Approach

The approach below gives a guideline in how to solve the problems presented during this course. Correctly applying this approach will lead to a good understanding of the concepts presented in this course.

Analysis

1 Explain the problem: which physical phenomena are important in this problem?

2 Make a sketch of the problem

3 Give the known variables (with the appropriate units!)

Approach

1 Explain the assumptions you make to solve the problem

2 Show the solution method for solving the problem

Elaboration

1 Show the calculation steps and explain the equations you use

2 Give references if values are found online or in tables

Evaluation

1 Check the units of your solution

2 Is the answer realistic/expected?

3 Did you answer all the questions asked?

4 Iterate if this is required

Assignment 1

Consider an drip coffee machine like the one shown. Electrical energy is converted to heat by use of a heating element. The drip coffee machine is rated at a power of 1200 W. Initially, the water has a temperature of 20 ^{o}C. When it drips into the filter, the water has a temperature of 94 ^{o}C.

Suppose we would like to set 8 cups of coffee ($\rho = 1$ g/cm^3, $c_p = 4.2$ kJ/kgK), all containing 200 mL.

a) How long will it take for all the water to reach the temperature of 94 ^{o}C?

b) Determine the current through the heating element, if the applied voltage is 230 V. Also determine the resistance of the heating element.

c) Determine the cost of energy for setting 8 cups of coffee. Take the price of electricity to be 0.15 €/kWh

The coffee is served at a temperature of 80 ^{o}C. After serving, one cup is mixed with 5 mL of coffee milk ($\rho = 1.1$ g/cm^3, $c_p = 3.9$ kJ/kgK) at a temperature of 10 ^{o}C. When stirred, the coffee with milk has a homogeneous temperature.

d) Determine the temperature of the coffee with milk after stirring. Heat losses can be neglected.

A product designer has the idea to bring a portable coffee maker on the market for cyclists. The principle is that a coffee maker converts 30% of the kinetic energy into thermal energy to make coffee.

From a standstill, a mountain biker goes from the top of a mountain ($h = 50$m) all the way to the valley, without pedalling and any frictional losses. In the valley, the coffee maker starts to work and he starts pedalling so his velocity remains constant. 30% of the power that he delivers is used for the coffee maker. The power delivered by pedalling can be described as:

$$P = 4.8 \cdot v$$

Where P describes the Power [W] and v the velocity of the mountain biker [m/s].

e) Determine the time that the mountain biker has to pedal in the valley, before he has prepared one cup of coffee. The initial temperature can be assumed to be 20 ^{o}C and it should reach 94 ^{o}C again.

During the coffee break, the cyclist eats some chocolate chip cookies as well (=195 kcal each).

f) How many of these cookies contain the same amount of energy that was used for the preparation of the coffee?

g) Why would eating this amount of cookies not be enough in the real world situation to set this cup of coffee?