2021A28

CABLING, RESISTIVITY

ANSWERS

Level 1: First, let's begin with our resistance equation that uses resistivity:

$$R = \frac{\rho L}{A}$$

We have two of these variables calculated. ρ and L are 0.00000001 Ω -m and 40 meters respectively. All we need is to calculate the cross-sectional area of the cable. We have the diameter as 5 centimeters, or 0.05 meters, of the copper in the cable which is the portion that will be conducting electricity. We need to find the area of a circle from this diameter.

$$Area\ of\ Circle = \pi * r^2 = \pi * (\frac{d}{2})^2$$

$$Area\ of\ Circle = 3.14 * (\frac{0.05m}{2})^2$$

$$Area\ of\ Circle = 3.14 * (\frac{0.05m}{2})^2$$

$$Area\ of\ Circle = \ 0.002\ m^2$$

Now, we have everything that we can plug into our equation for resistance.

$$R = \frac{0.00000001\ \Omega\text{m} *\ 40m}{0.002m^2} = 0.0002\Omega$$

Nice! A low resistance in our cabling means we can deliver more wind energy to our customer!

Level 2: We need to choose between the two provided options for cables, but thankfully, we already know a lot about resistivity and resistance from the Level 1 question. Let's find the cross-sectional area of each cable. First, we'll do the circular cable, as we are familiar with it from the Level 1 question.

$$Area\ of\ Circle = \pi * r^2$$

$$Area\ of\ Circle = 3.14 * (0.07m)^2$$

$$Area\ of\ Circle = 0.015\ m^2$$

Second, we'll do the triangular cable.

$$Area\ of\ Triangle = \frac{\sqrt{3}}{4} * s^2$$

$$Area\ of\ Triangle = \frac{\sqrt{3}}{4} * 0.08m^2$$

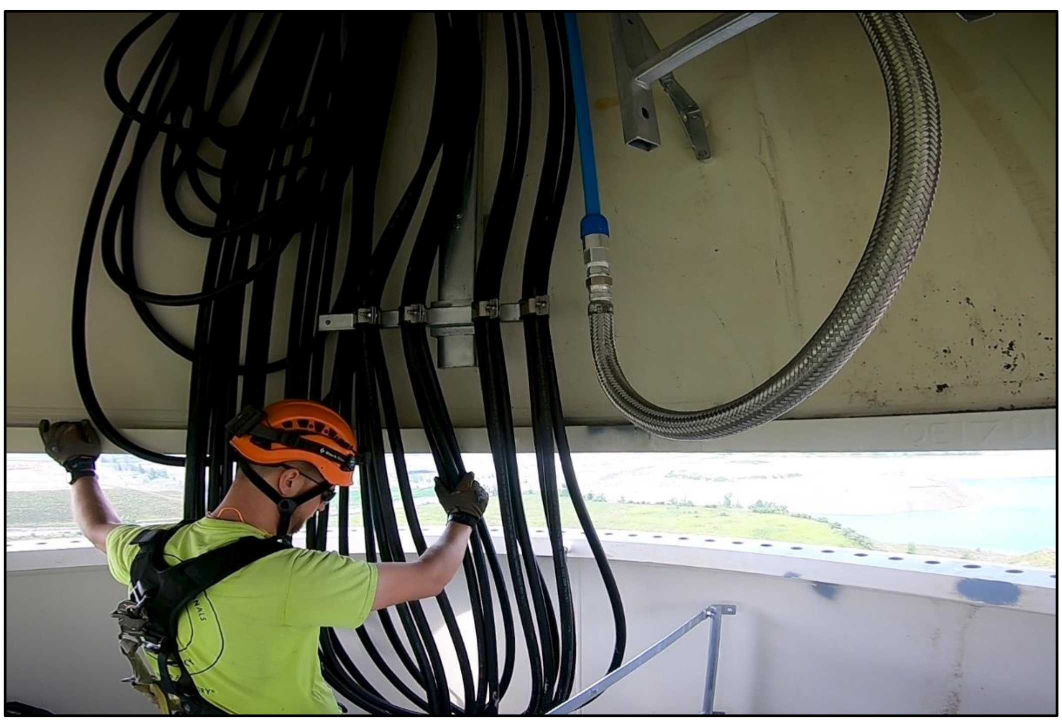
$$Area\ of\ Triangle = 0.0028m^2$$

Great! Now, let's calculate the resistance of each cable.

$$Resistance\ of\ Copper = \frac{0.00000001\Omega\text{m} * L}{0.015m^2} = 0.0000007\frac{\Omega}{m} * L$$

$$Resistance\ of\ Aluminum = \frac{0.000000027\Omega\text{m} * \text{L}}{0.0028m^2} = 0.00001\frac{\Omega}{m} * L$$

But wait… we don't have the length. However, it doesn't matter for this problem! We know that the cables are the same length, so their resistances will grow proportionally with the length. Therefore, we just need to look at the coefficient in front of the length; the smaller value there will be our preferred cable. Because the copper cable has a smaller coefficient, that cable will have less resistance and less energy loss when transmitting electricity.



Thick cabling can be seen as One Energy lowers one tower section onto another. These cables carry power all the way down the turbine and then on to our customers!