

Syllabus for Oil Technology

Part-I:

History and general introduction

Oils, fats, waxes, mineral oils, essential oils, their sources, composition and structures. Constituents of natural fats Glycerides and fatty acids, their nomenclature, classification and principle sources; theories of glyceride structure. Production and consumption pattern of various Oils & Fats in the Country vis-à-vis world.

Non-glyceride components, important minor constituents and contaminants

Phosphatides, sterols, gossypol, carotenoids, hydrocarbons, coloring matter, natural pigments, vitamins, antioxidants, Fatty Alcohols, Sterols, Tocopherols, Tocotrinols, Oryzanols, Triterpine Alcohols Waxes etc. Gossypol, Sesamol and Sesamoline, Flavoring compounds. Some minor important constituents of oilseeds: ricin, sinigrin, linamarine, saponin, allylithiocyanate, gossypol, sesamol and sesamoline; environmental contaminants.

Physico-chemical characteristics of natural oils, fats and fatty acids

Oiliness and viscosity, cloud point, titre, density and coefficient of expansion, melting point, plasticity of fats & plastic range, smoke, flash and fire points, Boiling point; solubility and miscibility, refractive index, Acid value, saponification value, Iodine value, thiocyanogen value, diene value, acetyl and hydroxyl value Riechert Miessel and Polensky values, and Kirshner value, Peroxide Value, Anisidine Value, Oxirane Value, TBA value, Totox value, unsaponifiable matter. BIS methods for testing of oils and fats.

Adulteration tests for vegetable and animal fats and oils and their chemistry

Boudiens Test, Holde Test, Halphens test, Hexa Bromide Test, Ammonium Molybdate test, Belliers Turbidity Test, Test for the presence of Argemone, Sal Neem Kusum, Karanja, Animal fat, Allylithiocyanate test, Detection of rice bran oil in other oils and other relevant test.

Brief introduction to chemical reactions of fats and fatty acids

Esterification, interesterification, saponification, hydrolysis: reactions involving the carboxyl groups e.g., formation of metal soaps: nitrogen derivatives, acid chlorides, anhydrides etc.: alkoxylation, pyrolysis: reactions in the fatty acid chain; hydrogenation, dehydrogenation, halogenation, addition of sulphur, phenols, cresols, hydrogen sulphide and mercaptans: sulphation and sulphonation and miscellaneous addition to the double bonds, Rancidity and mechanism of chemical and auto oxidation, natural & synthetic antioxidants.

Natural sources of oils and fats

Global and National production, demand and supply scenario of oilseed and oils, Import and export of oils, oilseeds and oil cake, Past trends and future projections in fluctuations of production and price and their reasons.

Handling and Storage of Oils and oilseeds

Handling of oilseeds, oil bearing materials and crude oils. Storage of oilseeds, Grading and evaluation of oilseed and oil bearing material as per BIS/ Codex, Drying of oilseed.

Commercial oils, oilseeds, cultivation, characteristics, composition and utilization from plant sources

Coconut, palm, palm kernel, olive, cocoa butter, sunflower, safflower, sesame, groundnut, mustard, rape-seed, canola, soybean, niger seed, linseed, castor, rice-bran, cottonseed, corn, tung, oiticica, neem, mahua, kusum, karanja, sal, mango kernel, tobacco, shea fat, watermelon, wheat germ, algae oils, chia seed oil, jatropha etc. Genetically modified oilseeds.

Production, characteristics, composition and utilization of oils from animal sources

Milk fats and butter, lard, tallow other animal fats and greases etc. Fish and marine oils: halibut, herring, shark, menhaden, whale, sardine, fish liver oils, krill oil etc, Different methods of rendering.

Natural and synthetic waxes characteristics, composition and utilization

Natural waxes such as bees wax, shellac wax, carnauba wax, sugarcane wax, Montana wax, jojoba wax, sperm-oil, rice bran, sunflower and spermaceti, synthetic waxes, their occurrence, classification, general properties and uses.

Pre-treatments of oil bearing materials:

Cleaning, delinting(for cotton seeds), dehulling, decortication, size reduction, pre-pressing, flaking, extrusion, pelletization, stabilization (for rice bran), etc. Plants, processes and the machinery used.

Production of Oil by mechanical expression:

Machinery employed for expression/ mechanical extraction of oils viz. Ghanis, hydraulic presses, screw presses, low pressure and high pressure expellers, expander- extruder system fruit processing for oil recovery, processing of palm & coconut and bye products.

Production of Oil by solvent extraction:

Principle of solvent extraction, solvents and their availability, selection of solvents, advantages and limitations, properties of different solvents. Solvent extraction techniques: Batch and continuous plants and processes employed for solvent extraction of low and high oil bearing materials.

De-solventization of meals:

Equipments and plants employed for de-solventization from extracted meal and recovery of solvent from micella, current trends, storage & detoxification of oil cakes, production of protein products, concentrates and isolates.

Alternative extraction processes:

Principle and comparison with conventional solvent extraction processes. Use of supercritical fluid and liquefied gases for oilseed extraction and oleo stearin preparations, HCF extraction, Aqueous extraction. Enzymatic extraction; Solvent losses and utility requirements, energy conservation. Safety & hazards, maintenance and environmental consideration of solvent extraction plants & solvent recovery systems.

Fat splitting and fatty acid distillation:

Hydrolysis of oils and fats; composition of partially split fats. Effect of temperature, pressure, catalyst and ratio of reactants in hydrolysis of fats; degree of splitting; Plants and processes employed for fat

splitting: Twitchell process, enzymatic fat splitting, low, medium and high pressure autoclave processes; semi-continuous and continuous processes of fat splitting, columns for DFA production. Fatty acid distillation, crystallization, fractionation, high purity fatty acid products blends distillation. Specifications of fatty acids and glycerin as per BIS, Recovery of glycerin from spent soap lye & sweet water.

Pretreatment of oils:

Impurities of crude oils & micronutrients: Effect of refining and other processing on specific impurities. Washing of crude cotton seed oil, degumming of oils and fats: Mechanism of degumming, various methods employed for degumming, Px series of separators, De-waxing of oils: Principle and methods of de-waxing of individual oils, Winterization in oils.

De-acidification of oils and fats:

De-acidification by alkalis e.g. caustic soda and sodium carbonate; batch and continuous methods; separators, refining losses, effect of operating variables, liquid-liquid extraction, miscella refining; Zenith refining, cold refining, physical refining of oils: Batch, semi-continuous and continuous methods, principle of major types of continuous process, their merits and demerits, esterification, nano-neutralisation etc. and their limitations. Treatment and disposal of gums and soap stock: Batch and continuous methods.

Bleaching of oils and fats:

Theory of adsorption bleaching; components responsible for oil color; chemical and physical characteristics of various bleaching agents; activated bleaching earth and activated carbon and their methods of manufacture, extraction of oils from spent earth, determination of bleach ability and bleaching efficiency of adsorbents, batch and continuous methods of bleaching by adsorption; DOBI value, filtration techniques for removal of spent bleaching agents from bleached oils viz. Plate & frame filter, polish filter, pressure leaf filter, use of hydro gel & silica gel, chemical bleaching; color fixation in oils and fats.

Membrane technology, Biotechnology and other separation processes of crude vegetable oils and specification of refined oils:

Degumming, de-acidification and bleaching. . Fractionation of Palm Oil and other vegetable and animal oils & fats. Biotechnology: Principle and its application in oil and fat processing, blending of oils, micronutrients present in vegetable oil and effect of processing on micronutrients Nutritional significance, specifications of blended and refined oils. Specifications of oils as per FSSAI, permissible limits of additives.

Quality control and Quality Assurance:

Concept of quality assurance and quality control in relation to oil industry; quality management systems - ISO 9000; total quality management (TQM); hazard analysis of critical control points (HACCP); good manufacturing practices (GMP); role of international organisations such as ISO; IDF; CAC; AOAC; WTO and national organisations like BIS; and Agmark; FSSAI and APEDA (Agricultural and Processed Foods Export Development Authority) in oil industry; guidelines for setting up quality control laboratory. Legislation on oils and allied products.

Chromatographic Techniques:

Theoretical developments of various techniques viz. thin layer chromatography, column chromatography, gas-liquid chromatography, HPLC and Super critical Chromatography; their principles, practices and their applications in the quality control and quality assurance of oils, fats and allied products.

Spectroscopic Techniques;

Ultra-Violet, Visible, FTIR, NIR and NMR, Mass spectroscopic techniques: principles, practices and their application in the analysis of oils and allied products; Interpretation of spectra and quantitative applications.

Special quality control methods:

Nickel content of catalyst and hydrogenated oils; iron, sulphur and phosphatide content of crude and refined vegetable oils; wax content of vegetable oils; Vitamin A, D & E(natural & fortified); residual pesticide and solvent analysis, chlorophyll content, amino acid analysis by chemical and instrumental method etc.

Hyphenated techniques:

TLC-FID/FPD, GC-MS, SFC-GC, LC-MS, ICP-MS, AAS in analysis of oils and fats.

Sources, classification and chemistry of essential oil bearing materials

Different methods of manufacturing essential oils, Grading and standardization of essential oils

Physico-chemical characteristics of essential oils

Specific gravity, refractive index, optical rotation, solubility, acid value, ester value, Analysis of essential oils e.g. free alcohol, total alcohol, aldehyde and ketone content, phenol content, common adulterants and their detection

Production, properties and composition of important Indian essential oils

Rose, jasmine, khus, sandal wood, keora, palmarosa, lemon-grass, peppermint, lemon, spices oils, clove oil, orange oil, eucalyptus oil, natural fats and bi additives compounds etc.

Part-II:

Hydrogenation of oils:

Principle and importance of hydrogenation, kinetics of reaction, operating variables and their effect on rate of hydrogenation, selectivity and isomer formation, trans fat replacement solutions and technology, worldwide trends & regulations.

Hydrogenation catalysts and hydrogen production:

Catalyst structure, catalyst poisons and promoters, theory of catalysis, properties of catalysts e.g. porosity, selectivity, activity and other properties, different types of catalysts employed for hydrogenation of oils and fats, methods of catalyst manufacture, regeneration of nickel catalyst, Manufacture of hydrogen: methods of production and purification, storage of hydrogen, distribution through manifold & direct gasification in hydrogenation vessel. Estimation of purity of hydrogen and oxygen gas. Hydrogen gas requirements for hydrogenation of different oils.

Modification of oils and their applications:

Analysis of modified fats, dilatometry- theory and practice, Trans unsaturated fatty acids and polyunsaturated fatty acids in nutrition and health, Energy conservation in hydrogenation process, frying & stability characteristics, nutrition & health aspects, Inter-esterification, fractionation, winterization, diacylglycerols as low calorie fats. Hydrogenation of palm stearin.

Glyceride structure:

Advanced theories of glyceride structure of natural fats, Determination of glyceride structure; Synthesis of glycerides; estimation of mono – di and tri glycerides. stereo specific analysis, lipase hydrolysis, polymorphism of fats and fatty acid. chemical synthesis of fatty acid and their derivatives.

Mechanism of important chemical and biochemical reaction of fats and fatty acids:

Esterification, inter-esterification, isomerisation, polymorphism, dehydration, pyrolysis and oxidation of fatty acid esters and other oleo chemicals derived from fats and fatty acids, products and byproducts from castor oil, soybean oil, rapeseed oil, neem oil, mahua oil, cotton seed oil etc.

Oil derivatives and their applications:

Production and utilizations of fatty nitriles, amines, sulphited and sulphurised oils; properties, specification, plant and processes employed. Textile chemicals, leather chemicals, polymer additives, paint additives, lubricants additives.

Chemistry and applications of drying oils:

Modification of oils for surface coating industries, thermal and chemical modification methods; properties of modified oils, changes in drying oils during heat bodying and oxidative polymerization. process and plants employed for their commercial production. Processes for production of malenised oils, epoxidised oils, boiled oils, stand oils blown oils, urethanes oil sand alkyds, evaluation of surface coating materials.

Production and applications of methyl ester:

Various methods for production of methyl esters, production of biodiesel, specifications as per ASTM and BIS, sulphated and sulphonated methyl esters and their applications.

Procurement process for oilseeds and oils:

Different mechanisms, Agencies involved in procurement at national and international level. GST and import/export duty structure for oilseeds, oils – crude and refined, edible as well as non edible. Components of transport, loading/unloading, insurance and storage involved in cycle of procurement. Present day practices of sale through bulk/ packaged imports, with supply chain management.

Components of Costing and Human resource development:

Capital cost of project for establishing oil mills, solvent extraction plant, oil refinery plant, & other plant related to oil industries, technical appraisal of plants. Human resource Planning: Importance and processes, Job analysis and Engagements, Training need analysis.

Utilities & Production planning:

Financial projections- calculation of cost of production for oil mills, solvent extraction plant, oil refinery plant & other plant related to oil industries Break Even Point, Rate of Return, Pay Back Period, Depreciation etc. Energy conservation in oil processing industry, concept of variable frequency drive, PLC & SAP. Factory lay out: Principles, general considerations, typical flow diagrams, single & multi storied buildings, different sections of a oil refinery factory and their locations, Instrumentation and automation in oil refinery. Machine layout of solvent extraction and oil refinery plant.

By- products of oil and oilseed processing industry and their utilization:

Phospholipids, production of industrial and edible grade Lecithin, gums. Manufacture of cattle and poultry feed; production of protein concentrates and isolates. Re-esterification of fatty acid with glycerin and its trans-esterification for production of biodiesel. Utilization of deteriorated deep fried oil for industrial utilization.

Safety measures, Effluents and their treatment:

Segregation of deodorizer distillate and isolation of value added products by conventional and molecular distillation and other plants and machinery involved. Classification of effluents of oil and allied industries, Safety considerations in storage of hazardous and inflammable raw materials. Fire Protection and safety: Sources, types, Fire & explosion index, safety measures for protection. Health and Hazards: Resources, competence & regulations, systems & tools, HAZOP guidelines, Environment: Eco-friendly, waste minimization & waste disposal, Effluent Treatment Plants, system efficiency, respiratory protective equipments. GOI specifications of effluents, eco-friendly processes and green technologies.

Introduction to oils & fats

Introduction to oils & fats, types of glycerides, theories of glyceride structure, determination of glyceride structure, non-glyceride components of oils, component fatty acids of oils & fats.

Chemical reactions of oils & fats

Chemical reactions of oils & fats and their industrial importance, physico-chemical characteristics of oils & fats, classification of oils, adulteration of oils.

Post harvest technology of oilseeds

Post harvest technology of oilseeds, handling and storage of oilseeds, different methods for extraction of oils from oil-bearing materials.

Refining of oils

Degumming, de acidification, bleaching hydrogenation, deodorization, physical refining, Fractionation, De waxing, Winterization of oils. Nutraceuticals derived from oil

Introduction to GM crops

Genetically modified crops for oil bearing materials, composition, characteristics, composition of GM and non-GM crops, certification of GM crops, global scenario in GM crops.

Enzymes and their Technology

Types of enzymes, sources and their isolation and their applications, immobilized enzymes, assay of enzymes for oil application

Bio processing of Oils & Fats

Bio Processing of Oils: Bio degumming, Bio de-acidification, Bio bleaching, Chemistry and technology of bio-interesterification, bio-hydrogenation interesterified fats vis-a-vis bio-interesterified fats/hydrogenated fats.

Specialty fats & Oils

Structured Lipids, Margarine and Shortening, Production of plastic fats, Cocoa butter substitute, Food emulsions, Medicinal applications, Preparation of de-acylglycerols, polyol and other oleo chemicals.

GM Oilseeds

Canola (rapeseed), Linola (flax), High Oleic sunflower, Low-linolenic soyabean etc.

Introduction to Packaging

Elements of packaging & its influence on customers, scopes and functions of a package. Materials used for packaging: paper and paperboards; films and foils; glassware; metals plastics; wood; miscellaneous other materials. Comparison of glass & plastic packaging.

Criteria and selection of packing material

Requirements of packaging surfaces for oils and allied products viz. Compatibility with the material to be packed, properties of various packaging materials and their specifications, & essential components for selection of packaging materials, essential criteria for selection of packaging materials, Different packaging and sealing machine for liquid /semisolid packaging. Edible packaging & eco friendly alternative to the plastic.

Forms of packaging:

Folded cartons/boxes; corrugated board boxes, metal containers bags and envelopes, aerosols. Tubes, cans and different forms of plastics, types of polymers use as packaging materials & useful commercial blend of polymers packaging.

Printing of packaging surfaces

Requirements of Printing and evaluation of printed surfaces, co-extrusion, extrusion Coatings and laminations of the packaging surfaces, types and properties of coatings and limitations, different types of laminating machines. Typical laminates film's constructions and its benefits & application. Coating weight "Neck-in" and drawdown in extrusion Coatings and laminations.

Packaging of various products

Oils and fats, soaps and detergents; cosmetics; petrochemicals, wax and wax products; essential oils and perfumes; lubricating oils and greases; by products of oils, soaps and allied industries. Food packaging & its environmental impacts. Limitation of solid waste management practices. Types of packaging material and environmental issues, advantages and disadvantages. Minimizing environmental impact. Physical & chemical tests of packing materials.

Industrial pollution and its impact

Magnitude of industrial waste, Legislative regulations. Recycle and reuse of waste water, recovery of by-products from industrial effluents.

Environmental Management Policy and Regulations

Environmental policy global and Indian scenario, scope of air and water pollution problems, economic considerations of waste disposal, separation and segregation of wastes, gaseous, liquid and solid waste disposal with special reference to oils and allied product processing CPCB/ state pollution control board guidelines and regulations.

Waste Management

Pollution prevention and environment Management system ISO 14000. Waste audit, Different regulation means & acts for air, water& solid pollution control.
