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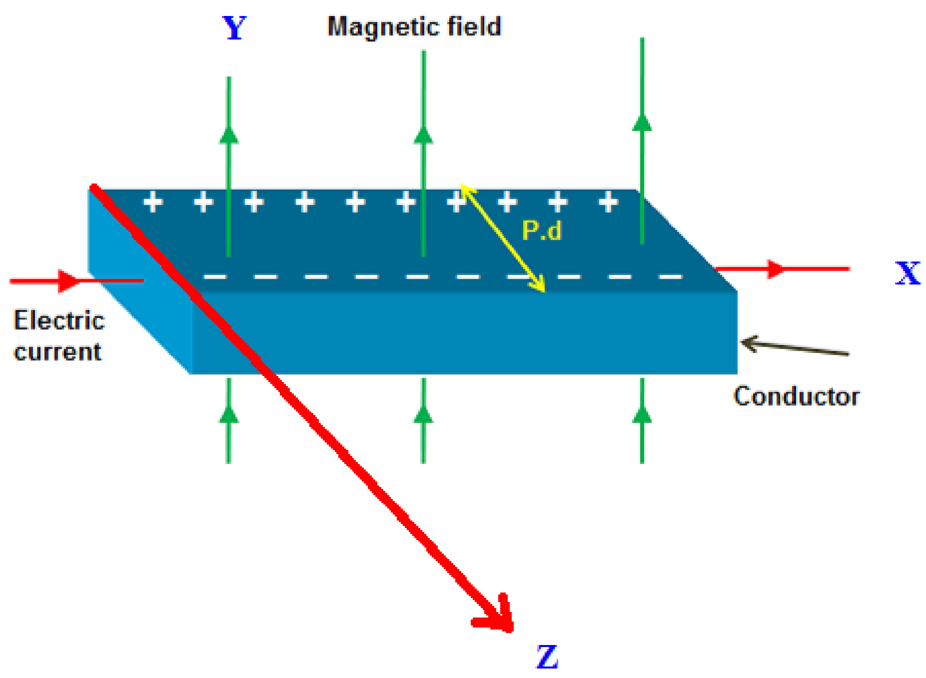
HALL EFFECT(హాల్ ప్రభావం)

Hall effect was discovered by E.H.Hall due to which it was named after his name. according to this, when a magnetic field is applied perpendicular to the direction of a current carrying conductor, a potential difference is developed between the points on the opposite side of the conductor. As shown in the following figure, consider a uniform, thick metal strip with its length parallel to X-axis. If a magnetic field of induction 'B' is applied perpendicular to this along Y-axis, the charge on the conductor experiences a force along z axis direction. This can explained by Fleming's Left Hand rule. If the charge carriers are electrons, then they will experience a forces along positive Z-axis direction. Therefore, the electrons will be accumulated along positive Z-axis. Due to this reason, opposite charge will be developed on the opposite side.



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Thus a potential difference in other words e.m.f is developed. This e.m.f. is known as Hall e.m.f. If charge carriers are positively charged, the sign of e.m.f. is reversed. Thus, we can find the nature of charge carriers by Hall effect.

Further, from Hall effect, one can understand that charge displacement takes place which gives rise to Hall electric field E_H. this field acts inside the conductor to oppose sideway drift of the charge carriers

From the already know theory, the magnetic deflecting force is F_B given by $q(v_d XB)$

Hall electric deflecting force F_H is given by qE_H

When the net force on the charge carriers is zero, $q(v_d xB) + qE_H=0$

Therefore, $E_H= -(v_d xB)$

If we write magnitude only, $E_H= -v_d B$ **--------**(1)

From the relation between drift velocity and current density j, one can write $v_d = \frac{j}{nq}$

Substituting this value in equation (1), we get

$$E_H = \left(\frac{1}{nq}\right) jB \qquad \text{---------(2)}$$

If V_H is Hall voltage in equilibrium, then $E_H = \left(\frac{V_H}{d}\right)$, where d is width of the bar. **--------**(3)

When the potential difference between two faces is measured, Hall field calculated using equation (3). By the measurement of current 'i' on the bar, current density i/A can be calculated, the magnetic field induction can be measured by gauss meter. therefore, on substitution of the values of E_H, j and B in equation (2), one can calculate the value of $\frac{1}{nq}$

Therefore, the ratio of Hall electric field E_H to the product of current density j and magnetic induction B is known as Hall coefficient. It is denoted by R_H.

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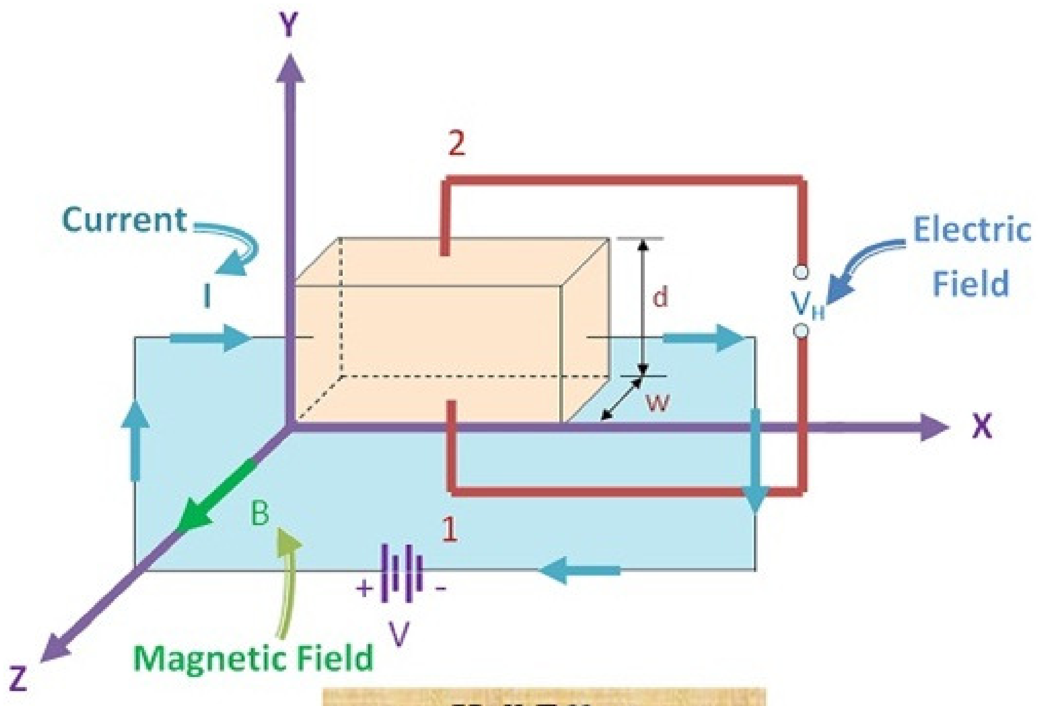
$R_H = \left(\frac{E_H}{jB}\right) \Longrightarrow \frac{E_H}{jB} = \frac{1}{nq}$ {from equation (2)}

$$\therefore R_H = \frac{1}{nq}$$

The Hall coefficient is negative for electrons and is positive when the charge carriers are holes.

Another way of representation of Hall effect:



Hall Effect

Application of Hall Effect:

1. It gives the information about the charge carriers
2. It is useful in understanding the electrical conduction various materials
3. Strong magnetic fields can be measured using Hall effect

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4. The mobility of charge carriers can be measure by the conductivity of the material and Hall electric field
5. It is useful in the measurement of drift velocity of the charge carriers.
6. Measurement of hall coefficient gives the number of charge carriers per unit volume.

Questions:

1. What is Hall effect? Explain.
2. What is Hall effect? Discuss the importance of Hall coefficient
3. Explain with necessary theory, the Hall effect and derive an expression for Hall coefficient.
4. What is Hall effect? Mention its applications.
5. Write a short note on Hall effect
6. Explain how the Hall effect can be used for measurement of Voltage
7. Explain Hall effect and obtain an expression for Hall voltage.

References:

1. Unified Physics, Volume III, Jai Prakash Nath Publications, Meerut

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