- l_g = length of the airgap
- l_c = length of the core
- A_g = Cross-sectional area of the airgap
- A_c = Cross-sectional area of the core

By using Ampere's law:

$$\oint \mathbf{H} \cdot d\mathbf{l} = H_c l_c + H_g l_g = NI \qquad (1)$$

$$B_c A_c = B_g A_g = \Phi_c \qquad (2)$$

$$B = \mu_0 \mu_r H$$

Now,

$$\mu_0 \mu_{rc} H_c A_c = \mu_0 \mu_{rg} H_g A_g = \Phi_c \qquad (3)$$

$$H_c = \frac{\Phi_c}{\mu_0 \mu_{rc} A_c}, \quad H_g = \frac{\Phi_c}{\mu_0 \mu_{rg} A_g}$$

Now, put H_c and H_g values in eq. (1):

$$\frac{\Phi_c}{\mu_0 A_c}\left[\frac{l_c}{\mu_{rc}A_c}+\frac{l_g}{\mu_{rg}A_g}\right]=NI \qquad (1)$$