Transfer in Porous media

Component
École Nationale Supérieure d'Électrotechnique d'Électronique

In brief

- **Code:** N9EM19B
- **Open to exchange students:** No

Presentation

Objectives

The aim of this course is to present some aspects of transport in porous media from the pore scale to the porous medium scale. At the pore scale, specific small-scale hydrostatic effects will be presented, then electrokinetic transport related to surface charges at the walls will be described. Next, a description of porous media and their properties will be proposed, followed by averaging methods for translating local transport equations into global ones. The first application will be hydrodynamic transport through a porous medium, with a demonstration of Darcy's law. This will be followed by two lectures on dispersion and diffusion in porous media, both for particle/molecular transport and heat transfer.

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Description

1/ Pore-scale hydrostatics

At the end of this part, students should be able to :

Explain the effects of surfaces on small-scale hydrostatics
Demonstrate the main relations linked to surface tension (Young, Jurin, Laplace)
Summarize the main electrokinetic transfers in a pore (electroosmosis, diffusio-osmosis, etc.)
Adapt the preceding notions to solve a coupled transport problem
2/ Averaging: from pore to porous medium

At the end of this section, students should be able to :

Describe some natural and artificial porous media
Define Knudsen's number
Define and explain the main properties of a porous medium (tortuosity, porosity, saturation)
Explain what the Representative Elementary Volume is
Summarize the different averaging methods for porous media
Calculate the spatial average of a scalar or vector field in a porous medium
3/ Hydrodynamic transport in a porous medium

At the end of this section, students should be able to :

Summarize and interpret Darcy's law
Estimate the permeability of certain porous media
Cite experimental methods for measuring permeability
Define the Klinkenberg effect
Apply Darcy's law with inertia, and its consequence on permeability (Ergun's law)
Choose the right approach for evaluating hydrodynamic transport in a porous medium

4/ Particle diffusion and dispersion in porous media

At the end of this part, students should be able to :

Name the different types of dispersion mechanisms in a porous medium
Write and apply Fick's law
Demonstrate Taylor dispersion in a cylinder
Describe the phenomenon of diffusion in a porous medium
Write and interpret the averaged advection-diffusion equation
5/ Heat transfer in a porous medium

At the end of this section, students should be able to :

Name and describe the three mechanisms of heat transfer in porous media
Summarize the thermal conduction model in porous media
Interpret the different thermal conductivity models
Summarize the thermal convection model in porous media
Define Rayleigh and Nusselt numbers in porous media
The exam will mix the analysis of a scientific article with one or more classical exercises related to the above objectives.

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