Interfacial transport phenomena in engineering flows

Subject area: Mechanical Engineering

University:	TU/e
Level:	MA all years
Teaching mode:	hybrid: some students participate online, other students attend real-life
Instructor(s):	Dr. G. Finotello, Dr. N.O. Jaensson, prof. N. G. Deen

Short description

Apprehension and capacity to solve problems on thermodynamic processes concerning dynamic interfaces are the main educational targets. In addition students should become familiar with current engineering methods to solve heat and mass transport across a deforming interface.

Full description

"Multiphase flows are of prime importance in the automotive branch (injection of gasoline), in power engineering (steam atemperation), in agriculture (insecticides), in inkjet printers and in many fysiological transport processes in the food industry. Break-up of liquid filaments and coalescence of drops are essential processes in sprays and the development of structures in the mixing and dispersion of fluids. Transport of mass across a fluid-gas interface is important in the atmosphere and climate (rain), in-house climate control (humidity and temperature control), steam generation, and heat recovery in power plants, as well as in diffusion induced and flow-induced phase separation. The role of surfactants is of eminent importance for the so-called tears of wine, in polymer and food production and in drug-delivery systems. Diffusion in the surrounding gas phase with inert components prevents the sudden disappearance of the oceans, hampers heat transfer with condensation and eases combustion.
In this course, the conservation laws valid on an interface between a gas mixture and fluid will be derived. The focus is on systematic approach and solution methods and on the capability to solve the above-mentioned processes and related phenomena that occur during the transport of heat and mass across an interface. The conservation laws will be combined with principles of non-equilibrium thermodynamics to describe an interface thermodynamically via an additional stress tensor in the Navier-Stokes equations. The focus will be on fluid-fluid systems of several components. Simple engineering models for important applications will be based on fundamental descriptions. Examples of these applications are separation of phases, surface tension, diffusion and Marangoni convection, as well as the coupling of evaporation and chemistry in the gas phase.
Various topics will be considered in detail during lectures:
- Droplet evaporation in a gas mixture, including analytical and numerical solutions, the diameter squared law during evaporation, and comparison with experimental results.

- Gas-liquid flows mass transfer and reaction.
- Mass and Heat transfer in presence of chemical reaction in gas-solid systems."

Learning outcomes

"Students are able to
• describe the momentum, mass and heat transport phenomena with basic equations;
• develop the basic transport equations for processes at gas-fluid and gas-solid interfaces;
• apply solution methods for processes of interfacial transport phenomena;
• extend knowledge of interfacial transport phenomena to transport phenomena by means of computational fluid dynamics."

General information

Contact hours per week:	4
Total workload:	140 (in student hours for the whole course)
ECTS credits:	5
Language:	English
Course start date:	07 September 2022
Course end date:	28 October 2022
Add. info about start date:	
Weekly teaching day/time:	Lectures and Instructions for the assignment are all planned for the time: Wednesday, 15:30-17:30 and Friday, 10.45-12:45
Time zone:	CET (Denmark, Germany, France, Netherlands, Switzerland, Czech Republic)
Further information:	The course end date: 28 October (end of lectures) and 5 November (deadline of the Assignment III).
Prerequisites:	Students are assumed to know and master all the basic mathematics and concepts of Heat and Flow. In particular, students should have successfully passed, for instance: Calculus and Introduction Transport Phenomena.
Activities and methods:	Lectures, Seminars
Presence on campus:	

Final examination

Form:	assignment
Date:	05 November 2022
Location/format:	take-home group assignments
Re-sit possibility:	yes
Transcript available:	end of semester
Add. info/requirements:	"Deadline of the Assignments: 1. Assignment I, Submission deadline on Canvas: September 29. 2. Assignment II, Submission deadline: October 20. 3. Assignment III, Submission deadline: November 5 2022."

Registration

To register for this course, follow the registration requirements of your **home university** as specified here: www.euroteq.eu/courses-registration.

Administration

Number of places:	15
Minimum participants:	
Internal course code:	4BM60
Contact:	G.Finotello@tue.nl

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