produces it in a matter due to the motion of electrons. Since, both the Heat and Electricity related at the atomic level. There is need to form an equation relating heat, electric and magnetic fields at the atomic level. Hence, the study of them is important.

II. HISTORY

The use of heat is as old as Stone Age where the man used it to cook food. But, scientific study of heat started only during 18th century in Europe. Later, it is advanced and used for variety of causes like power generation and power driven machines. The present understanding is it was caused by atomic vibrations, which increases its energy. But, there is no equation given till now which relates heat to the magnetism except the Joules law which gives relation between flows of current and heat. The electricity is believed to be due to the movement of Electrons from an atom to atom due to the voltage difference causing them to migrate.

III. THE PROPERTIES OF HEAT AND ELECTRICITY

The properties of Heat

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1) There are both good and poor conductors of heat
2) Heat flows from the region of higher temperature to the region of lower temperature
3) There are three modes of transmission of heat namely conduction, convection and radiation
4) The parameters of Heat are Temperature and state of matters such as solid, liquid, gas and Plasma

The properties of Electricity
1) There are both good and poor conductors of Electricity
2) Electricity flows from the High potential to low potential.
3) There is two methods to transmit electric current namely voltage difference and propagation of electromagnetic wave
4) The parameters of Electricity are voltage and current.

IV. THE DIFFERENCE BETWEEN HEAT AND ELECTRICITY

The Electricity is due to the movement of electrons in a conductor from one atom to another. The same way heat is due to the spin motion of electrons without moving from one atom to another. It can be shown using equation that heat is due to change in magnetic field which in turn is due to spin motion of electrons.
From Joule's law
$H=i^2Rt$
H= heat in joules, i=current and t=time for which current flows
Power= i^2R..... (1)
Also, we have Power=FV..... (2)
Where F= force and V=velocity
Equating the above two equation
We get $H= i^2Rt= FVt$..... (3)
$F= (1/4\prod\varepsilon_0)q^2/d^2$
Where F= electrostatic force of attraction, q=charge of electron and d=distance between them
Also we have $V=(E/B)\ \text{cosec}\Theta$
Substituting in equation 3
$H= i^2Rt=(1/4\prod\varepsilon_0)q^2/d^2\ (E/B)\ \text{cosec}\Theta\ t$
$H=(q^2/t^2)Rt=(1/4\prod\varepsilon_0)q^2/d^2\ (E/B)\ \text{cosec}\Theta\ t$
Since i=q/t
Cancelling common on both sides we get
$H=R/t=(1/4\prod\varepsilon_0)/d^2\ (E/B)\ \text{cosec}\Theta\ t$
$H=R/t=(1/4\prod\varepsilon_0)/d^2\ (E/B)\ \text{cosec}\Theta\ t$
Since R=v/i we get
$H=v/it=(1/4\prod\varepsilon_0)/d^2\ (E/B)\ \text{cosec}\Theta\ t$
v= voltage, i =q/t
After cancelling we get
$H=v/q=(1/4\prod\varepsilon_0)/d^2\ (E/B)\ \text{cosec}\Theta\ t$
Since $E=q/4\prod\varepsilon_0\ d$ we get
$H=v/q=(1/4\prod\varepsilon_0)/d^2\ (q/4\prod\varepsilon_0\ dB)\ \text{cosec}\Theta\ t$
$H=((1/4\prod\varepsilon_0)^2\ q^2/d^3Bv)\ \text{cosec}\Theta\ t$
Since $v= q/4\prod\varepsilon_0\ d$
$H= (v^2/(dBv)/t)\ \text{cosec}\Theta$
$H= (v/(dB)/t)\ \text{cosec}\Theta$
$H= (v/(d(B/t))\ \text{cosec}\Theta$ ..... (4)
We can see that B/t is change in magnetic field. Hence, we can

conclude that heat is the result of change in magnetic field which in turn is due to the variation in spin motion of electrons.

Suppose if we want equation in terms of voltage, we can rearrange the above equation and get

$v = Hd(B/t) \sin\Theta$..... (5)

Voltage is directly proportional to Heat, distance between charges and change in magnetic field or flux.

V. The Phases of Matter

The phases of matter depend on temperature of the matter .As we can see from the above equation 4

heat is directly proportional to voltage and inversely proportional to the distance between the electrons and change of magnetic field or magnetic flux. Hence, as the matter is at low temperature the electrons spin is very less also low magnetic flux and electrons are at short distance. Once the heat is added to the matter, the distance between the electrons starts to increase because of high spin of electrons. Since the spin of electrons are increased, its KE increased and change in magnetic field decreased but not sufficient enough to get separate from the core of an atom nucleus. The bondage of electron to its nucleus is strong but, bondage of an atom with other atoms or molecules becomes flexible or loose, which leads to liquid state of matter, further heat addition leads to further increase of spin of electrons, which increases its KE and decreases magnetic flux. But, it is not sufficient enough to get separated from its core nucleus and hence wanders as individual atoms separated from one another which results in gas state of the matter.

VI. Modes of Heat Transfer

There are three modes of transfer of heat namely conduction, convection and radiation. Conduction usually observed in solids where the atoms are closely and strongly bonded due to electrostatic force of attraction. The application of heat reduces the magnetic flux of electrons which gets propagated to all the neighbouring electrons and thus gets transmitted. Convection observed in liquids also explained in the same way where its magnetic flux reduced and distance between electrons increased which makes low density of liquid. The liquid at top whose heat content is less is denser. This difference in density makes the liquids to drift up and down till all possess equal magnetic flux and distance between the electrons and thus heat gets transferred in liquid. The heat radiation can be explained by the high spin of electrons which makes low magnetic flux. Once its spin exceeds threshold limit, it flung out as photons of electromagnetic waves as it is evident from equation 4 and will be of sinusoidal in nature.

VII. Magnetic Transition

The magnetic properties of materials always depend on its temperature. The materials depend on curie temperature to get converted to diamagnetic or paramagnetic substance. This fact itself indicates that heat depends on magnetic field. It is also known that heat demagnetises the magnetic material because heat is inversely proportional to magnetic field. More heat means less change in magnetic field or flux as per equation 4.

VIII. How the Thermocouple Works

The thermocouple works due to temperature difference between two different materials given by the following equation

$v_1 - v_2 = (H_1 d_1 (B_1/t) \sin\Theta_1 - H_2 d_2 (B_2/t) \sin\Theta_2)$

The potential difference developed depends upon the above equation. It shows the potential difference developed and hence the electrons flow mainly depends on the heat content and change in magnetic field between the two materials.

IX. Induction Stove

The induction stove works more efficient in converting electricity into heat because it directly involves in change in magnetic field as per the equation 4.The change of magnetic field or flux should be less in order to get more heat for the given voltage as heat is inversely proportional to magnetic flux or field. The lesser the magnetic flux or field more is the heat produced or heat is amplified.

X. How Material Burns in to Fire

When the heat is added in to material, it leads to increase in electron's KE and less magnetic flux, which makes the high spin of the electrons which increases distances between electrons which accounts for the increase in length of materials or expansion of materials. Once its spin reaches such a stage where it cannot bind to the attractive force of nucleus, it flung out as photons of high energy, which we all witness as fire.

XI. Superconductivity

The superconductivity of materials depends on its

Temperature and magnetic field or flux as given by equation 4.The less heat means low magnetic flux. When Heat H=0 we observe change in magnetic field or flux also becomes zero. Hence, at cryogenic states we observe zero magnetic flux which leads to superconducting state. Materials superconducting states can be destroyed by application of heat or changing magnetic field or flux.

XII. Heat and Electric Conductivity of Materials

There are materials which are both good and bad conductors of heat and electricity. The difference can be attributed to the number of valence electrons and magnetic flux. If the valence electrons exist in a material or there is free movement of electrons or ions from one atom to another, it will be good conductor of electricity otherwise bad conductor of electricity. In case of heat the good conductor should have both potential difference or valence electrons and magnetic

flux gradient otherwise it will be of bad conductor of heat as shown in equation 4.

XIII. CONCLUSION

Hence, from above argument we can conclude that the heat is due to spin motion of electron, which is in turn due to change in magnetic field. Heat wave is also sinusoidal as it is indicated by the presence of sin Θ in the equation 4.Hence the infrared waves are sinusoidal and electromagnetic which is caused due to heat waves.

From the above argument we can infer that heat flow not only controlled by its temperature alone it can also be control by the magnetic field or flux. The different matters can exist in four states like solid, liquid, gas and plasma at different temperatures which implies that matter not only depends upon its temperature or heat content but also depends on its magnetic flux otherwise all matter would have been either solid or liquid or gas at any particular given temperature.

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