<u>Exemplo - reta de carga</u>[1]

EXAMPLE 1.2 ver anotação (3)

Consider the magnetic system of Example 1.1. If the coil current is 4 amps when each air gap length is 1 mm, find the flux density in the air gap.

Solution

In Example 1.1, the flux density was given and so it was easy to find the magnetic intensity and finally the mmf. In this example, current (or mmf)

air gap is linear, whereas that of the core is nonlinear. We need nonlinear magnetic circuit analysis to find out the flux density. Two methods will be discussed.

1. *Load line method.* For a magnetic circuit with core length l_c and air gap length l_g,

$$Ni = H_g l_g + H_c l_c = \frac{B_g}{\mu_0} l_g + H_c l_c$$

Rearranging,

$$B_g = B_c = -\mu_0 \frac{l_c}{l_g} H_c + \frac{Ni\mu_0}{l_g} \qquad (1.21)$$

This is in the form $y = mx + c$, which represents a straight line. This straight line (also called the *load line*) can be plotted on the B–H curve of the core. The slope is

$$m = -\mu_0 \frac{l_c}{l_g} = -4\pi 10^{-7} \frac{360}{2} = -2.26 \times 10^{-4}$$

The intersection on the B axis is

$$c = \frac{Ni\mu_0}{l_g} = \frac{500 \times 4 \times 4\pi 10^{-7}}{2 \times 10^{-3}} = 1.256 \text{ tesla}$$

The load line intersects the B–H curve (Fig. E1.2) at $B = 1.08$ tesla.

Another method of constructing the load line is as follows: If all mmf acts on the air gap (i.e., $H_c = 0$) the air gap flux density is

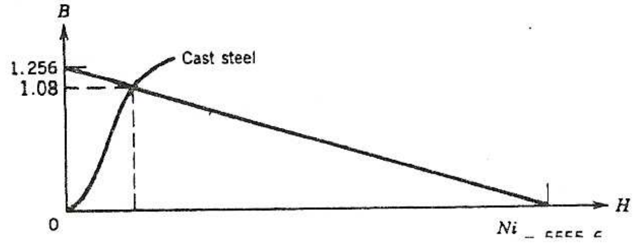
$$B_g = \frac{Ni}{l_g}\mu_0 = 1.256 \text{ T}$$

This value of B_g is the intersection of the load line on the B axis.

If all mmf acts on the core (i.e., $B_g = 0$),

$$H_c = \frac{Ni}{l_c} = \frac{500 \times 4}{36 \times 10^{-2}} = 5556 \text{ At/m}$$

This value of H_c is the intersection of the load line on the H axis.



2. *Trial-and-error method.* The procedure in this method is as follows.
   - (a) Assume a flux density.
   - (b) Calculate H_c (from the B–H curve) and H_g $(= B_g/\mu_0)$.
   - (c) Calculate F_c $(= H_c l_c)$, F_g $(= H_g l_g)$, and F $(= F_c + F_g)$.
   - (d) Calculate $i = F/N$.
   - (e) If i is different from the given current, assume another judicious value of the flux density. Continue this trial-and-error method until the calculated value of i is close to 4 amps.

   If all mmf acts on the air gap, the flux density is

$$B = \frac{Ni}{l_g}\mu_0 = 1.256 \text{ T}$$

Obviously, the flux density will be less than this value. The procedure is illustrated in the following table.

B	H_c	H_g	F_c	F_g	F	i
1.1	800	8.7535×10^5	288	1750.7	2038.7	4.08
1.08	785	8.59435×10^5	282	1718.87	2000.87	4.0

[1] P.C. Sen, Principles of Electric Machines and Power Electronics, 2nd Edition, Wiley, 1996.