RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER

SCHEME & SYLLABUS FOR THE POST OF ASSISTANT CONSERVATOR FOREST & FOREST RANGE OFFICER GRADE Ist COMPETITIVE EXAMINATION, 2018
FOREST DEPARTMENT

OPTIONAL SUBJECT - CHEMICAL ENGINEERING

1. Process Calculations and Thermodynamics : Calculations for mole, molecular weight, equivalent weight, etc., Composition of gaseous mixtures, liquid mixtures, solid mixtures, etc., Ideal gas law & other equations of state and their applications, Dalton law, Raoult's law, Henry's law, Solutions and their properties. Laws of thermodynamics, PVT relationships for pure components and mixtures. Energy functions and interrelationships - Maxwell's relations, fugacity, activity and chemical potential. Vapour-liquid equilibria, for ideal/non-ideal, single and multi-component systems. Criteria for chemical reaction equilibrium, equilibrium constant and equilibrium conversions.

2. Fluid Flow & Particle Dynamics : Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation and its applications. Fluid drag and pressure drop due to friction, Reynold's Number and friction factor - effect of pipe roughness. Economic pipe diameter. Flow meters- Orifice and Venturi meter, impulse momentum equation and its application, Pumps. Agitation and mixing of liquids. Crushing and Grinding - principles and equipment. Particle size and shape: Measurement and analysis, Screening and screen analysis- Screen effectiveness, Working principle of industrial screening equipment, Shape factor, Selectivity index, crushing laws, filtration and filtration equipment. Free and hindered settling, fluidization and minimum fluidization velocity.

3. Heat Transfer : Mechanism of heat transfer: conduction, convection and radiation, heat transfer coefficients, heat transfer rate, steady and unsteady heat conduction, LMTD and effectiveness. Types and applications of heat exchangers, NTU methods for the design of double pipe and Shell & Tube Heat Exchangers. Boiling, condensation, single and multiple-effect evaporators.

4. Mass Transfer : First and second law of diffusion, mass transfer coefficients. Gas Absorption, calculation of operating lines, Counter current multistage operation, HETP dilute solution, HTU, NTU. Distillation- simple distillation, relative volatility, fractional distillation, plate and packed columns for distillation. Calculation of theoretical number of plates. Liquid-liquid equilibria. Extraction - theory and practice. Drying. Humidification, dehumidification and adsorption.

5. Chemical Reaction Engineering : Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, constant volume and varying volume batch reactor. Performance equation for ideal batch reactor, space time and space velocity, size comparison for single reaction, multiple reactors, mixed flow reactors in series. Recycle reactors, auto catalytic reactions, design for parallel reactions, multiple reactions in series and series-parallel combinations reactions, fractional yield.

6. Plant Design and Economics : Design code, design pressure, design temperature of cylindrical and spherical shells under internal and external pressures, process design and sizing of chemical engineering equipment such as compressors, heat exchangers and boilers; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in design.

7. Process instrumentation and dynamics control : Introduction to process variables: Direct and inferential measurement, on and off line measurement, static and dynamic characteristics of instruments and their general classification, error, accuracy, repeatability, drift, threshold, zero-stability etc., Instrumentation systems: Working principle of transducers/instruments employed for the measurement of flow, level, pressure, temperature, density, viscosity, pH, radiation, composition, humidity, advantages and disadvantages, preparation of instrumentation diagrams, instrumentation of important equipment like distillation column, heat exchanger, etc.

8. Chemical and Petroleum Technology : Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); polymerization industries;

polyethylene, polypropylene, PVC and polyester synthetic fibers. Origin occurrence of petroleum, formation and evaluation of crude oil, testing of petroleum products, petroleum refining processes, cracking and reforming, fluid catalytic cracking, general processing, vacuum distillations. Proximate and ultimate analysis of solid, liquid and gaseous fuel: Calorific value, antiknock rating and octane number, aetane number, flash point; char value, smoke point, viscosity and aniline point.

9. Environmental Technology : Classification of air pollutants, primary and secondary pollutants, source of air pollution, atmospheric dispersion: meteorology, adiabatic lapse rate, atmospheric stability, inversion – types of inversion, maximum mixing height, atmospheric classes, plumes and types of plumes under different atmospheric condition, plume rise, characteristic of water and waste water, oxygen demand, BOD, NBOD, CBOD, primary treatment by sedimentation, flocculation, coagulation, filtration, disinfections, waste water treatment, biological (secondary) waste water treatment, advance treatment methods.

10. Safety in Chemical Process Plant : Safety, hazard and Risk, accident-nature and loss statistic. Hazards: Detection, management, recent trends in safety & hazard analysis, hazardous waste treatment, laws, industrial hygiene: identification and evaluation, source models: introduction, spills of toxic, flammable and explosive materials, fires and explosions: distinction, definitions, characteristics and explosion hazard rating of process plant, preventions of fire and explosions.

Note :- **Pattern of Question Paper**

1. Objective type paper
2. Maximum Marks : 200
3. Number of Questions : 120
4. Duration of Paper : Three Hours
5. All questions carry equal marks.
6. There will be Negative Marking.