Aalto University
School of Chemical Technology

CHEM-E6140: Fundamentals of Mineral Processing and Recycling
Final Exam
18.10.2023

INSTRUCTIONS:

Please use the provided Excel template for all your calculations and to write your answers.
The data in the instruction given as x.xx are the values different for every student. The x.xx values can be found in the Excel template.
***It is not allowed** to use course materials during the exam, and it is strictly forbidden to browse the internet or use any form of online communication. However, you are allowed to have a one page 'cheat sheet' (1 page, A4 format, double sided, printed) – a concise set of notes (for example with all equations) that you prepared before the exam.*
*Please submit the exam (Excel file) **until 13:00 on 18. October 2023.** Use the submission box available in Section 'Final Exam' on MyCourses web page. Late submissions will not be accepted.*

1. Thermoelectric devices (TEDs) are solid state devices capable of converting a temperature gradient into electric power. As the interest for alternative sources of energy grows, it is expected that the demand for TEDs will increase in the future. As a consequence, your company is considering the development of a recycling process for TEDs.
A sample from commercial TEDs received by your company revealed that they have the following composition:

Fraction	Mass (g)
Semiconductor (Bi_2Te_3)	x.xx
Connectors (Cu)	x.xx
Ceramic (Al_2O_3)	x.xx

- What is the chemical composition of TEDs (15 points)?

(Atomic masses (g/mol) are: Bi = 209; Te = 128; Cu = 63,5; Al = 27; O = 16)

2. After grinding a TED sample with a ring mill, the size distribution in the Table below was found. Generate a distribution function based on the Gates-Gaudin-Schumann model and provide a d_{50} value for this population (15 points)

Size fraction	Mass retained in sieve (g)
<125 µm	x.xx
125-250 µm	x.xx
250-355 µm	x.xx
355-500 µm	x.xx
500-1000 µm	x.xx
1000-2000 µm	x.xx
2000-3350 µm	x.xx
>3350 µm	x.xx

3. After grinding the TED samples, they were mixed with water to produce a slurry containing 12% of solids in a stirred tank. It is planned that the slurry will be transported from a stirred tank to a conditioning tank right before the concentrator. If the flowrate of slurry is 120 ton/h, determine the pumping power required (in KW) (30 points).

- The total pipe length between the stirred suspension tank and the preparation tank is x.xx m and the concentrator is x.xx m higher than the stirred tank (the presence of instruments and corners in the pipeline is negligible)
- The pipe is made of steel (commercial) and has an inner diameter of 12 cm
- The solid density of the TED particles is 2,9 ton/m^3
- The slurry's viscosity is 0,9 cp and it can be assumed to behave as a Newtonian fluid

4. The sieved fractions produced in Problem 2 were analyzed using QEMSCAN to determine their mineralogical composition, found in the Table below.

- Produce separability curves for the TED components (10 points)
- Since the connectors are the most valuable components: which set-point would you propose to recover at least x.xx % of Cu, with the best possible grade? (15 points)

- What is the best Cu grade achievable with this recovery? (15 points)

Fraction (µm)	Bi_2Te_3	Al_2O_3	Cu
<125	20%	80%	0%
125-250	13%	87%	0%
250-355	7%	93%	0%
355-500	6%	94%	0%
500-1000	4%	96%	0%
1000-2000	1%	36%	63%
2000-3350	0%	62%	38%
>3350	0%	24%	76%

Diagrams

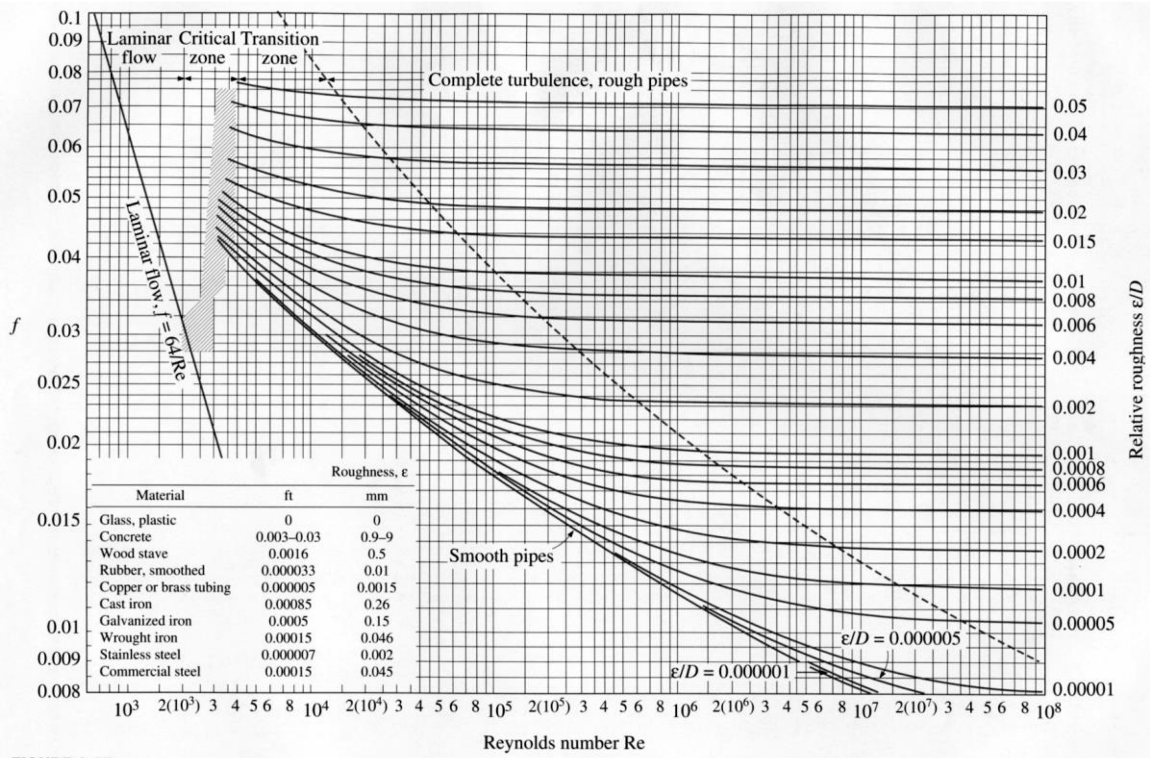

FIGURE A-27

The Moody chart for the friction factor for fully developed flow in circular tubes.

R. Serna and A. Klemettinen