

4.7 POTENTIAL GRADIENT

Under operating conditions, the insulation of a cable is subjected to electrostatic forces. This is known as dielectric stress. The dielectric stress at any point in a cable is infact the potential gradient (or electric intensity) at that point.

Consider a single core cable with core diameter d and internal sheath diameter D . The electric intensity at a point x metres from the centre of the cable is

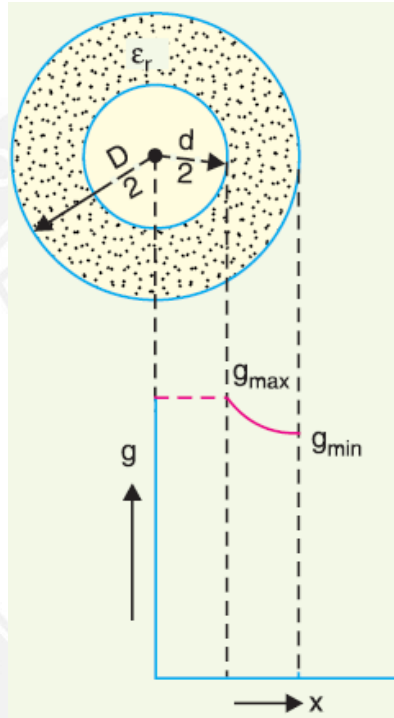


Figure 4.7.1 Potential Gradient – Cable

[Source: "Principles of Power System" by V.K.Mehta Page: 277]

$$E_x = \frac{Q}{2\pi \epsilon_o \epsilon_r x} \text{ volts/m}$$

By definition, electric intensity is equal to potential gradient. Therefore, potential gradient g at a point x metres from the centre of cable is

$$g = E_x$$

$$g = \frac{Q}{2\pi \epsilon_o \epsilon_r x} \text{ volts/m}$$

.....(i)

$$V = \frac{Q}{2\pi\epsilon_o\epsilon_r} \log_e \frac{D}{d} \text{ volts}$$

$$Q = \frac{2\pi\epsilon_o\epsilon_r V}{\log_e \frac{D}{d}} \dots\dots(ii)$$

Substituting the value of Q from exp. (ii) in exp. (i), we get,

$$g = \frac{2\pi\epsilon_o\epsilon_r V}{\log_e D/d} = \frac{V}{x \log_e \frac{D}{d}} \text{ volts/m} \dots\dots(iii)$$

It is clear from exp. (iii) that potential gradient varies inversely as the distance x . Therefore, potential gradient will be maximum when x is minimum *i.e.*, when $x = d/2$ or at the surface of the conductor. On the other hand, potential gradient will be minimum at $x = D/2$ or at sheath surface.

Maximum potential gradient is,

$$g_{max} = \frac{2V}{d \log_e \frac{D}{d}} \text{ volts/m} \quad [\text{Putting } x = d/2 \text{ in exp. (iii)}]$$

Minimum potential gradient is,

$$g_{min} = \frac{2V}{D \log_e \frac{D}{d}} \text{ volts/m}$$