FUNDAMENTALS OF PARTICLE AND FLUID–SOLID PROCESSING

PROF.ARNAB ATTA
Department of Chemical Engineering
IIT Kharagpur

TYPE OF COURSE : New | Core | UG
COURSE DURATION : 12 weeks (29 Jul'19 - 18 Oct'19)
EXAM DATE : 16 Nov 2019

PRE-REQUISITES : Fluid Mechanics
INTENDED AUDIENCE : Chemical Engineering
INDUSTRIES APPLICABLE TO : GAIL, ONGC, IOCL, Reliance Industries, Tata Steel, Haldia, Petrochem

COURSE OUTLINE :
The objective of this course is to familiarize students with various industrial operations involving particulate solids and its handling in various unit operations, where fluid-particle interactions are of paramount importance. This course will describe and explain the fundamentals of fluid-particle mechanics, which are essential for the understanding of numerous industrial fluid-solid processes like packed bed operation, fluidization, sedimentation, filtration, separation of solids from fluids, etc.

ABOUT INSTRUCTOR :
Prof. Arnab Atta is presently an Assistant Professor of Chemical Engineering at IIT Kharagpur. He obtained his Ph.D. in Chemical Engineering from IIT Delhi, as a National Doctoral Fellow. During his Ph.D., he was granted the Canadian Commonwealth Fellowship to visit and pursue a collaborative research in the Department of Chemical Engineering, Laval University, Quebec, Canada.
His research interests are inclined towards developing CFD models for a range of applications in multiphase flow and systems at different length scales. He also actively works on droplet based microfluidic flows.

COURSE PLAN :

Week 1: Introduction to relevance of fluid-particle mechanics and processing operations in chemical engineering. Solid particle characterization Size distribution, determinations of mean particle size, methods of particle size measurement

Week 2: Fluid-particle mechanics: Flow around immersed bodies, concept of drag, boundary layer separation

Week 3: Fluid-particle mechanics: Motion of particles in a fluid, effect of particle shape, influence of boundaries on terminal velocity

Week 4: Fluid flow through granular and packed beds of particles: Ergun equation, Kozeny- Carman equation, Darcy's law, permeability

Week 5: Fluidization: Minimum fluidization velocity, relevant particle properties, types of fluidization,liquid- solid and gas-solid systems

Week 6: Introduction to separation of solids from fluids. Sedimentation - Free and hindered settling, fine and coarse particles, Richardson-Zaki equation

Week 7: Filtration: Principles of flow through filter cakes and medium, filtration practice, selection of filtration equipment

Week 8: Centrifugal separations: Gas cyclone and hydrocyclone, efficiency of separation, sedimentation in a centrifugal field

Week 9: Particle size reduction: Particle fracture mechanisms, energy requirement for size machine types and characteristics of comminution equipment, selection of appropriate machine

Week 10: Particle size enlargement: Interparticle forces, comparison and interaction between forces, nucleation and growth of particles, granulation equipment

Week 11: Transport of fluid-solid systems: Hydraulic and pneumatic transport, flow regimes, rheological models, dilute and dense phase

Week 12: Colloids and nanoparticles: Introduction, surface forces, suspension rheology, and application