INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 5, Issue 4)
Available online at: www.ijariit.com

Correction in Ohm's law

Manjeet Singh
monurao18@gmail.com
Parul University, Vadodara, Gujarat

ABSTRACT

In physics, we study about fluid flow, Electric current, heat flow, and many more flows but the common thing in all the flows is that it needs some driving force to move something due to which flow will occur and when we observe equations of all these flows, they look similar but if we compare these similar equations of different flows then it looks like that something is missing in defining equations.

Keywords— *Gravitational voltage, Gravitational resistance, Electric pressure*

1. INTRODUCTION

The flow is the change in the quantity of something with respect to time, the quantity may be charge or mass. If any charge moves with some velocity (due to electric potential difference), it generates electric current, if a mass moves (due to gravitational potential difference) with respect to the time it generates mass flow (or gravitational current at cosmic level). Both these flows look different but when we go mathematically, mass flow (or fluid flow) is defined by Bernoulli's equation and the electric current is defined by ohm's law, but if we compare ohm's law with Bernoulli's we find that we are missing some terms in ohm's law

2. RESEARCH METHODOLOGY

When a charged particle comes near to another charged particle it experiences a force, coulomb's force as like if a mass comes near to another mass it feels gravitational attraction.

The force between two electric charges and between two masses is given by coulomb's law and by newton's law of gravity respectively. These looks same but with a small difference that gravity is an only attractive force but Colombian force is both attractive and repulsive.

Suppose that there is a huge charge particle as shown in figure 1 which creates some equipotential surfaces around it, Now if a small charge comes near to it then it will experience a force (attractive or repulsive depends on the nature of both charges) due to which it will start moving and this movement will generate some electric current. Generally, we study that the flow of charges requires a material medium called conductors. But for now, suppose that there are only two charges in the whole space as shown in figure 1.

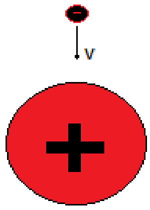

Fig. 1: Symbols of charge particle

And a small negative charge is falling towards positive charge (it will follow the smallest path) due to its attraction then the motion of this negative charge will be same as if a small mass fall (free-fall) towards the earth.

When we give some potential difference at the endpoints of a wire, the overall motion of electrons in that wire will be the same as we discussed the motion of an electron in the above example.

Now suppose that some charged particles (electrons) are flowing in a wire due to electric potential difference also known as voltage as shown in figure 2.

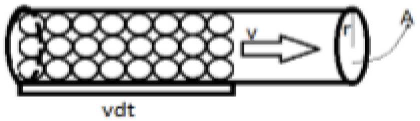

Fig. 2: Charged particles flowing in a wire

2.1 According to ohm's law

$$V = IR \qquad eq_1$$

Where

$$I = \frac{dq}{dt}$$

$$dq = nev_d tAI = \frac{nev_d tA}{t}$$

Or

$$I = nev_d A = \rho_e v_d A \quad (ne = \rho_e)$$

$$I = \rho_e v_d A \qquad eq_2$$

- ρ_e is charge density in a conductor
- A is the cross-sectional area of conductor
- v_d is drift velocity of electrons and is equals to

$$v_d = \frac{eE\tau}{m} \qquad eq_3$$

(E is an effective electric field in the conductor and τ is average time of collision of electrons and can be taken as constant)
So

$$v_d \; \alpha \; E$$

$$v_d = cE \qquad eq_4$$

(c is any constant = $\frac{e\tau}{m}$)

From eq_2

$$I = \rho_e v_d A$$

$$I = cE\rho_e A$$

($v_d = cE$ from eq_4)

$$I = c\rho_e AE \qquad eq_5$$

$$E = \frac{V}{dx} \qquad eq_6$$

$$I = c\rho_e A\frac{V}{dx}$$

[$E = \frac{V}{dx}$ from eq_6]

On re-arranging we get

$$V = I\left(\frac{dx}{c\rho_e A}\right) \qquad eq_7$$

$$V = IR \text{ and } R = \frac{dx}{c\rho_e A}$$

Relation b/w electric voltage and electric pressure

2.2 According to coulomb’s law

$$F = qE$$

$$V = \frac{F}{q}dx$$

We can write it as

$$V = \frac{F}{A}\frac{Adx}{q}$$

$$V = \frac{P}{q}Adx = \frac{P}{\rho_e}$$

($P = \frac{F}{A}$, $\rho_e = \frac{q}{Adx}$ = Charge density)

$$V = \frac{P}{\rho_e}$$

(Here P is electric pressure)

$$P = V\rho_e \qquad eq_8$$

2.3 Ohm's law for gravitational current

Now suppose that there are some massive particles flowing in a cylindrical path or in a tube (having a fixed length 'dx') due to the gravitational potential difference (free fall) as shown in figure 3.

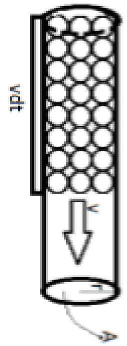

Fig. 3: Particles flowing in a cylindrical path

2.4 According to equations of Gravitational current

$$G = \rho v A$$

ρ is mass density

v is the velocity of flowing particles

A is the cross-sectional area of tube

According to eq^n of motion

$$v = u + at$$

let u = 0

$$v = at \qquad eq_9$$

(here acceleration a = E = Gravitational field)

So

$$v = Et$$

Let's suppose that "t" is constant as we have taken it in current electricity

So

$$t = c_1$$

$$v = c_1E \qquad eq_{10}$$

So

$$G = \rho c_1 EA$$

($v = c_1E$ --- from eq_{10})

$$G = \rho c_1 EA \text{ or } \rho c_1 aA \qquad eq_{11}$$

$$(a = E)$$

According to Newton's Law

$$E = \frac{V}{dx}$$

Here E and V are Gravitational field and gravitational potential or voltage
Putting the value of E in eq_{11}

$$G = \rho c_1 AE$$

$$G = \rho A c_1 \frac{V}{dx}$$

On re-arranging we get

$$V = G\left(\frac{dx}{\rho A c_1}\right)$$

Or

$$V = GR, \qquad eq_{12}$$

where

$$R = \frac{dx}{\rho A c_1}$$

Or $V \propto G$

Here V, G & R is gravitational voltage, gravitational current and Gravitational Resistance respectively. This can be considered as ohm's law for gravitational current. But if we think practically then "t" can't be constant because if the acceleration of a particle for a fixed length is variable then the time taken by particle to travel that distance will also be variable.

Using equations of motion

$$s = ut + \frac{1}{2}at^2$$

$$s = \frac{1}{2}at^2$$

(because u = 0)

$$t = \sqrt{\frac{2s}{a}} \text{ or } \sqrt{\frac{2dx}{E}}$$

$$(s = dx,\ a = E)$$

from eq_9

$$v = at$$

$$v = a\sqrt{\frac{2s}{a}}$$

or

$$v = \sqrt{2as} \text{ or } v = \sqrt{2adx}$$

$$v = k\sqrt{E}$$

$$(k = \sqrt{2dx},\ a = E)$$

so

$$G = \rho v A$$

$$= \rho k\sqrt{E}A$$

$$G = \rho k\sqrt{\frac{V}{dx}}A$$

$$\sqrt{V} = \frac{G\sqrt{dx}}{\rho k A}$$

$$V = \frac{G^2 dx}{\rho^2 k^2 A^2}$$

$$V = \frac{G^2 t}{\rho k^2 A}\left(\frac{dx}{\rho A t}\right), \left(\frac{dx}{\rho A t} = R\right)$$

$$V = \frac{G^2 R}{k^2 \rho A} \times t$$

$$V = \frac{G^2 R}{k^2 \rho A} \times \sqrt{\frac{2dx}{E}}$$

$$V = \frac{G^2 R}{k^2 \rho A}\sqrt{\frac{2dx}{\frac{V}{dx}}}$$

or

$$V = \frac{G^2 R}{k^2 \rho A}\sqrt{\frac{2dx}{V}}dx$$

$$V\sqrt{V} = \sqrt{2}\frac{\text{Ɠ}^2{}_R}{k^2\rho A}dx$$

$$V\sqrt{V} = \sqrt{2}\frac{\text{Ɠ}^2{}_R}{k^2} \times \frac{dx}{\rho v A} \times v$$

$$V\sqrt{V} = \sqrt{2}\frac{\text{Ɠ}^2{}_R}{k^2} \times \frac{dx}{\text{Ɠ}} \times v$$

$$V\sqrt{V} = \sqrt{2}\frac{\text{Ɠ}_R}{k^2}dx \times k\sqrt{E},\ (v = k\sqrt{E})$$

$$V\sqrt{V} = \sqrt{2}\frac{\text{Ɠ}_R}{K}dx \times \frac{\sqrt{V}}{\sqrt{dx}}$$

$$V = \frac{\text{Ɠ}_R}{K}\sqrt{2dx}$$

or

$$V = \frac{\text{Ɠ}_R}{K}K$$

$$V = \text{Ɠ}R$$

$$\text{Or } V \propto \text{Ɠ}$$

This proportionality remain as it is, even if t is variable, so we can treat it as a constant c_1

Relation b/w gravitational voltage and pressure

2.5 According to Newton's law

$$F = ma = mE$$

$$V = \frac{F}{m}dx$$

$$V = \frac{F}{A}\frac{Adx}{m} = \frac{P}{\rho}$$

$$\text{Or } P = \rho V \qquad eq_{13}$$

Let's suppose that the flowing particles are of fluid then

2.6 According to Bernoulli's equation

$$P_1 - P_2 = \rho g(h_2 - h_1) + \frac{1}{2}\rho(v_2^2 - v_1^2)$$

$$P_1 - P_2 = \rho a(h_2 - h_1) + \frac{1}{2}\rho(v_2^2 - v_1^2) \qquad (g = a)$$

Putting the value of P from eq_{13}

$$\rho(V_1 - V_2) = \rho a(h_2 - h_1) + \frac{1}{2}\rho(v_2^2 - v_1^2)$$

OR

$$(V_1 - V_2) = a(h_2 - h_1) + \frac{1}{2}(v_2^2 - v_1^2)$$

($V_1 - V_2$ Gravitational potential difference)

Multiply and divide $\rho A c_1$ in potential energy term

$$(V_1 - V_2) = \rho A c_1 a\frac{h_2 - h_1}{c_1\rho A} + \frac{1}{2}(v_2^2 - v_1^2)$$

($h_2 - h_1 = dx$ = length of tube)

From eq_{11},

$$\rho A c_1 a = \text{Ɠ}$$

$$(V_1 - V_2) = \text{Ɠ}\left(\frac{dx}{c_1\rho A}\right) + \frac{1}{2}(v_2^2 - v_1^2)$$

$$V = ᏀR + \frac{1}{2}(v_2^2 - v_1^2)$$

(where $V = V_1 - V_2$ and $R = \frac{dx}{\rho A c_1}$)

So we can say that

$$V \neq ᏀR$$

but

$$V = ᏀR + \frac{1}{2}(v_2^2 - v_1^2) \qquad eq_{14}$$

If we compare this eq^n with eq_{12} then here is an extra term, this extra term indicates the Kinetic energy difference of moving massive particles (in case of gravitational current) b/w two points in a tube having varying cross-sectional area, we can also say that it is a correction term in OHM's Law and this term exist when the cross-sectional area of tube varies with length

This correction term should also exist for current electricity

Derivation of Bernoulli's Eq^n for current electricity. Suppose the same example of flowing charge particles in a wire as described in figure 2.

Work done = Change in PE + Change in KE

$$F.dx = qEdx + \frac{1}{2}m_e(v_2^2 - v_1^2)$$

(m_e = mass of moving electrons)

$$\frac{F}{A}dx = \frac{qE}{A}dx + \frac{1}{2}\frac{m_e}{A}(v_2^2 - v_1^2)$$

$$\frac{F}{A} = \frac{qEdx}{Adx} + \frac{1}{2}\frac{m_e}{Adx}(v_2^2 - v_1^2)$$

$$P = \frac{qEdx}{Adx} + \frac{1}{2}\frac{m_e}{Adx}(v_2^2 - v_1^2)$$

$$P = \rho_e Edx + \frac{1}{2}\rho_m^e(v_2^2 - v_1^2)$$

(ρ_m^e = mass density of electrons)

Putting the value of P from eq_8

$$\rho_e V = \rho_e Edx + \frac{1}{2}\rho_m^e(v_2^2 - v_1^2)$$

$$V = Edx + \frac{1}{2}\frac{\rho_m^e}{\rho_e}(v_2^2 - v_1^2)$$

$$V = Edx + \frac{1}{2}K_1(v_2^2 - v_1^2)$$

$$V = \frac{\rho_e cAEdx}{\rho_e cA} + \frac{1}{2}K_1(v_2^2 - v_1^2)$$

$$V = I\frac{dx}{\rho_e cA} + \frac{1}{2}K_1(v_2^2 - v_1^2)$$

Or

$$V = IR + \frac{1}{2}K_1(v_2^2 - v_1^2) \qquad eq_{15}$$

Here R is R_{eq} (Equivalence Resistance) & v_1, v_2 are drift velocities of electrons at end points of wire having varying cross-sectional area

So

$$V = IR_{eq} + \frac{1}{2}K_1(v_2^2 - v_1^2)$$

$$V = IR_{eq} + \frac{K_1}{2\rho_e^2}\left(\frac{\rho_e^2 v_2^2 A_2^2}{A_2^2} - \frac{\rho_e^2 v_1^2 A_1^2}{A_1^2}\right)$$

(A_1 and A_2 are cross-sectional areas of wire at end points)

$$V = IR_{eq} + \frac{K_1}{2\rho_e^2}\left(\frac{I^2}{A_2^2} - \frac{I^2}{A_1^2}\right)$$

$$V = IR_{eq} + \frac{K_1 I^2}{2\rho_e^2}\left(\frac{1}{A_2^2} - \frac{1}{A_1^2}\right) \qquad eq_{16}$$

This Eq^n is corrected ohm's law

$$K_1 = 5.68563006493004 \times 10^{-12}$$

It is the ratio of mass density of electrons to the charge density of electrons or ratio of mass to the charge of an electron or $\frac{m}{e}$ of electron.

3. RESULTS

- The statement of Ohm's law that the current in a conductor is directly proportional to potential difference is wrong or $V \neq IR$
- The corrected equation of Ohm's law is

$$V = IR_{eq} + \frac{K_1 I^2}{2\rho_e^2}\left(\frac{1}{A_2^2} - \frac{1}{A_1^2}\right)$$

and

$$K_1 = 5.68563006493004 \times 10^{-12}$$

4. APPLICATIONS

- We can calculate the kinetic energy difference of flowing electrons in a wire
- We can calculate the relation b/w gravitational current and gravitational potential at a cosmic level
- We can determine the minute corrections during the application of ohm's law

5. REFERENCES

[1] Colm O'Sullivan, "Ohm's Law and the definition of resistance", Physics Education, August 1980
[2] Madhu Gupta, "Georg Simon Ohm and Ohm's Law", IEEE, September 1980
[3] Eman Qawasmi, "Ohm's and Kirshoff's Law", Khalifa University
[4] Martin E Saleta, Dina Tobia, Salvador Gil, "Experimental Study of Bernoulli's Equation with Losses", American Journal of Physics, July 2005
[5] Ruqiong Qin, Chunyi Duan, "The principle and applications of Bernoulli Equation", Journal of Physics, October 2017
[6] Priyadharsini Sivaraj, "A study on Motion of a free falling body in Kinematic Equation", IJRASET, January 2018
[7] Gianfranco Spavieri, G T Gillies and Miguel Eduardo Rodriguez "Physical Implications of Coulomb's Law", Metrologia, October 2004
[8] P.H. Wiley and Warren Stutzman, "A simple experiment to demonstrate Coulomb's Law", American Journal of Physics, January 1978
[9] Isobel Falconer, "Charles Augustin Coulomb and the fundamental law of electrostatics", Metrologia, September 2004
[10] Erik Verlinde, "On the origin of Gravity and the Laws of Newton", Institute of theoretical physics, January 2010
[11] Klapka and Raymond, "Theory of Gravity and beyond", The general Science, December 2018

