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Chapter 1 : Transport Phenomena

Transport of momentum, mass and heat plays an important role in a variety of biological, technological and natural processes. The interplay of transport with other physical and chemical processes leads to fascinating structures on a wide range of scales in contexts such as morphogenesis, synthesis.

The Subject of Transport Phenomena. Viscosity and the Mechanisms of Momentum Transport. The Equations of Change for Isothermal Systems. Velocity Distributions in Turbulent Flow. Interphase Transport in Isothermal Systems. Macroscopic Balances for Isothermal Flow Systems. Thermal Conductivity and the Mechanisms of Energy Transport. The Equations of Change for Nonisothermal Systems. Temperature Distributions in Turbulent Flow. Interphase Transport in Nonisothermal Systems. Macroscopic Balances for Nonisothermal Systems. Energy Transport by Radiation. Diffusivity and the Mechanisms of Mass Transport. Concentration Distributions in Solids and Laminar Flow. Equations of Change for Multicomponent Systems. Concentration Distributions in Turbulent Flow. Interphase Transport in Nonisothermal Mixtures. Macroscopic Balances for Multicomponent Systems. Other Mechanisms for Mass Transport. A Vector and Tensor Notation. Fluxes and the Equations of Change. The Kinetic Theory of Gases. Tables for Prediction of Transport Properties. Constants and Conversion Factors.

Chapter 2 : Transport Processes | Chemical Engineering | MIT OpenCourseWare

Transport phenomena are ubiquitous throughout the engineering disciplines. Some of the most common examples of transport analysis in engineering are seen in the fields of process, chemical, biological, [1] and mechanical engineering, but the subject is a fundamental component of the curriculum in all disciplines involved in any way with fluid.

What does that mean, though? Fluid Mechanics deals with the transfer of momentum in a fluid. On a molecular scale that means that the molecules banging into each other transfer their momentum to other molecules. Heat Transfer deals with the transfer of heat. Heat is just another way to say energy. So, really we are studying how energy moves around. Typical methods of Heat Transfer are: If you touch something hot, you get heat transfer via conduction. If you hold your hand above a burner on a stove, the hot air rising from the burner is moving heat via convection. Stand in the sun. Now, move to the shade. The warmth that you feel from the sun is heat transferred via radiation. Mass Transfer deals with the transfer of mass. One example of mass transfer is if you take a glass of water and put one drop of red dye in it. The study of how the dye spreads out is Mass Transfer. OK, then how are they all related? They all are similar in their behavior. They all move stuff Momentum, Heat, or Mass from a place where there is a lot of the stuff to a place where there is less stuff. Here are some examples: In Fluid Mechanics momentum is transferred from a place where we have a lot of momentum to a place where we have less. A good analogy is the flow of traffic on a busy freeway. The far right lane on the freeway typically move slower than the far left lane, with the lanes in the middle going faster the further left you move. This can be compared to flow over a flat plate, where the slower flow the right lane on the freeway is right next to the plate, and the faster flow the left lane on the freeway on the surface of the fluid. The transfer of momentum is like the cars changing lanes, as slower cars pull into faster lanes the lanes slow down to allow the car to accelerate and not cause a pile-up on the freeway , and the faster cars pulling into slower lanes and speeding up the lane a little bit. In Heat Transfer, energy moves from a place where there is a lot to a place where there is less. For example, if you heat up a brick, then drop it into cold water, the brick gets colder and the water gets warmer. Once the brick and the water are at the same temperature, no more energy can be transferred. Back to the red dye example: But, as the dye spreads out, the concentration of the dye slowly increases, until, it is all at the same low concentration everywhere. Once the concentration of the dye in the water is the same everywhere, no more mass transfer can take place. The one of the most important similarities between all of these examples is: The math for all of these "transport phenomena" all are based on 2 ideas: The rate of change of stuff is proportional to some driving force, as in the examples above. The first idea is summed up by three similar laws for each of the three "transport phenomena" here in one dimension and rectangular coordinates:

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Chapter 3 : Transport Phenomena, 2nd Edition | General & Introductory Chemical Engineering | Subjects |

The study of transport phenomena is an important area of chemical engineering. In many ways it differentiates chemical engineering from other High Absorption Performance of HCl in 1-OctylMethylimidazolium Chloride.

Momentum, Energy, and Mass Transport Analogies The conservation laws for the different transported quantities momentum, energy, and mass can be derived from simple principles. The production or consumption term, Rs, is given in quantity per unit volume and unit time. Based on the figure above, the equations for the balance of the quantity are as follows: Further, if there is no accumulation or depletion over time, then the fluxes into the volume must exactly balance the fluxes out of the volume, so that the total flux into or out of the volume element is zero. In order to follow the conservation laws, this balance equation has to be satisfied in every tiny volume element in a continuum a fluid or solid, for example in the studied system. For the conservation of momentum, the conserved quantity is a vector, while the flux term is expressed in a tensor form including the so-called stress tensor. Combining the conservation of momentum, the constitutive equations for the flux of momentum, and the conservation of mass for an incompressible Newtonian fluid yields the Navier-Stokes equations. These equations are the basis for the modeling of fluid flow CFD and their solutions describe the velocity and pressure field in a moving fluid. If the conserved quantity is energy, the heat transfer equation in the system can be derived from the conservation equation above. Finally, let us look at mass transport. Assume that we want to study the composition of a fluid where transport and reactions are present. We can then define and solve the conservation equations for the mass of each species in the fluid. The concentration ci of each species i is the conserved quantity and its flux is denoted by Ni.. Using the conservation equation above gives us the following equation for each species: In this equation, Di denotes the diffusion coefficient of species i in the solution. Note the high concentration of oxygen in the yolk, where there is hardly any metabolism taking place, only energy storage. Also, insects "breathe" by diffusion. Diffusion-reaction processes are widely used to describe biological systems. If there is advection, which means that there is a net transport of the whole solution, then we get the transport equation often used in reacting systems where fluid flow is present: In this equation, u denotes the velocity vector. If there is an electric field E applied on the solution and ions are present, then we obtain the Nernst-Planck equations used in electrochemical systems: In this equation, zi denotes the valence of species i and ui denotes the mobility of speciesi. The mobility is directly related to diffusivity through the Nernst-Einstein relation. The third term in the flux vector is called the migration term. The analogy in the conservation of transported quantities is also present in the constitutive relations for the fluxes. In gases, the transport properties for viscosity, thermal conductivity, and diffusivity are derived from collisions, Brownian motion, and molecular interactions. In liquids, the theory is less general, but still relates molecular momentum, energy, and mass transport properties for a given fluid. In conclusion, the principle of defining the model equations is straightforward. It is a matter of defining the conservation laws and the relations for how flux can be provoked. It is by solving these equations for a given system over and over again under different conditions, and then studying the results, that we get an understanding of the transport phenomena in the system. January 14, Last modified: March 22, References.

Chapter 4 : Environmental Transport Phenomena | Chemical Engineering

The Squires group develops microfluidic "labs on chips" that probe fundamental phenomena coupling physical, chemical, and fluid-mechanical processes. Specific areas including probing the migration of suspended colloids, drops and polymers under chemical gradients of various types, and the conceptual design of systems that exploit such migration, e.g. to drive engineered particles to.

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Chapter 5 : Chemical engineering - Wikipedia

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Chapter 6 : NPTEL :: Chemical Engineering - Transport Phenomena (UG)

If you talk to people in chemical engineering education, the two course that essentially define chemical engineering are thermodynamics and transport. Those are the two cornerstone courses that synthesize all of the intro courses together and prov.

Chapter 7 : Overview of Fluid Flow, Heat Transfer, and Mass Transport

Transport phenomena is in charge of understanding how Heat, Momentum and Mass transfers across a boundary in a certain direction(s) dT/dx, dV/dy, dC/dz This is a series of videos describing.

Chapter 8 : Transport phenomena - Wikipedia

Convective transport of heat and mass in both laminar and turbulent flows. Emphasis on the development of a physical understanding of the underlying phenomena and upon the ability to solve real heat and mass transfer problems of engineering significance.

Chapter 9 : Transport Phenomena - Chemical and Biological Engineering

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