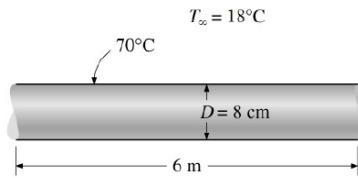


# Lecture 4

## 4.1 Cooling of a hot water pipe

A 6-m-long section of a horizontal hot water pipe with a diameter of 8.0 cm passes through the basement of the Oosthorst. The temperature in the basement is 18 °C and the complete outer surface of the pipe is 70 °C. Determine the rate of heat loss from the pipe by convection.



## 4.2 Convection of heat from a coffee machine

When the can of a coffee machine is removed and the machine is still switched on, the heater plate just heats the air above. Consider a 16-cm-diameter circular heating plate in a surrounding which is at 20 °C. It is measured that the heater plate consumes 90 W of electricity. Assuming that 52.4% of this power is emitted by thermal radiation and the other part by natural convection, find the equilibrium temperature of the heater plate surface. Hint: some plastic and soldered parts directly around the heater plate have a melting point around 250 °C. The manufacturer guarantees that this temperature will not be exceeded.



## 4.3 Heat convection parameters

List all fluid and flow parameters influencing the heat transfer coefficient  $h$ , directly or indirectly, for forced as well as for natural convection. Explain how they affect the heat transfer coefficient.

#### 4.4 Light bulb temperature

Consider a 25 W lightbulb with a light-efficiency of 10 %. The lightbulb has a diameter of 8.0 cm, and an outside temperature of 25 °C. When assuming all heat is lost due to natural convection, determine the surface temperature of the lightbulb.



## 4.5 Cooling of a head - Hand-in

An average person generates heat at a rate of 100 W while resting in a room at 21 °C. One-tenth of this heat is lost from the head by convection. The head can be approximated as a sphere with a diameter of 0.30 meters. Radiative losses are negligible.

- a) Determine the average surface temperature of the head.

While skiing, people wear a protective balaclava hat that envelops the entire head, serving as a safeguard against the frigid conditions. When using the balaclava hat only 7.5% of the person's generated heat is lost through the head by natural convection. This balaclava hat is made from merino wool, a material endowed with a thermal conductivity measuring 0.03 W/mK and a thickness of 5 mm. After skiing, the ambient temperature drops to a chilling -10 °C.

- b) Determine again the average surface temperature of the head while standing still.
- c) Sketch the temperature profile showing how the temperature changes from the center of the head to the surrounding cold air.