MASS TRANSFER OPERATIONS II

PROF. CHANDAN DAS
Department of Chemical Engineering
IIT Guwahati

PRE-REQUISITES : Mass Transfer Operations I

INTENDED AUDIENCE : Under graduate students/Candidates from professional fields

INDUSTRY SUPPORT: All chemical and design industries like TATA STEEL, Worley Parsons Oman Engineering LLC, Hindalco Industries Limited, Indian Oil Corporation Ltd., Engineers India Ltd, etc.

COURSE OUTLINE :

This course will provide an overview on mass transfer at basic to an intermediate level. This course applies the concepts of diffusion and interphase mass transfer to the analysis of different unit operations such as humidification, drying, adsorption,extraction, leaching, crystallization and membrane processes. The course synthesizes fundamental concepts and analytical skills to understand mass transfer operations and to tackle the sort of complex problems. Information on key topics will be provided in the form of summary of lecture notes, problems and adequate references.

ABOUT INSTRUCTOR :

Prof. Chandan Das is a Professor in the Department of Chemical Engineering at Indian Institute of Technology Guwahati (IITG). He has received his PhD in Chemical Engineering from Indian Institute of Technology, Kharagpur (IITKGP) after completing his B. Tech and M. Tech in Chemical Engineering from University of Calcutta. He has guided, so far, 10 scholars for their doctoral degree, 28 M.Tech. and is guiding 8 more doctorate scholars. Dr. Das is the recipient of "Dr. A.V. Rama Rao Foundation's Best Ph.D. Thesis and Research Award in Chemical Engineering/Technology" for the year 2010 from Indian Institute of Chemical Engineers (IIChE). Dr. Das has authored about one hundred fifty technical publications in peer reviewed journals and proceedings. He has authored four books entitled "Treatment of Tannery Effluent by Membrane Separation Technology" in Nova Science Publishers, USA, and "Advanced Ceramic Membranes and Applications", “Polymeric Membrane Synthesis, Modification and Applications: Electro-spun and Phase-inverted Membranes” and “Polymeric Membrane Synthesis, Modification and Applications: Electro-spun and Phase-inverted Membranes” in CRC Press, USA and six book chapters. He has two patents in his credit. He has handled seven sponsored projects and seven consultancy projects so far. He has visited Denmark, Malaysia, Sri Lanka, Japan and, Greece for exchanging ideas, etc. Being associated with various research works in the area of water and wastewater treatment, such as treatment of tannery wastewater using membrane separation technology, as well as removal of pollutants using micellar-enhanced ultrafiltration, Dr. Das has gained expertise in membrane separation technology for removing various pollutants from contaminated water and wastewater. His research activity encompasses both understanding of fundamental principles during filtration as well as the development of technology based on membrane separation. In particular, his research areas are modeling of microfiltration, ultrafiltration, nanofiltration, reverse osmosis, treatment of oily wastewater, tannery effluent using membrane-based processes. He has explored the detailed quantification of flux decline from fundamentals. As an offshoot of the major research, he has fabricated ceramic membranes using low cost precursors as sawdust. Catalyst is coated on the ceramic support for manufacturing catalytic membrane reactor. He is also working on decontamination of chromium laden aqueous effluent using Spirulina platensis. He is actively involved in the productions of high value added products, namely, total phenolics, flavonoids, tocopherol, etc. from black rice as well as of 6-gingerol, vitamin C content, essential oil content from ginger of North East India.

COURSE PLAN :

Week 1: Humidification and air conditioning:
1. Basic concepts, Adiabatic saturation temperature
2. Humidification and dehumidification operations and design calculations of cooling tower
3. Mechanical Draft Towers: forced draft towers and induced draft towers

Week 2: Humidification and air conditioning:
1. Key points in the design of cooling tower and Step-by-step design procedure of cooling tower
2. Air conditioning, Example problems on dehumidification

Week 3: Drying Operations:
1. Mechanism of drying and drying equilibria; Drying rate curve
2. Drying: rate of drying for batch dryers

Week 4: Drying Operations:
1. Drying: rate of drying for continuous dryers
2. Drying time calculation from drying rate curve
3. Through circulation and cross circulation drying

Week 5: Liquid Extraction:
1. Introduction to liquid-liquid extraction, Liquid-liquid equilibria
2. Effect of temperature on liquid-liquid equilibria
3. Design calculation of single stage extraction

Week 6: Liquid Extraction:
1. Design calculation of single stage extraction
2. Design calculation of multistage extraction
3. Selection of extractors

Week 7:Leaching:

1. Leaching: single stage operation
2. Leaching: multistage operation
3. Supercritical fluid extraction, Equipment for leaching

Week 8:Membrane Separation Technology:

1. Fundamentals of membrane separation processes
2. Limitation of membrane separation processes

Week 9:Membrane Separation Technology:

1. Various models and application: design aspect
2. Electric field enhanced membrane separation processes
3. Micellar-enhanced ultrafiltration

Week 10: Adsorption and Ion-exchange:

1. Adsorption: types and nature of adsorption, Adsorption isotherm
2. Stage wise and continuous adsorption

Week 11: Adsorption and Ion-exchange:

1. Fluidized bed and teeter bed, steady state moving bed adsorber
2. Unsteady state fixed bed adsorbers, Ion-exchange

Week 12: Crystallization:

1. Crystallization, types of crystal geometries
2. Solid-liquid phase equilibrium, Theory of crystallization
3. Design of crystallizer, Crystallization equipment