FURTHER DETAILS REGARDING MAIN TOPICS OF PROGRAMME NO. 07/2014 (Item No. 24)

ANALYST (CHEMICAL TESTING LABORATORY)

INDUSTRIES AND COMMERCE

(CATEGORY NO. 339/2010)

PART I-QUESTIONS BASED ON TECHNICAL QUALIFICATION

UNIT I

Fluid dynamics: - Types of fluid flow in pipes, viscous and turbulent flow- Reynolds's Experiment - Bernoulli's Theorem: -- Expressing flow rates as velocity, volume rate and mass rate - Equation for continuity.

Flow measurement: - Flow metering- classification of flow measuring equipments. Hydrodynamics method, mechanical method and special methods. Orifice meter, venturimeter, pitot tube and weirs. Rotameter - working principles, materials of construction and applications meters .

Pipes and pipe fittings: Pipes and tubes - pipe and tube standards,

Gaskets and packing: -Sealing of rotating shafts - stuffing boxes and mechanical seals Fundamentals of flow control mechanism and valve classification- Gate valve and its variations like sluice valve and slide valve - Plug valve (cocks) - 2 way and 3 way and non-lubricating plug valves, Ball valves, stop valves - Globe valve, Butterfly valve, Diaphragm valve

Pump classifications - Positive displacement and Centrifugal.

Positive displacement pumps - reciprocating and rotary - reciprocating tvpe - piston plunger pumps - simplex and duplex - single acting and double acting.

Diaphragm pumps - Rotary -- gear pump, screw pumps, lobe pumps.

Centrifugal pumps: - Basic working principles, types of impellers for different fluids, single suction and double suction type. Priming of centrifugal pumps and self-priming pumps. Turbine pumps, NPSH cavitations,

Fans, Blowers, compressors - Positive displacement blowers, turbo blowers, turbo compressors, positive displacement compressors, vacuum pumps and ejectors. Nash Hytor.

UNIT II

Heat transfer by conduction in solids - steady state and unsteady slate fl-. Fourier's law of conduction - Rate equation for heat flow - steady state heat flow conduction through single wall - derivation of equation -- Thermal conductivity - units.

Theorv of convection - film concept of heat transfer temperature gradient in forced convection - derivation of overall heat transfer coefficient from individual heat transfer coefficient .

Forced convection: Heat transfer by forced convection inside tubes for laminar and turbulent flow - Dimensional equation - simple problems - mechanism of natural convection - heat transfer in boiling liquids - saturated boiling — elementary idea of black body - gray body - emissivity -emissive power -- radiation laws. Stefan Boltzmann equation.

Parallel flow - counter current flow - cross flow heal exchangers - Fouling effect calculation - Heat transfer equipment - Heaters and heat exchangers - single pass shell and tube heaters Multi pass healers - floating head healers - use of baffles on shell side of heat exchangers, double pipe heat exchangers - plate type heat exchangers - air fin cooler.

Evaporation - Examples of industries where evaporation is used as a unit operation. Tvpes of evaporators - basis of classification - horizontal tube - vertical tube - climbing film - falling film - forced circulation evaporators - examples of application of each in industries -continuous operation and control of evaporators - evaporator accessories - Multiple effect evaporators.

UNIT III

Diffusion
Molecular diffusion - molar flux - Fick's rate equation

Absorption
Mechanism of Absorption - conditions of equilibrium between gas and liquid - Henry's law - factors controlling rate of absorption - equipments for absorption operations -packed tower - packing materials - characteristics of packing - liquid distributors - channeling.

Adsorption
Physical and chemical adsorption - various types of adsorbents - applications - manufacture of adsorbents; ion exchange - principle — molecular sieves

General mechanism of diffusional processes - Definitions and mathematical expressions for Molal humidity - Absolute humidity - Relative humidity - percentage humidity - Humid volume - Humid heat - Enthalpy and dew point - Humidity chart. Adiabatic saturation temperature -- wet bulb temp cooling towers - atmospheric - natural and forced draft, cross flow type -- humidification and dehumidification - air condition.

Purpose and industrial applications - drying equipment – classifications - tray dryer tunnel dryer - rotary dryer - turbo dryer - spray dryer -drum dryer - cylinder dryer - fluid bed dryer -dry basis and wet basis of expression of moisture content - equilibrium moisture content - free moisture content - bound and unbound water - mechanism of batch drying of solids - constant rate and falling rate period.

Distillation as an inter phase mass transfer- industrial application - definition of terms - less volatile, more volatile, low boiling, high boiling - vapour - liquid equilibrium diagrams and their importance. Ideal and non-ideal solutions - Roault's law -

calculation of X-Y data using Roault's law. Azeotropes - maximum and minimum boiling - volatility and relative volatility - calculation of relative volatility of a binary mixture. Types of distillation-equilibrium - simple distillation, steam distillation.

Rectification, Azeotropic distillation, extractive distillation, and molecular distillation.

Rectification
Applications of leaching - batch and continuous - heap leaching - percolation tanks - shank system - agitated vessel - continuous counter current decantation - Boll man extractor -Rotocel extractor - Kennedy extractor

Liquid - Liquid extraction- Raffinate - Extract - construction details of mixer settlers -spray and packed towers .

Crystallization
Application - equilibrium curve for a solid - liquid system - yield of crystals - solubility - saturation - super saturation - crystal growth - methods of super saturation - material balance equation-Construction details of Tank crystallizer - cooling crystallizer. evaporator crystallizer.

UNIT IV

Filtration and Centrifugation
Filtration and its application in industry -Classification of filters atmospheric, pressure and vacuum filters - field of application and constructional details, working and application of the following. Sand filter- open - Filter presses - plate and frame filter press, Leaf filters - pressure and vacuum types - Moore filter - Continuous filter - rotary drum - working cycle – selection of filters - filter aids, their function and applications.

Centrifugation:
Centrifugal force developed in centrifuges - classification of centrifuges - batch- semi continuous, continuous - top driven - bottom driven - perforated solid bowl - super centrifuges - operation - field of application

Size Reduction
Nature of the materials to be crushed - hardness, structure, moisture content, Types of crusting equipments, coarse crushers -Intermediate crushers -fine grinders -open circuit grinding - closed circuit grinding. Laws of crushing - Kick's law - Rittingers law - Bonds law - Jaw crusher - gyratory - crusher -crushing rolls - angle of nip - capacity, hammer mill - ball mill - critical speed- Raymond mill - tube mill Average particle size - specific surface of mixture, volume surface mean diameter - arithmetic mean diameter - mass mean diameter - shape factor.

Size Separation
Screens: Tyler and U.S. standard screens -Screen analysis: efficiency and capacity of screens Types of screening equipment - grizzlies - trammels, shaking screens, vibrating screens Air separation methods: cyclone separator - air separator - bag filter. Electrostatic precipitator - settling chambers - cyclone separator - venturi scrubbers - separation of solids in liquids - Stokes law and its application, terminal velocities- Sedimentation, Agitation and Mixing Sedimentation separation in liquid medium - batch sedimentation - application of batch settling tests to design of continuous thickness - Kynch theory, determination thickener area - equipments -double cone classifier - Dorr classifier - gravity continuous thickeners - elutriator jigging - tabling -

light and dense medium separation based on difference in densities and its application. Principle of froth flotation cells, froth floatation cells - simple flow sheet for floatation plant, magnetic separators - Purpose of agitation - agitation equipment - propellers, paddles .

Fluidiization, Storage and Transportation of Solids Storage of Gases and Liquids Mechanism of fluidization conditions for fluidization - batch fluidization - boiling effect - minimum porosity

UNIT V

Process Control

Recorders, timers - transducers-Characteristics of measuring elements and process control system - open and closed loop systems -block diagrams of back ward feed, forward feed controls - types of control modes - on-off, proportional, integral, derivative, and their combinations. Characteristics of these controls.- Pneumatic systems for the above modes of control. Self operated controllers, elementary principles of controls — its advantages over the other, final control elements - control valves, actuators, pneumatic, hydraulic, electric and mechanical and solenoid valve

Computerized Control

Descriptive treatment of the following: -Telemetering devices. Analog and digital signal transmission, A/D, D/A converter, analog and digital-computer control system - microprocessor, distributed control svstem – SCADA, Comparison of SCADA with DCS.

PROPERTIES OF STEAM *&* BOILERS

Properties of steam - Explanation of properties of steam such as total heat of water, latent heat, total heat of steam, super heat, dryness fraction. Function of boilers - classification - working principle - fire tube and water tube boilers - Simple vertical boiler - Cochran boiler- Boiler mountings - accessories.

OPERATIONAL MAINTENANCE OF CHEMICAL PLANT EQUIPMENTS Principle of management - types of maintenance - maintenance schedule – records - replacement - maintenance of chemical plant equipments - Troubles and remedial actions - start up and commissioning of equipments - plant inspection - vessel entry - testing methods - non destructive testing methods - radio graphic & ultrasonic test.

PLANT LOCATION AND LAY-OUT

Location of Chemical Plant - Important factors considering Plant Location and Plant Lay-out - Master Plot Plan and Unit Plot Plan - Chemical Plant Buildings - Roofing - Flooring - Ventilation and Illuminations.

PART II – QUESTIONS BASED ON DEGREE IN CHEMISTRY

Module 1

Environment, nature of environmental threats and the role of chemistry, chemistry of the air, water, soil environment, Factors affecting environment, types of environment. Importance of clean air, pollution, orgin of pollution, Air pollutants, Health and environmental effects of pollutants. Water pollution, visible signs of

water pollution, effects of water pollution, water quality Standard Biological magnification and bioaccumulation. Sewage, Sewage analysis BOD and COD. Soil pollution-control measures, noise pollution and noise control, chemical pollution, pesticide pollution, thermal pollution-effects And control measures.

Module 2

Purification of organic compounds, detection and estimation of elements, molecular formula. Hybridisation, bond, lengths bond angles bond energy, localized chemical bonds, Van der Waals interaction, Hyper conjugation, resonance, aromaticity, Inductive and field effects, hydrogen bonding. Type of reagents

Electrophiles and nucleophiles. Types of organic reactions, energy considerations. Reactive intermediates-carbocations, carboanions, free radicals, carbenes, arynes and nitrenes. Method of determination of reaction mechanisms. Types of isomerism, Optical isomerism, Relative and absolute configuration, Geometrical isomerism and conformational isomerism.

Module 3

Idea of De Broglie matter wave, Heisenberg uncertainity principle, Atomic orbitals, Schrodingcr wave equation, quantum numbers, Shape of s, p, d orbitals. Aufban and Pauli exclusion principals, Hund's multiplicity rule, Electronic configuration of the elements. Atomic and ionic radii, Ionization energy, Electron affinity and electronegativity. Trends in periodic table and applications in prediting and explaining the chemical behaviour. Some characteristic study of s, p, d and f block elements.

Module 4

Basic concepts-system, surroundings, types of systems, Extensive and Intensive properties, macroscopic properties, state functions and path functions, type of process, Definition of internal energy and enthalpy. Heat capacities at constant volume and at constant pressure. Mathematical statement of first law, reversible process and maximum work.

Thermo chemistry – standard states, enthalpies of formation, combustion and neutralisation. Hess's law and its applications.

Properties of liquids, Surface tension and its measurement, factors affecting surface tension, viscosity, Refractive index and its determination.

Chemical kinetics, rate of reaction, factors influencing the rate of a reaction, order of chemical reaction, determination of order of reaction, theories of chemical kinetics, effect of temperature on rate of a reaction. Arrhenius equation, Concept of activation energy.

PART III – CURRENT AFFAIRS & RENAISSANCE IN KERALA

General Knowledge

Geography of India- Physical Features- Climate-Soils- Rivers- Famous Sites – Etc. – Demography- Economic and Social Development-Poverty Alleviation-Economy and Planning-Etc. – History of India- Period from 1857 to 1947- National Movement- Etc.

Current affairs

Important World, National and Regional Events related to the Political and Scientific fields, Sports, Cinema and Literature etc.

Renaissance in Kerala
Important Events/ Movements/Leaders

Brahmananda Swami Sivayogi, Chattampi Swami, Sree Narayana Guru, Vagbhatananda, Thycaud Ayya, Ayya Vaikundar, Poikayil Yohannan (Kumara Guru), Ayyankali, Pandit Karuppan, Mannathu Padmanabhan, V.T.Bhattathirippad, Dr. Palpu, Kumaranasan, Vakkom Moulavi, Blessed Kuriakose Elias Chavara, Etc

NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper.