Non-equilibrium thermodynamics
Exercise 1
Introduction

1

a) According to your experience so far, and the texts in Chapters 1 and 2 in [1] or [2], what are the most important advantages of non-equilibrium thermodynamics?

b) What transport equations for heat, mass and charge have you learnt in other courses?

2

a) Calculate the work available by mixing 1 mole of water into an excess of sea water. The water concentration in sea water is 54.9 $kmol/m^3$, while it is 55.6 $kmol/m^3$ in pure water. The temperature is 300 K.

b) What happens to this work when fresh water is mixed irreversibly with salt water (like in nature where a river meets the sea)?

3

In a power plant, assume that 73 MW thermal energy is delivered from a reservoir at 1150 °C to the turbine. The turbine produces 25 MW mechanical power. The ambient temperature is 8 °C.

a) What is the first law efficiency for the process where thermal energy is transformed into mechanical energy?

b) What is the second law efficiency of the process?

c) What is the lost work of the process?

d) What is the maximum (theoretical) attainable value for each of the efficiencies?

e) What is the difference in the way lost work is calculated in exergy analysis compared to in non-equilibrium thermodynamics?

f) What is the relation between the 2nd law efficiency and the entropy production?

References

[1] Signe Kjelstrup, Dick Bedeaux, Eivind Johannesen, and Joachim Gross. *Non-Equilibrium Thermodynamics for Engineers*. World Scientific, 2010.

[2] Signe Kjelstrup, Dick Bedeaux, and Eivind Johannessen. *Elements of Irreversible Thermodynamics for Engineers*. Tapir, 2nd edition, 2006.