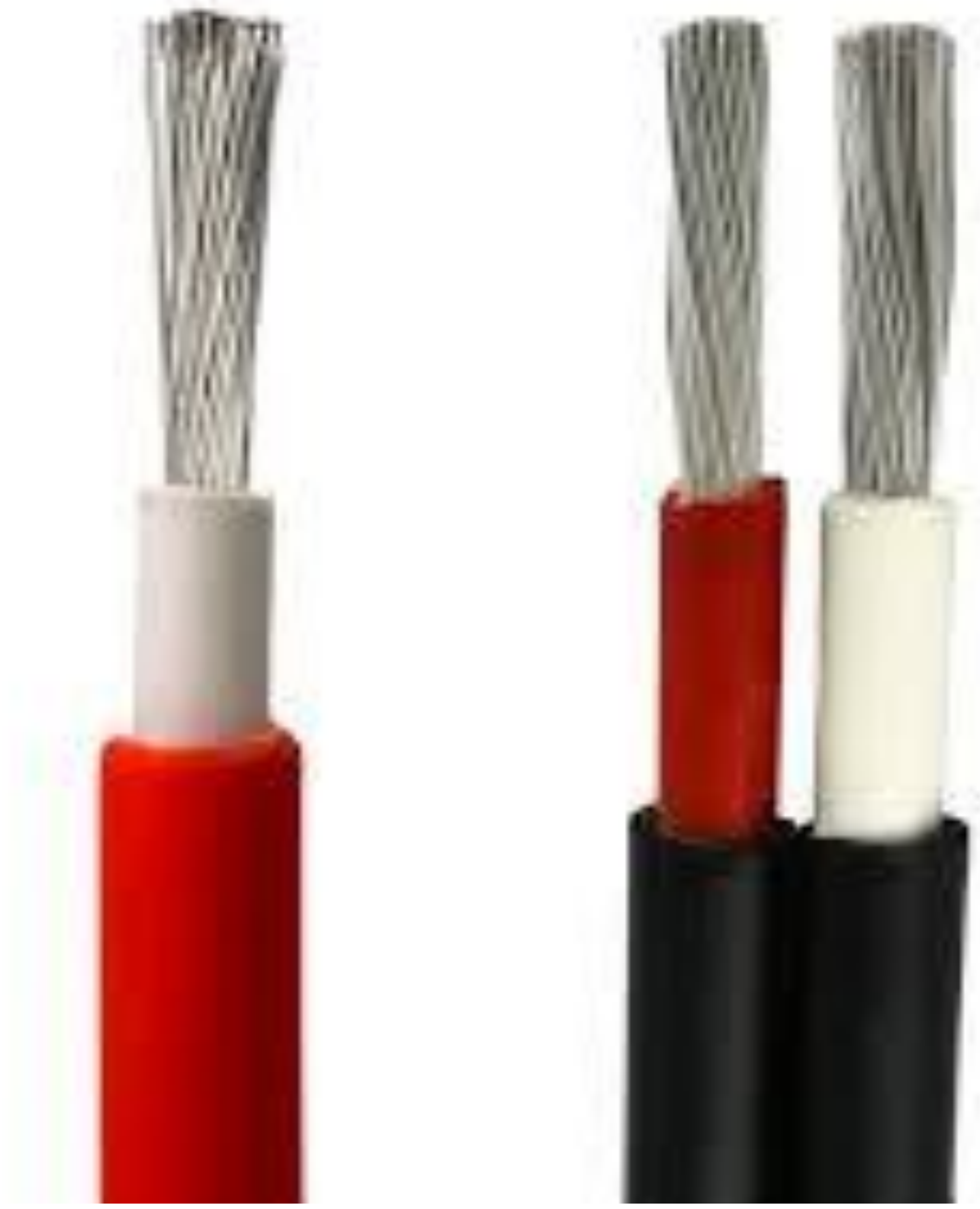
Conductor sizing

Single-core vs Multi-core cables

- Single-core cables: they have only one metal conductor and are often used for high voltage power transmission

- Multi-core cables: they have at least two (or more) conductors and are usually used in low voltage control or communication systems



https://www.jzdcable.com/news/Industry-News/what-is-the-difference-between-single-core-cable-and-multi-core-cable.html

Problem #1:

How to facilitate heat dissipation?

Definition: When a strong current is passed through a high voltage cable, heat and power loss occur. If the heat level gets too high, it can have a negative effect on the life of the cable

Solution #1:
Heat balance method

$$d = \sqrt[3]{\frac{4 \cdot \rho \cdot I^2 \cdot 10^3}{\pi^2 \cdot \lambda \cdot \Delta t}}$$

- d: minimum diameter of the conductor
- ρ: resistivity of the conductive material
- Δt: difference between the maximum temperature that can be tolerated and that of the external environment
- I: current flowing through the conductor
- λ: thermal conductivity coefficient (Air = 15 W/(°C*m^2)])

Problem #2:

How to prevent a voltage drop?

Definition: Voltage drop is the reduction in voltage in an electrical circuit between the source and the load.

Voltage drop is the amount of voltage loss that occurs through a circuit due to its resistance.

Solution #2:
Maximum voltage drop method

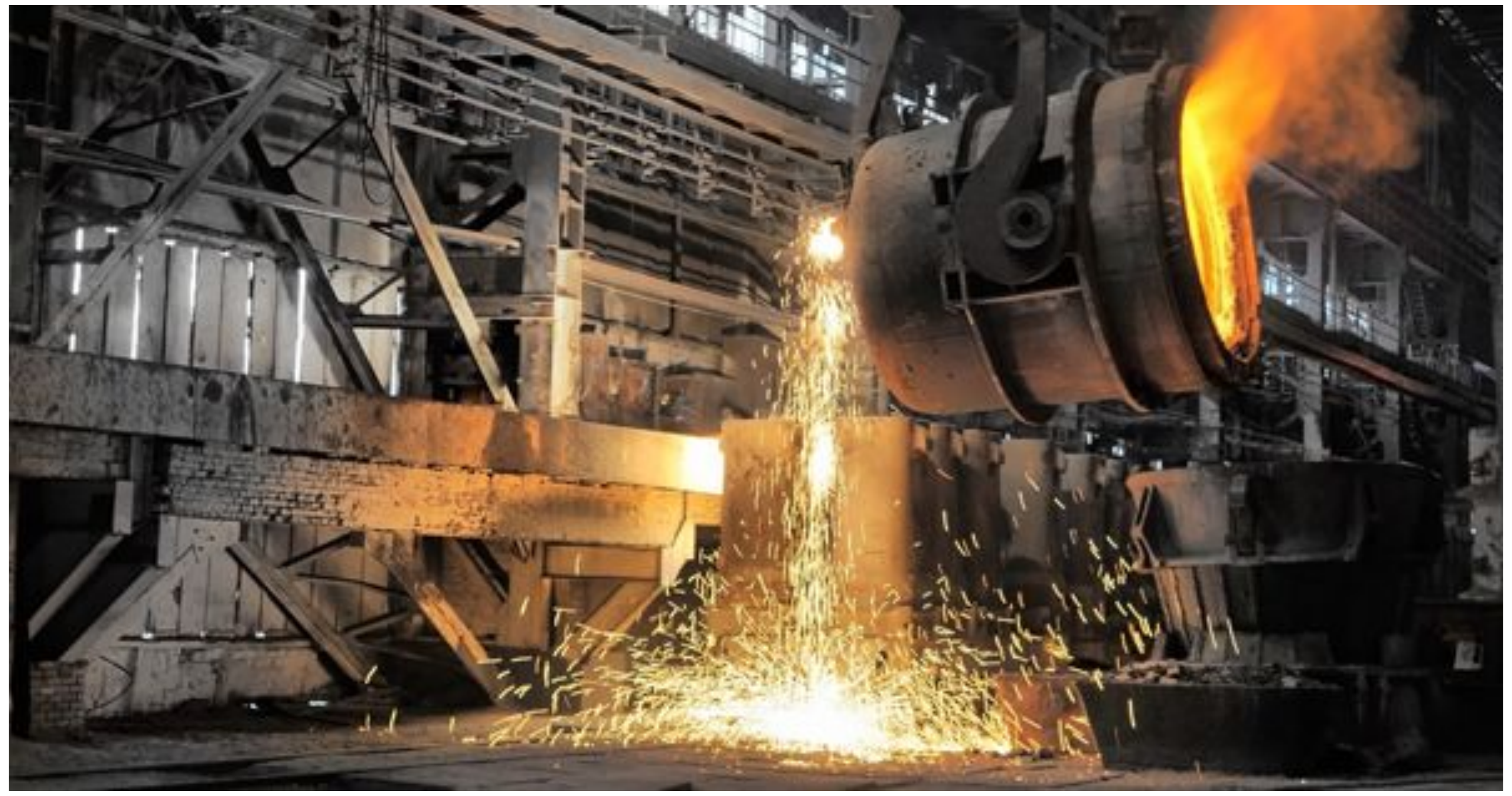
$$S = \frac{2 \cdot \rho \cdot l \cdot I}{\Delta V}$$

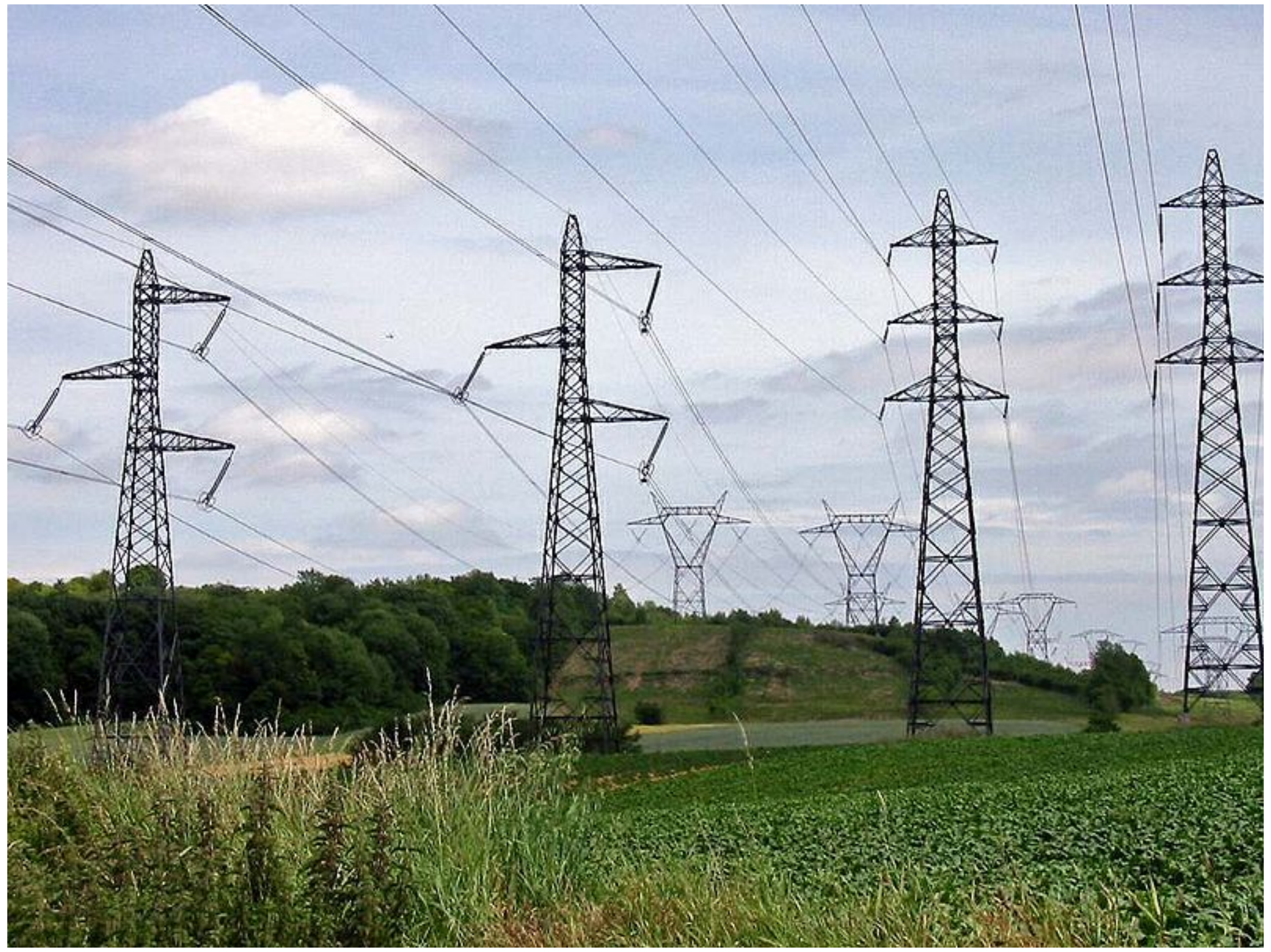
- S: section of the conductor
- ρ: resistivity of the conductive material
- l: length of the conductor
- I: current flowing through the conductor
- ΔV: maximum acceptable voltage drop

Discussion topic:

Are you able to find practical cases in which it is necessary to use the two methods?

HINTS:





Exercise 1: Sizing a cable for an industrial foundry

An industrial foundry requires a cable to power a machine consuming 50 kW of electrical power. The foundry operates in an environment with an ambient temperature of 50°C. Using the thermal balance method and assuming a maximum allowable cable temperature of 100°C, calculate the minimum cross-sectional area of the cable required to prevent overheating.

Exercise 2: Sizing a cable for a desert-based application

A solar power plant located in the desert needs a cable to connect its photovoltaic panels to the main grid. The total power generated by the panels is 100 kW. The desert environment experiences extreme temperatures, with an ambient temperature reaching up to 60°C. Using the thermal balance method and assuming a maximum allowable cable temperature of 90°C, determine the minimum cross-sectional area of the cable needed to ensure safe operation under these conditions.

Exercise 3: Sizing a cable for an outdoor lighting system

An outdoor lighting system consists of a series of LED lamps powered by a central transformer. The distance from the transformer to the farthest lamp is 100 meters, and the system operates at a voltage of 12V DC. The maximum allowable voltage drop is 5% of the system voltage. Determine the minimum cross-sectional area of the cable needed to ensure proper illumination, given a maximum current of 10A.

Exercise 4: Sizing a cable for a remote power supply

A remote telecommunications tower requires a cable to connect the power source to the equipment at the top of the tower. The tower is located 200 meters away from the power source, and the system operates at a voltage of 48V DC. The maximum allowable voltage drop is 2% of the system voltage. Calculate the minimum cross-sectional area of the cable necessary to maintain reliable power delivery, considering a maximum current of 30A.