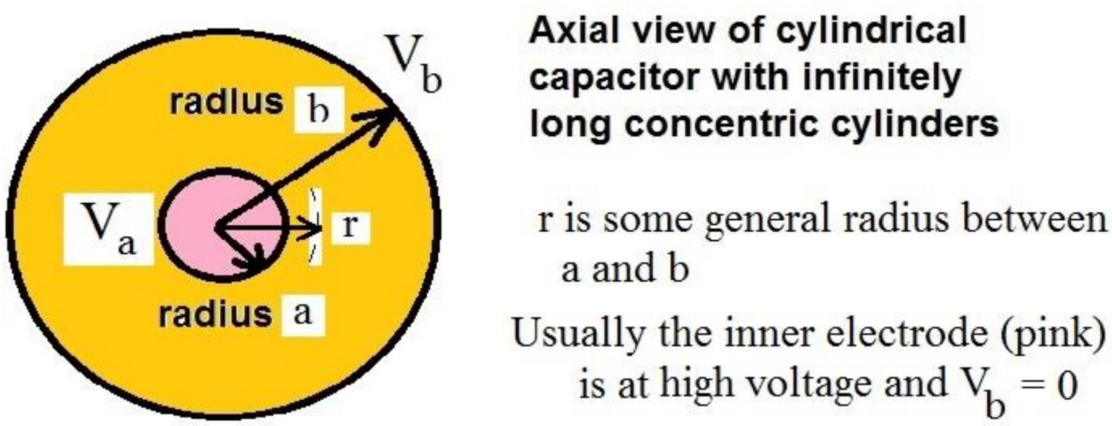
Electric field and potential for Concentric Cylinders



We use the Laplace equation in cylindrical coordinates to give:

$$\frac{1}{r}\frac{\partial}{\partial r}(r\frac{\partial V}{\partial r}) = 0$$

Since the right hand side of the equation is zero this equation reduces to-

$$\frac{\partial}{\partial r}(r\frac{\partial V}{\partial r}) = 0$$

Integration gives $r\frac{\partial V}{\partial r} = A$ where A is a constant.

Integration again gives $V = A\ln(r) + B$ (1)
where B is the second integration constant.

Now the boundary conditions are applied.

When r = a, V = V_{HT} the high voltage supply
When r = b, V = 0

So V_{HT} = A.ln(a) + B and 0 = A.ln(b) + B

Thus B = - A.ln(b) and V_{HT} = A(ln(b) – ln(a))

Now in equation 1 (for a general value of r) the voltage is given by

V = A. ln(r) – A. ln(b)

Giving V = - A. ln(b/r) where A = V_{HT} /ln(b/a)

Therefore
$$V = -V_{HT} \frac{\ln(b/r)}{\ln(b/a)}$$

Now vector **E =** $-\dfrac{\partial V}{\partial r}$ **r with r being unit vector**

So the magnitude of E is

E = V_{HT} /{r.ln(b/a)}

And E is in an outwards direction.