

CHEM-E6140: Fundamentals of Mineral Processing and Recycling
Final Exam
20.10.2020

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 allowed to use course materials during the exam. However, it is strictly forbidden to browse the internet or use any form of online communication.

Please submit the exam (Excel file) **until 12:00 on 20. October 2020**. 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/m³
- 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

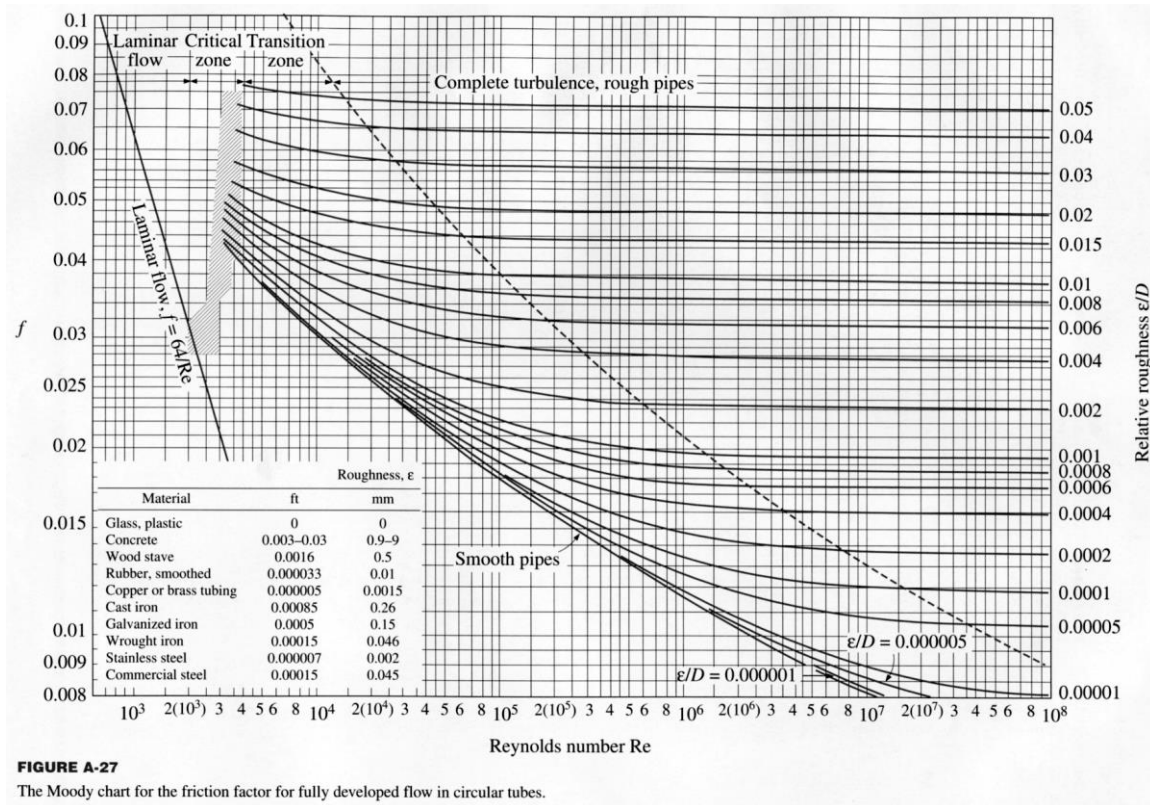


FIGURE A-27
The Moody chart for the friction factor for fully developed flow in circular tubes.

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