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

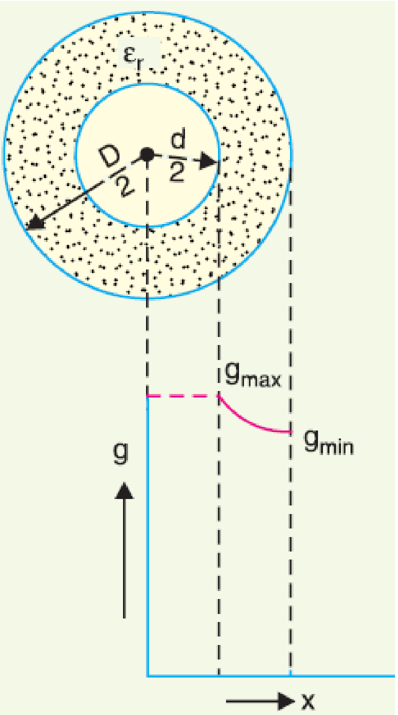

Figure 4.7.1 Potential Gradient – Cable

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

$$E_x = \frac{Q}{2\pi \varepsilon_o \varepsilon_r x} \text{ volts/m}$$

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

$$g = E_x$$

$$g = \frac{Q}{2\pi \varepsilon_o \varepsilon_r x} \text{ volts/m} \qquad \text{.......(i)}$$

$$V = \frac{Q}{2\pi\varepsilon_o\varepsilon_r}\log_e\frac{D}{d} \text{ volts}$$

$$Q = \frac{2\pi\,\varepsilon_o\varepsilon_r V}{\log_e\frac{D}{d}} \qquad \text{.......(ii)}$$

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

$$g = \frac{\dfrac{2\pi\varepsilon_o\,\varepsilon_r\,V}{\log_e D/d}}{2\pi\varepsilon_o\,\varepsilon_r\,x} = \frac{V}{x\,\log_e\frac{D}{d}} \text{ volts/m} \qquad \text{.......(iii)}$$

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,

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

[Putting $x = d/2$ in exp. (*iii*)]

Minimum potential gradient is,

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