

## Transmission of Electrical Power : Notes/W.S.-50

A very important use of transformers is to step up the voltage that is produced by a generator. This allows current to be transferred over long distances with little loss of power.

In order to see how this happens, we compare the power output to the power input of the transformer. If the transformer is efficient,  $P_{\text{out}} = P_{\text{in}}$ , or;

$$I_s \mathcal{E}_s = I_p \mathcal{E}_p$$

This can be rewritten;

$$\frac{\mathcal{E}_s}{\mathcal{E}_p} = \frac{I_p}{I_s}$$

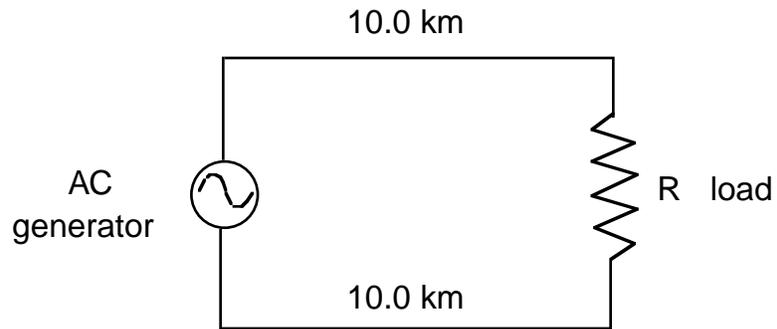
This means that if the voltage is stepped up, then the current is stepped down. Electrical power is generally transmitted at a high voltage because the current should be small to minimize energy losses due to the heating of the transmission lines.

The resistance of a wire (usually copper or aluminum) can be large if the length of the wire is many kilometers long. The energy lost due to this resistance per unit time is;  $P = IV = I^2R$ . Since the power loss due to heating is proportional to  $I^2$ , the current must be minimized, so that less energy is lost due to heating the wire, and more energy is transmitted to the load.

Problems:

- 1) A step-up transformer is used to transform a generator voltage from 120 volts to 1500 volts. The primary current is 5.0 amps. Find the secondary current.
- 2) A copper wire has a resistance per unit length of  $5.40 \times 10^{-3} \Omega/\text{m}$ . (the resistance depends on the diameter of the wire, small diameter wires have a larger resistance)

A pair of wires is used to transmit A.C. electrical power to a load as shown below. Answer the following questions.



- a) Find the resistance of 20.0 km of the wire.
  - b) How can this resistance be decreased?
  - c) If the average current in this wire is 0.72 amps, find the power loss due to the heating of the wire.
  - d) If the voltage is stepped up by a factor of 10., find the new power loss due to heating.
- 3) If a power company decreases the current in its transmission lines by a factor of 50. (power doesn't change), by what factor is the energy loss due to heating reduced?

Answers: 1) 0.40 amps, 2)a) 108 ohms, b) Use a thicker wire., c) 56 watts, d) 0.56 watts, 3) 2500