ME-446

Liquid-gas interfacial heat and mass transfer

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Cursus	Sem.	Type
Energy Science and Technology	MA1, MA3	Opt.
Mechanical engineering minor	H	Opt.
Mechanical engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	3
Session	Winter
Semester	Fall
Exam	Written
Workload	90h
Weeks	14
Hours	**3 weekly**
Lecture	2 weekly
Exercises	1 weekly
Number of positions	

Summary

This course covers the fundamental and practical analysis of liquid-gas interfacial heat and mass transfer in various contexts including power generation, water purification, and cooling. Students will learn about the multiscale physics involved in evaporation, boiling, and condensation.

Content

1. Introduction to liquid-gas interfacial transport phenomena
2. Capillarity and wetting
3. Evaporation physics (diffusion-based model, kinetic theory treatment)
4. Boiling (onset of nucleation, nucleate boiling, critical heat flux, flow boiling)
5. Hydrogen production (bubbles from gas evolution reactions)
6. Condensation (filmwise, dropwise, jumping droplet)

Keywords

Interfacial phenomena, evaporation, boiling, hydrogen production, condensation, heat and mass transfer

Learning Prerequisites

Required courses

Undergraduate level courses in fluid mechanics, heat transfer, and thermodynamics

Important concepts to start the course

Basic understanding of:

- heat conduction, heat convection, and fluid flow
- thermodynamics of pure fluids
- mass, momentum, and energy conservation on both differential and finite control volume basis

Basic skills in MATLAB and/or Python

Learning Outcomes

By the end of the course, the student must be able to:

- Explain a wide range of capillarity-driven interfacial phenomena
- Model interfacial heat and mass transfer during phase change

- Optimize phase change systems for energy and water applications

Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Demonstrate the capacity for critical thinking
- Communicate effectively, being understood, including across different languages and cultures.

Teaching methods

The course is organized with lectures and exercises.

Assessment methods

25% Homework + 25% Final Presentation + 50% Final Exam

Supervision

Assistants	Yes
Forum	Yes

Resources

Bibliography

1. Carey, V. P. (Van P.). Liquid-Vapor Phase-Change Phenomena: An Introduction to the Thermophysics of Vaporization and Condensation Processes in Heat Transfer Equipment. Third edition. Boca Raton: CRC Press, 2020.
2. Lienhard IV, John H, and John H Lienhard V. A Heat Transfer Textbook. 5th ed. Mineola (N.Y.): Dover Publications, 2019.
3. Bird, R. Byron, Warren E Stewart, and Edwin N Lightfoot. Transport Phenomena. Rev. 2nd ed. New York: Wiley, 2007.

Ressources en bibliothèque

- Liquid-Vapor Phase-Change Phenomena / Carey, V. P. (Van P.).
- A Heat Transfer Textbook / Lienhard IV, John H, and John H Lienhard V.
- Transport Phenomena / Bird, R. Byron, Warren E Stewart, and Edwin N Lightfoot