ChE-330

Fluid mechanics and transport phenomena

Sivula Kevin

Cursus	Sem.	Type
Biotechnology minor	H	Opt.
Chemical Engineering	BA5	Obl.
HES - CGC	H	Obl.

Language of teaching	English
Credits	3
Session	Winter
Semester	Fall
Exam	During the semester
Workload	90h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

The concept of Shell balances, the Navier-Stokes equations and generalized differential balances equations for heat and mass transport are given. These relations are applied to model systems. Integral balances are introduced in the context of boundary layers and transfer coefficients.

Content

- Equations for molecular flow: material (Fick's law); heat (Fourier's law); momentum (Newton's law).
- Analogy between the three types of transfer (linked by their diffusivities).
- Non-Newtonian fluids (Bingham and Ostwald models, thixotropic and rheopectic fluids).
- Differential and integral mass balance.
- Derivation and application of the continuity equation.
- Integral and differential momentum balance.
- The Navier-Stokes equation (analytical solution for simple systems).
- The perfect fluid: Euler and Bernoulli equations, validity domain.
- Pressure drop in a complex flow circuit. Use of the Moody diagram.
- Momentum, heat and mass transfer in multiple variables systems (solving partial differential equations).

Keywords

Transport phenomena, Continuity equation, Navier-Stokes equation, Shell balance, Euler and Bernoulli equations, transfer in a system with multiple variables, transfer coefficent.

Learning Prerequisites

Required courses

ChE 201 Introduction to Chemical Engineering
ChE 204 Introduction to transport phenomena
Basic knowledge of mass and energy balances and the three fundamental laws of transport phenomina (Fick's law, Fourier's law, and Newton's law) are needed.

Learning Outcomes

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

- Analyze engineering problems involving transfer phenomena
- Construct Shell balances for transport problems
- Deduce the initial and boundary conditions for an analytical solution of differential equations
- Produce analytical solutions to partial differential equations

- Estimate transfer coefficients using boundary layer theory

Teaching methods

Lectures with exercises

Expected student activities

Solution of exercices

Assessment methods

Continuous control
Two written tests during the semester

Resources

Bibliography

Transport Phenomena (second Edition); R. B. Bird; W.E. Stewart; E.N. Lightfoot. John Wiley and Sons, Inc (2002)

Ressources en bibliothèque

- Transport phenomena / Bird