

CHEM-C2150 PROCESS DESIGN

Exam: 13.4.2022 time: 9-13

During the exam:

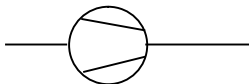
- Read the questions very carefully!
- Answer with pen and paper. Pay special attention to your handwriting and clarity of your answers! Answer in English, Finnish or Swedish.
- Clearly mark the question numbers to your papers.
- Use appropriate units in your calculations & answers.
- Avoid logging out from MyCourses during the exam.
- Avoid leaving the submission box during the exam.

Submitting your answers:

- Write your name and student number on each page.
- Take photo of each page with your smart phone.
- Collecting all photos into one file, e.g. Word, is highly recommended.
- Name your submission with student number. If you have multiple files, name each of them with your student number and page number, for example 123456_1.xxx.

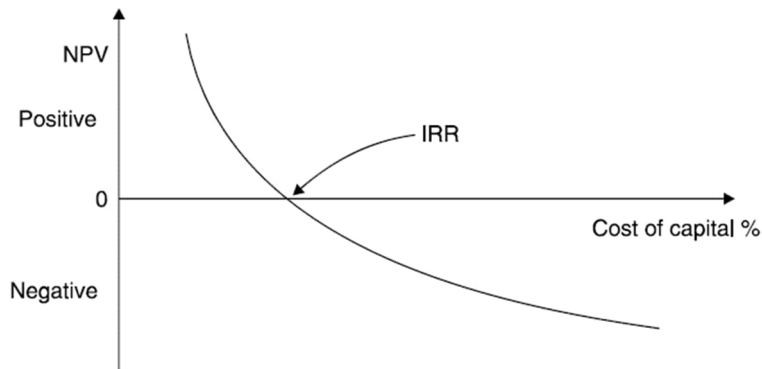
THEORY PART: (30 points)

1. (5p) What are the basic data needed for a process design?
2. (5p) What is the below equipment and how to size it.



3. (5p) What is meant by the minimum temperature difference (ΔT_{\min}) in the Pinch method and how it is selected?
4. (5p) What is the main difference between shortcut calculation models and rigorous models?
5. (5p) Explain shortly:
a) FICA, b) DC-201, c) JD-101, d) SV, e) WC

6. (5p) Explain the below Figure:
Net present value (NPV) vs Internal rate of return (IRR)



CALCULATION PART: (30 points)

7. (30p) In the following process, 2.5 t/h of fluid (density 800 kg/m³, $c_p = 2.5$ kJ/kg C) is pumped from FA-1 (at atmospheric pressure) to FA-2 (pressure 350 kPa). The stream is heated in EA-1 heat exchanger from 20 °C to 100 °C. The fluid is a light hydrocarbon mixture with a vapor pressure similar to water. The heating agent is at 3 bar steam ($t=133.65$ °C, $h = 2725.7$ kJ/kg and $l = 2164.2$ kJ/kg). The entire length of the pipe is about 100 m and you can assume that 30 m of the pipe is before the pump. The heights of the equipment from the ground are shown in the Figure.

- (10p) Size the pump GA-1 (head of the pump, NPSH, hydraulic and shaft power)
- (10p) Size the heat exchanger EA-1 (duty, area and amount of steam needed)
- (5p) Size all the pipes marked with solid line
- (5p) Add necessary basic controls and control valves for the whole process. (We want, constant feed to the reactor DC-1).

