Ph.D Entrance Test Syllabus

Syllabus for Ph.D. Entrance Test in Chemical Engineering

Section 1: Process Calculations

Steady and unsteady state mass and energy balances including multiphase, multicomponent, reacting and non-reacting systems. Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis.

Section 2: Thermodynamics

First and Second laws of thermodynamics. Applications of first law to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: Equation of State and residual properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibrium.

Section 3: Fluid Mechanics

Fluid statics, Newtonian and non-Newtonian fluids, shell-balances including differential form of Bernoulli equation and energy balance, Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, Turbulent flow: fluctuating velocity, universal velocity profile and pressure drop. Determination of bed porosity and pressure drop using kozeny-carman and Ergun equation.

Section 4: Mechanical Operations

Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids. General equation of cake filtration. Constant rate and constant pressure drop filtration. Determination of total filtration time for plate & frame Filter.

Section 5: Heat transfer Operation

Steady and unsteady heat conduction, convection and radiation, thermal boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators and their process calculations. Types of heat exchangers-Standard Representation-classification – parallel flow and counter flow - LMTD, NTU methods. Design of double pipe, shell and tube heat exchangers, single and multiple effect evaporators. Boiling and Condensation; pool boiling co-relations; film wise and drop wise condensation.

Section 6: Mass Transfer Operation

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stage-wise and continuous

contacting and stage efficiencies; HTU & NTU concepts; design and operation of equipment for distillation, absorption, leaching, liquid liquid extraction, drying, humidification, dehumidification and adsorption.

Section 7: Chemical Reaction Engineering

Introduction to chemical reaction engineering, Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, performance equations for ideal reactors, rate parameter estimation for ideal reactors, reactor combinations, multiple reactions, residence time distribution, single parameter model; selectivity and yield in multiple reactions, steps in heterogeneous reactions and rate-limiting step, heterogeneous catalytic and non-catalytic reactions and reactor design.

Section 8: Process Control and Instrumentation

Measurement of process variables; sensors, transducers and their dynamics, process modeling and linearization, transfer functions and dynamic responses of various systems, systems with inverse response, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response, controller tuning, cascade and feed forward control.

Section 9: Basics of Materials Structure

Atomic structure, chemical bonding – ionic, covalent, coordinate and metallic bonds, intermolecular forces, crystal systems- space latticemiller indices of atomic planes and directions- small problems in crystallography- crystal defects- point, line and surface defects- Bragg's law – X-ray diffraction- Metallography preparation of specimen – micro structure examination- working principle of metallurgical and electron microscope.

Section 10: Wastewater treatment

waste types, sources, effects on environment, Classification, Significance of wastewater contaminants, characterisation and treatment strategies, Discharge limit of wastewater, handling of wastewater, Preliminary or primary treatment of wastewater:-Different physical and chemical treatments, Secondary treatment:-Aerobic and anaerobic treatment, trickling filter, Rotating biological contactor (RBC) Advanced oxidation processes, Introduction, sludge treatment and disposal. Activated sludge process, Up flow anaerobic sludge blanket reactor (UASB),: lagoon, stabilizing pond, facultative pond etc. Tertiary treatment or advanced treatment:-Membrane separation process, membrane bioreactor (MBR) Disinfection, Need and benefits, Methodology, Techniques and barriers for waste reduction and alternative solutions in Industrial wastewater treatment, scope of conventional processes and operations, Use of Advanced strategies in wastewater treatment.

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REFERENCE BOOKS:

1. McCabe W.L., Smith J.C. Harriott P. “Unit Operations of Chemical Engineering”, 7th Edition, McGraw-Hill, New York, 2005.
2. B I Bhatt. S B Thakore “Stoichiometry”, 5th Edition, McGraw-Hill, 2011.
3. Levenspiel O., “Chemical Reaction Engineering”, 3rd Edition, John & Wiley & Sons, 1998.
4. Treybal R. E., “Mass Transfer Operation” 3rd Edition, McGraw-Hill, New York, 1980.
5. Smith J. M., Van Ness H.C., Abbott M.M., “Introduction to Chemical Engineering Thermodynamics”, 7th Edition, McGraw-Hill, New York, 2004.
6. Coughanowr D. R., “Process System Analysis and Control”, 2nd Edition, McGraw-Hill.
7. Rao, C.S, “Environmental pollution control engineering” 2nd Edition, New Age International, 2011.
8. Metcalf & Eddy, “Wastewater Engineering: Treatment Disposal Reuse”, 3rd Edition, McGraw-Hill, 1979.
9. Raju B.S.N, “Water Supply and Wastewater Engineering”, 3rd Edition, Tata McGraw-Hill, New Delhi, 1995.