PHYF214 PHYSICS LAB1 REPORT SEM1 2018-2019

EXP. No.: EM 3

EXP Name: Magnetic Field in a current carrying conductor

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I. AIM:

The Experiment aims at determining of the magnetic field inside a conductor as a function of the

1. Current in the conductor,
2. Distance from the axis of the conductor.

II. Theory:

The setup consists of an electrolyte in a cylindrical cavity with connections such that there is no net magnetic field on the outside of the cylinder and the grid on the surface won't produce magnetic field on the inside of the cylinder, the only magnetic field would be due to the electrolyte. The Induce Voltage (U_f) is given by:

$$U_f = 2n\pi AfB_0\sin(\omega t+\phi)$$

Where,
n is the number of turns,
A is the cross sectional area
f is the sinusoidal current frequency
$B_0\sin(\omega t+\phi)$ is the magnetic field produced

Considering uniform current density throughout the electrolyte, one can write the current as the function of radial distance r from the center as:

$$I = I_{tot}\frac{r^2}{R^2}$$

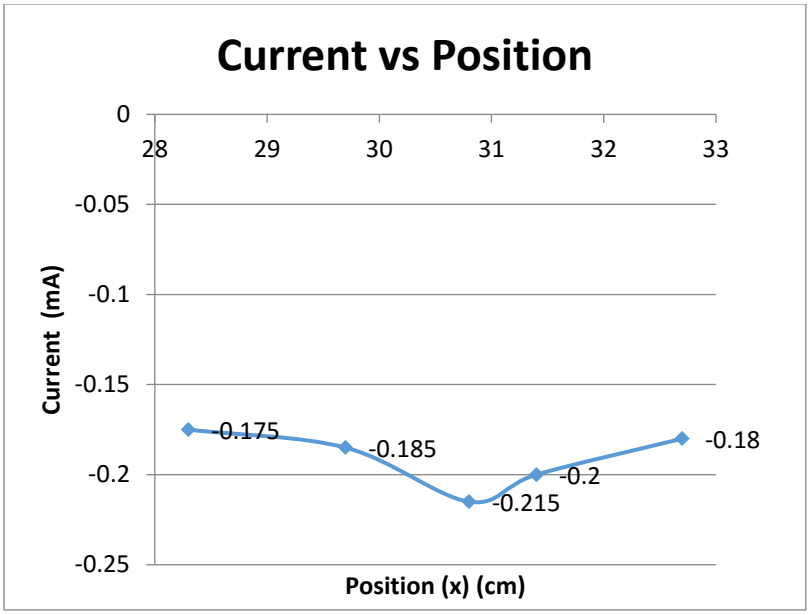
And consequently, the magnetic field as:

$$B = \frac{\mu_0}{2\pi} \quad I_{tot}\frac{|\vec{r}|}{R^2}$$

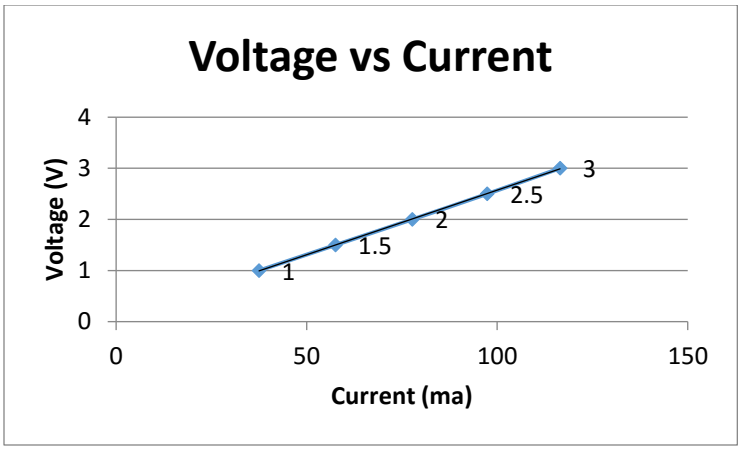
Considering that induced voltage (U) and magnetic field (B) enjoy a linear relationship, one can find B from U.

III. Observation Table and Graphs:

1. Variation with position	
X (cm)	Current (mA)
32.7	-0.18
31.4	-0.2
30.8	-0.215
29.7	-0.185
28.3	-0.175



2. Variation of current with voltage		
Frequency = 2500 Hz		
Voltage (V)	Current (mA)	Induced Voltage (V)
1	37.5	1.268
1.5	57.6	1.254
2	77.7	1.244
2.5	97.4	1.225
3	116.5	1.208



IV. Results:

Averaging the value of induced current and plugging in the relation between U and B, one can get the average value of B_0:

$$\langle U \rangle = 2n\pi A f B_0 \langle \sin(\omega t + \phi) \rangle$$

Or,

$$B_0 = \langle U \rangle / (n\pi A f)$$
$$= 1.77 \text{ mT}$$

Taking into account the error due to non-homogeneity of the electrolyte and the fast chemical reaction resulting in Oxygen bubbles accumulating to the top, the graph denoting the relation between magnetic field (denoted by the current in the first plot as they are linearly dependent) and position is plotted and the graph denoting the relation between current and position is plotted.

The minima in the first graph corresponds to the center of the cylindrical cavity (30.8 cm from the ground level).