

## Chemical Engineering

### PAPER - I

#### (a) Fluid and Particle Dynamics

Properties of fluids, concepts of compressible and incompressible flow, Laminar and turbulent flows, Equation of continuity and Navier-Stokes equation, Bernoulli's theorem, flow meters, fluid drag and pressure drop due to friction, Reynold's Number, friction factor and pipe roughness, , pumps, jet ejectors, compressors, blowers, fans. Agitation and mixing of liquids/solids/pastes, screening, crushing, grinding, principles and equipments. Rittinger's, Kick's and Bond's laws, filtration and equipments. Free and hindered settling, concept of fluidization, transport of solids.

#### (b) Mass Transfer

Molecular diffusion, Fick's law of diffusion, mass transfer coefficients, film and penetration theories, distillation, relative volatility, fractional distillation, plate and packed columns of distillation, calculation of theoretical number of plates. Liquid-liquid extraction, absorption & stripping, drying, humidification, dehumidification, leaching, crystallization, adsorption isotherms.

#### (c) Heat Transfer

Conduction, thermal conductivity, extended surface heat transfer. Free and forced convection, heat transfer coefficients, Nusselt number, co-current and counter current flow, LMTD, fouling factor. Design of double pipe and shell & tube heat exchangers, analogy between heat and momentum

transfer, boiling and condensation, single and multiple effect evaporators. Radiation, Stefan-Boltzman Law, emissivity and absorptivity, calculation of heat load of a furnace, Solar heaters.

**(d) Advance Separation Processes:**

Fundamentals of separation process, equilibrium separation processes, ion exchange, electro-dialysis, reverse osmosis, ultra-filtration, molecular distillation, super critical fluid extraction.

**(e) Process Equipment design**

Basic design procedures and theory, factors affecting vessel design, cost considerations, design of storage and pressure vessels, design of flat and elliptical head, design of supports, characteristics and selection of materials of construction.

**(f) Process Dynamics Instrumentation and Control**

Measuring instruments for level, pressure, flow, temperature, pH and concentration. Control variables, manipulated variable and load variables. Laplace transforms, transfer functions of first and second order systems, Block diagram representation, controllers and their transfer functions, stability of closed loop system, Routh array test, transient and frequency response, Bode plots.

# Chemical Engineering

## PAPER-II

### (a) Material and Energy Balance

Gas law, material balance without chemical reactions, material balance with chemical reactions, recycle/bypass/purge calculations, combustion of solid/liquid/gaseous fuels, energy balance calculations, heat of reaction, adiabatic flame temperature.

### (b) Chemical Engineering Thermodynamics

Laws of thermodynamics, PVT relationship for pure components and mixture, Maxwells relations, Fugacity, activity and chemical potential, vapor liquid equilibria for ideal/non-ideal, single and multi component systems. Criteria for chemical reaction equilibrium, equilibrium constant and equilibrium conversions, heat engines, heat pumps, refrigeration and related cycles.

### (c) Chemical Reaction Engineering

Molecularity and order of reactions, theories of reaction mechanism, kinetics of homogeneous reactions and interpretation of kinetic data. Ideal flow reactors(batch, mixed, plug flow) and their performance equations, series and parallel reactions, multiple reactor system, temperature and pressure effects. Heterogeneous reactions, catalytic and non-catalytic reactions, gas-solid and gas-liquid reactions, effectiveness factor, non isothermal reactors and reactor stability.

#### **(d) Chemical Technology**

Wood based chemicals, pulp and paper, sugar industry, edible oils extraction, soaps and detergents, biogas, coal and coal chemical, petroleum refining, (Atmospheric distillation/cracking/reforming), polyethylene's (LDPE/HDPE/LLDPE), PVC, Polystyrene, ammonia manufacture, cement and lime industries, paints and varnishes, glass and ceramics, alcohol and antibiotics, nitrogenous and phosphatic fertilizers.

#### **(e) Environmental Pollution Monitoring & Control**

Safety, ecology and environment, sources of pollutants in air and water, green house effect, ozone layer depletion, acid rain. Micrometeorology and dispersion of pollutants in environment, water quality index (WQI), air quality index (AQI), measurement techniques of pollutant levels and their control strategies. Solid wastes, their hazards and disposal techniques, Design and performance analysis of pollution control equipment, fire and explosion hazards, HAZOP and HAZAN, disaster management, environment protection acts.

#### **(f) Process Engineering Economics**

Fixed and working capital, cost estimation and comparison of alternatives. Net present value, pay back analysis. IRR, depreciation, taxes and insurance, break even point, PERT and CPM, profit and loss account, balance sheet and financial statement. Plant location and plant layout including piping.