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Measuring the temperature field of infrared heaters

Measurement tasks:

1. Measure the warming curve of a flat thermocouple when irradiated with different types of infrared illuminator and at different distances.
2. Measure the radiation fields for different types of infrared radiators and different distances from the measurement plane.
3. Enter the measured values in the graphs.

Theoretical introduction:

Infrared radiation is electromagnetic waves that are invisible and carry heat energy. The wavelength range of infrared radiation is from 760nm to 10,000nm. The formation of infrared radiation is related to processes within the atoms and molecules of the radiation source. If one of the electrons orbiting the nucleus of an atom is moved by external forces to a path with a larger radius and also a larger energy level, the atom enters an excited state. In this state, the atom remains for a very short time and when the electron returns to its original orbit, the excess energy is radiated to the surroundings in the form of electromagnetic radiation.

An infrared radiation source is any body that is in a transparent environment and has a temperature greater than 0 K. It radiates energy through its surface to the surroundings, but at the same time receives energy radiated by other bodies. The radiant energy that is absorbed by the opaque body is converted into thermal energy. Depending on the conditions of energy conversion, a body either heats up if it receives more energy than it radiates, or cools down if its radiating energy predominates.

Infrared radiation is mainly used for heating substances. If radiant energy is incident on the surface of a body, its temperature will initially rise quite rapidly and with it the body's own radiation to a cooler neighborhood. After some time, a steady state temperature condition is established where the temperature of the irradiated body is constant and independent of time. This implies that the radiant energy captured by the body and converted to heat inside the body is balanced by the amount of heat lost from the surface of the body by flow and radiation to the surrounding environment.

In industrial heating, due to the relatively small unit input power of infrared heaters, it is necessary to use a larger number of them simultaneously and arrange them in a so-called radiant field. In doing so, it is ensured that the incident radiant flux is distributed as evenly as possible over the area to be heated so that the entire area is heated to the same temperature. This depends on the appropriate composition of the radiation characteristics of the neighbouring radiators located in the radiation field. The radiation characteristics of the emitters, i.e. the distribution of their radiant flux in space, are influenced by the shape of the emitter itself and of the additional reflector. Under certain assumptions, radiant flux measurements can be converted to temperature measurements.

Measurement description:

Make the first measurement with the infrared heater in Figure 1 (for 2 selected distances of the infrared heater from the aluminium plate). There are 25 Fe-Ko thermocouples on the aluminum plate, which you will use to sense the temperature at various points on the irradiated plane. Take temperature readings only after they have stabilized. Take measurements for 2 selected distances of the infrared radiators from the aluminium plate.

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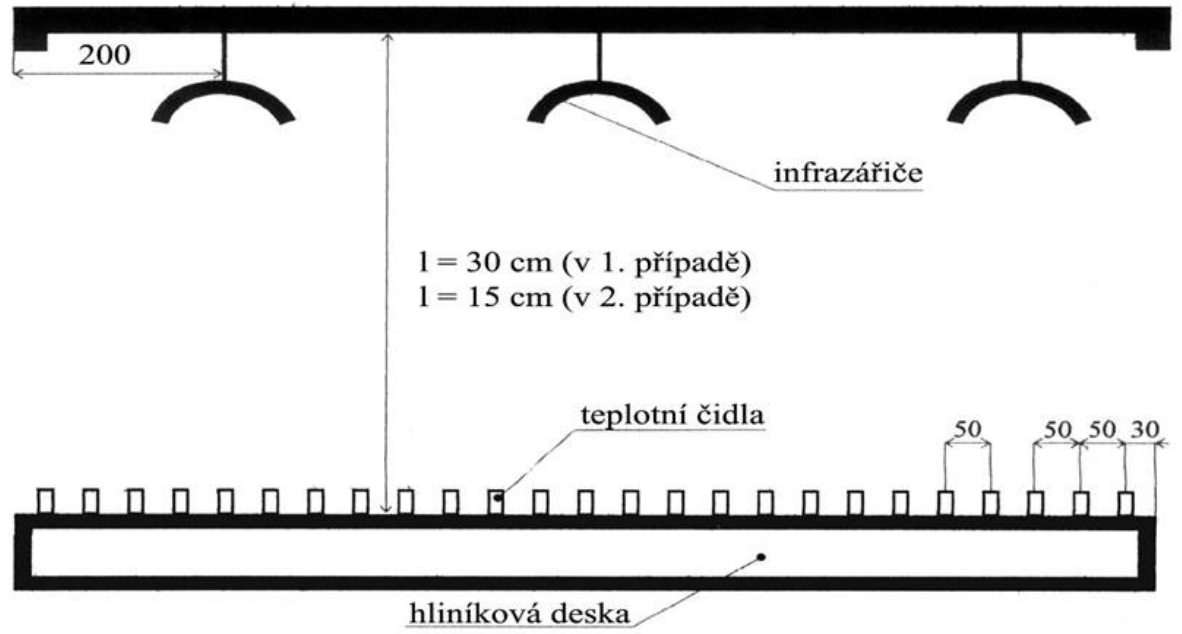


Fig. 1

Perform the second measurement with the area infrared radiator in Figure 2. There are 49 Fe-Ko thermocouples on an aluminium plate, which you will use to sense the temperature at different points on the irradiated plane. Take temperature readings after they have stabilized. Take measurements for two selected infrared mushroom radiators or for two selected distances of the infrared radiator from the aluminium plate.

In both measurement cases, the minimum distance of the infrared heater from the aluminium plate is 15cm to avoid damaging the thermocouples.

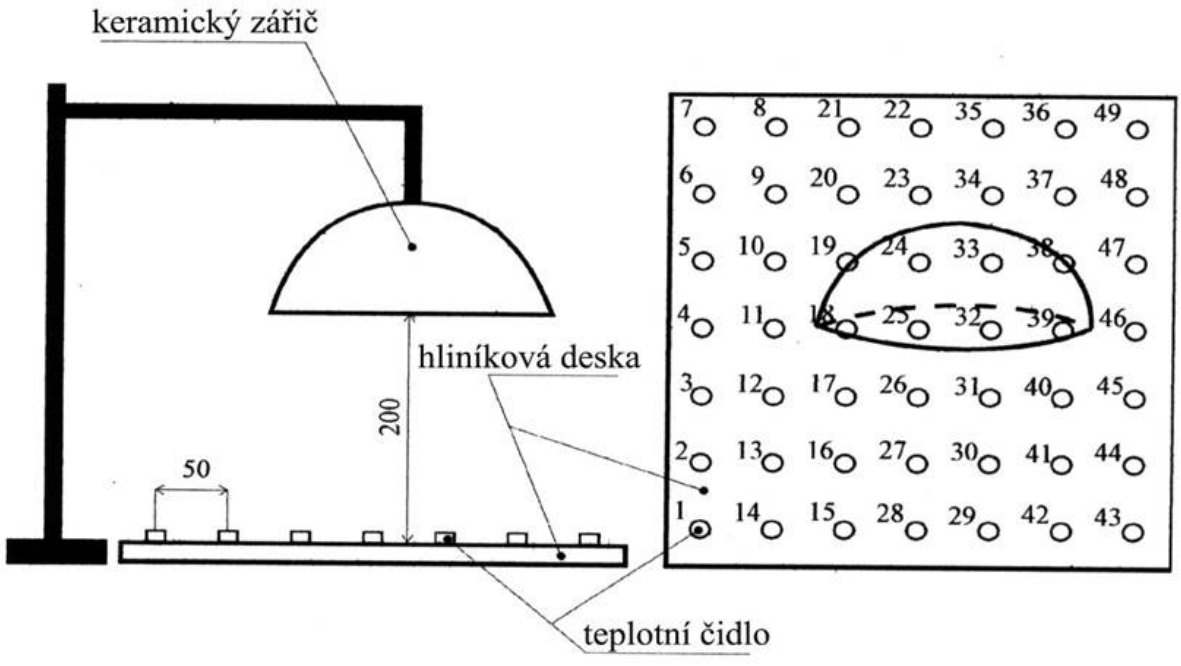


Fig. 2

Table with measurement values:

Graphs:

Determine the wavelength (using Wien's law)

$$\lambda T = 2898[\mu m]$$

Conclusion: