Copper and Electricity: Introduction

Answers

1. At 99.5% efficient, transformers are the most efficient part of the distribution system. However, they still waste the equivalent of 100,000 tonnes of oil per year. Imagine we improved their efficiency to 99.7%. How much oil equivalent would this save?

0.5% waste represents 100,000 tonnes. So 0.3% waste would be 3/5 ths of this i.e. 60,000 tonnes. Therefore the saving would be 40,000 tonnes per year.

2. The voltage drop across 1 km of copper cable is 30 V at 500 A.
Calculate the resistance.

$R = V / I$ = 30 V / 500 A = 0.06 Ω

3. In a piece of metal, when no current is flowing, the conduction electrons are moving around randomly.
What is their average velocity?

Average velocity is zero; recall that velocity is a vector quantity, and there are as many electrons with negative velocities as positive velocities.

4. The conventional direction of an electric current is the opposite of the direction of motion of the electrons that carry it. Why do you think this is so?

The convention was based on an arbitrary choice of which terminal of a cell should be positive and which should be negative. The direction of the current was then chosen to be from positive to negative on the assumption that the charge carriers were positive (before the discovery of the electron). Unfortunately, once it was found that the electron carried the current, it was too late to change.

5. Calculate the drift velocity of electrons in a copper wire of cross-sectional area 1 mm^2 when a current of 2.5 A flows through it. (For copper, n = 8.5 × 1028 per m^3. The charge on an electron, Q = 1.6×10^{-19} C)

$v = I / nAQ = 0.18 \text{ mm s}^{-1}$

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