

5.1. QUALITY CONTROL AND TESTING OF RUBBER & PLASTICS – I

L T P

4 - 4

RATIONALE

It is necessary to test the new materials and the product during various stages of their manufacture to control the quality. The subject provides the essential knowledge and skills for the tests to measure variation and determination of plastic and rubber. This enables the students to take corrective action to be taken in factory to improve the uniformity and serviceability of the finished articles.

DETAILED CONTENTS

1. Over view of various testing methods and organization such as ASTM, BIS, DIN & ISO (08 hrs)
2. Test preparation methods: milling, punching, template, cutting from sheets and film products. (08 hrs)
3. Test for Natural and Synthetic Rubber: Test raw materials; Odour test, Colour test (Weber test, Trichloroacetic acid test).

Test for Pre-vulcanised Rubber: Telloy test, Vander test.

Test for Post-vulconised Rubber: Specific gravity, hardness, tear resistance, abrasion tests, permanent set, resilience, chemical resistance, temperature resistance, tackiness, flax cracking.

Test for synthetic rubber: Colour tests for formaldehyde , test for polyacrylonitrate and acrylonitnle copolymer, test for polystyrene and styrene copolymer. (22 hrs)
4. Tests for Plastic
 - (a) Physical properties: Visual burning and heating, specific gravity, water absorption, Moisture content analysis. (08 hrs)

- (b) Test for readily detectable elements and group analysis (08 hrs)
- (c) Physical Testing of Plastics: Mechanical properties:
 Short term mechanical properties: Tensile strength, impact strength (izod & Charpy) flexural strength, fatigue resistance, compression strength, tear test.
 Short term mechanical properties: Creap and stress relaxation (10 hrs)

LIST OF PRACTICALS

1. Preparation of test samples for tensile, compressive and impact (involves instructions regarding size and shape for the above mentioned tests)
2. To determine the specific gravity of polymer and rubber samples.
5. To determine the water and chemical absorption of various polymer samples.
- 4 . To determine the resistance to shelling of a rubber and polymer sample in various liquids.
5. Acid Resistance Test of plastic sample (Sample of plastic is boiled in acidic medium and then observe the physical change).
6. To determine the Melt Flow Index (MFI)

INSTRUCTIONAL STRATEGY

It is a practical oriented subject which should be taught along with practicals like those for mechanical properties and physical characteristics.

RECOMMENDED BOOKS

1. Testing of Plastic by Roger Brown
2. Plastics Testing: Vishu Shah
3. Rubber Technology & Alexander S. Craig, liver & boyd Publsihers
4. Rubber Technology and Manufacture by G.P. Maurya SBP Publishers
5. Polymer Science and Technology, Premamoy Ghosh (2nd Ed.), Tata McGraw

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	08	15
2	08	15
3	22	40
4	08	10
5	08	10
6	10	10
Total	64	100

5.2 REACTION ENGINEERING

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RATIONALE

It is a core subject of chemical engineering and is essential for understanding the kinetics of various types of reaction vessels and the performance of reactive system used in industry.

DETAILED CONTENTS

1. **Introduction:** (5 periods)
What is reaction engineering? Chemical kinetics & their dynamics classification of chemical reactions. Based on (i) Phases involved, (ii) Catalytic and non-catalytic reactions, (iii) Molecularity of a reaction, (iv) Heat effect, (v) based on order of reactions, (vi) reversible and irreversible reactions.
2. **Homogeneous Reactions:** (20 periods)
Rate of chemical reaction, factors affecting the rate of reaction. Concentration dependent term of a rate equation. Rate constant, Elementary and non-elementary reaction. Difference between elementary and non-elementary reactions. Molecularity of a reaction, order of a reaction. Difference between molecularity & order of reaction. Representation of an elementary & non-elementary reaction. Temperature dependent term of a rate of equation, Temperature dependency from Arrhenius law, collision theory & thermodynamics. Activation energy & its significance, activation energy & temperature dependency. Simple numerical problems,
3. **Interpretation of constant volume batch reactor data:** (35 periods)
Kinetic run, kinetic data or rate data, integral method of analyses of rate of data, differential method of analysis of rate of data. Integral V/s differential method, Constant volume batch reactor, conversion, relation of concentration and conversion for constant volume batch reactor.

Find out the concentration of component B, C & D in

- (a) Chemical reaction of the type $aA + bB \rightarrow cC + dD$ and for
- (b) For flow systems.

Analysis of total pressure data obtained in a constant volume system, use of ideal gas law. To calculate C_{A0} . Integral method of analysis of rate data; integrated rate expression for different order of reactions:

- (A) Irreversible unimolecular type first order reactions:
 - i. Integrated rate equation or expression for the first order reaction in terms of concentration, relation between half-life and rate constant.

- ii. Integrated rate equation or expression for the first order reaction in terms of conversion.
- (B) Irreversible bimolecular type second order reaction:
- i. Integrated rate equation or expression for the second order reaction in terms of concentration. Relation between half-life and rate constant and concentration.
 - ii. Integrated rate equation or expression for the second order reaction in term of conversion.
 - iii. Integrated rate equation for second order reaction with $C_{A_0} \neq C_{B_0}$ in terms of concentration.
 - iv. Integrated rate equation or expression for second order reaction with $C_{A_0} \neq C_{B_0}$. In term of conversion.
- (C) Zero order reaction: zero order reaction in terms of concentration & Conversion. Characteristics of zero order reaction.
- (D) Empirical rate equation of n^{th} order. Determination of overall order of irreversible reaction from half-life, Irreversible reaction in parallel/series & homogeneous catalyzed reactions, Auto catalytic reactions, Reversible reactions: Reversible reactions of unimolecular type first order reactions, reversible unimolecular type second order reactions.
- (E) Differential method of analysis of data :
- I) Step by step procedure for analysis of the complete rate equation by differential method.
 - II) Variable volume batch reactor: - Unimolecular type general reaction expression in which the volume is a liner function of conversion of a reactant. An integrated rate expression for first order reaction for variable volume system. Integrated rate expression for zero order reaction for a variable volume system.
Bimolecular type reactions: integrated rate expression for first & second order reactions. Simple numerical problems.

4. Ideal Reactors: (20 periods)

Classification of reactors based on

- a. Shape & size
 - i. Tank reactors
 - ii. Tubular reactors
- b. Based on mode of operation
 - i. Batch reactors
 - ii. Semi batch reactors
 - iii. Continuous flow reactors

Application, advantages, disadvantages and comparison of reactors.

Relation between C_A & X_A . Ideal batch reactor: - Performance/design equation for batch reactor for constant volume/constant density and for variable volume/density reaction system. The performance measures of flow reactors: - Space time and space velocity. Steady state mixed flow reactors (CSTR):- The performance equation for constant and variable volume/density reaction system. Steady state plug flow reactor: - Performance equation for plug flow reactor for first order reaction in case of constant density and variable density system. Holding time and space time for flow reactors.

INSTRUCTIONAL STRATEGY

Simple models can be made to show batch reactors, plug flow reactors and continuous reactors. Emphasis should be laid on problem solving / numerical solving for rate constants and temperature dependence of rate constant.

RECOMMENDED BOOKS

1. Chemical Reaction Engineering by Levenspiel, Job Wiley Publications
2. Chemical Engineering Kinetics by Smith, McGraw Hill Publication
3. Elements of Chemical Reaction engineering by Fogler, Prentice Hall of India
4. Reaction Kinetics for Chemical Engineering by Wales, McGraw Hill Publication
5. Chemical Reactin Theory – An Introduction by Denbigh and Turner, Cambridge University Press Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	05	10
2	12	20
3	35	50
4	20	20
Total	80	100

RUBBER AND PLASTIC PROCESSING – II

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RATIONALE

The purpose of this subject is to equip the students with the knowledge of Extrusion Process, Blow Moulding and Calendering Operations. This subject develops the competence of the students in major industrially practical processing techniques.

DETAILED CONTENTS

1. Extrusion Process
 - (a) Introduction to extrusion process (33 hrs)
Different types of extrusion (Ram, Single Screw, Twin Screw, Vented Barrel Extruder). General/principle of operation., die swell, functions of various parts of extruder (barrel, screw, screen, die, breaker plate, adapter and others and their materials.
 - (b) Types of screws

For use of different plastics, heating systems and different zones (feed, compression and metering)
 - (c) L / D ratio, compression Ratio, groove feeding and their relations to processing output and energy utilization.
 - (d) Blown film production, pipe, wire and cable coating , palletization plants , cooling rings, nip rolls, guessting device, bubble casing, winding equipment and cutting devices, stretching and orientation, effect of variables on product quality.
2. Co – Extrusion Process – Blow moulding (21 hrs)
 - (a) Principles, process parameters, Parison programming compressed air flow, description of blow moulding machines, types of materials used and limitation of blow, parting line and its significance and effect of temperature, air pressure and humidity on processing, automatic blow moulding.

- (b) New concepts including extrusion, stretch blow moulding , injection street blow moulding , multilayer moulding.
 - (c) Parison programming and blow moulding of irregular containers.
 - (d) Decoration of Blow Moulding products
 - (e) Faults and Remedies.
3. Calendaring (10 hrs)
- Process, material used, advantages of calendaring over extrusion, types of calendar, coating by calendaring, surface finishing

LIST OF PRACTICALS

1. Study of extruder in blown film plants
2. Study of cable/coating plants
3. Study of pipe and wire coating plants
4. Operation of extruder, control of process parameters (temperature, pressure, extruder speed)
5. Study of bag making process
6. Study of palletization process
7. Study of blow moulding machine
8. To study hot stamping process for plastic
9. Study of ultrasonic welding
10. To make a sheet using the process of calendaring

INSTRUCTIONAL STRATEGY

As the subject involves lot of processing, field visit is must to give details about various processing techniques used in rubber as well as plastic industries. Small and simple experiments/practicals will give idea about operational aspect of rubber and plastic industries.

LIST OF RECOMMENDED BOOKS

1. Plastic Engineering Handbook by Michael L. Berins
2. Plastic Extrusion Technology by Griff, Reinhold Book Corporation., London
3. Plastic Processing Data Handbook by DV Rosato
4. Extrusion of Plastics by Fischer, Itiffe London Publication.
5. Blow moulding by Fischer, Itiffe London Publication.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	33	55
2	21	40
3	10	15
Total	64	100

5.4. COMPOSITE TECHNOLOGY

L T P
4 - 4

RATIONALE

This course is designed to enable the students to acquire basic knowledge of reinforced plastics. The acquired knowledge will help the students in identifying the need for reinforcements, types of reinforcements and applications of reinforced plastics. Topics like nano-technology will help the students to keep abreast with the latest technological developments.

DETAILED CONTENTS

1. Introduction to composites . Advantages over virgin materials (06 hrs)
Principle of Composite Reinforcement
2. Classification of Composites (Properties and advantages) (06 hrs)
 - Particulate reinforced
 - Fibre reinforced (FRP)
 - Laminates
3. Particulate Reinforced Composites (16 hrs.)
 - (a) Different types of particulates; carbon black,. Silica, Mica, flyash, talc, CaCO₃, metallic powder, nano particulates.(clay, monocellulox etc.)
 - (b) Preparation, properties and applications of particulate reinforced plastics including flyash reinforced epoxies and polyesters, nano particles, reinforced polymers.
 - (c) Processing of particulate reinforced composites
4. Fibre reinforced plastics (20 hrs)

Properties, composition and advantages of various types of fibers; Carbon, glass fibers (different types) natural fibers (jute, aramid) boron fibers, man made fibers (acrylic, nylon, PAN)

Properties and application of FRPs including

 - Glass fibre reinforced polyesters
 - Glass fibre reinforced epoxies
 - Glass fiber wilt polyurethenes
 - Carbon fibre reinforced epoxies and polyesters
 - Nature fibre reinforced polyesters, polypropylene.

5. Processing and production techniques like hard lay-up, spray-up, bag moulding, filament winding, filtration etc. (16 hrs)

Types of Laminates

- Rigid and flexible laminate
- Plastic – plastic laminates
- Plastic – other material (plastic-wood, plastic paper, plastic metal etc.)

Preparation and properties and application of following laminates

- Packing material of food materials
- Polywood

LIST OF PRACTICALS

1. Preparation of flyash reinforced composites with polyester and measurement of the tensile strength
2. Preparation of metallic powder (aluminium powder) reinforced epoxy polycarbonate and measurement of its electrical conductivity.
3. Isolation of natural fabrics from Jute
4. Preparation of glass fibre reinforced polyester composites using hand lay-up techniques
5. Determination of fibre content in a composite sample
6. Comparison of various fibres like glass fibres and acrylic fibres for strength and other properties.

INSTRUCTIONAL STRATEGY

Industrial visit is highly recommended so as to make the student aware of working conditions in the industry as far as composite technology is concerned.

RECOMMENDED BOOKS

1. Handbook of plastics, elastomers and composites Charles A. Harper (Mc Graw Hill Co. New Delhi)
2. Polymer Engineering Composites by Richardson Mcw, Applied Sc. Publisher, London
3. Micro component polymer systems, Miller I.S and Rostane S.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	06	10
2	06	10
3	16	25
4	20	30
5	16	25
Total	64	100

5.5 ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT

L T P
Periods per week 5 - -

RATIONALE

In the present day scenario, it has become imperative to impart entrepreneurship and management concepts to students so that a significant percentage of them can be directed towards setting up and managing their own small enterprises. This subject focuses on imparting the necessary competencies and skills of enterprise set up and its management.

DETAILED CONTENTS

SECTION – A ENTREPRENEURSHIP

1. Introduction (23 periods)
 - Concept /Meaning and its need
 - Qualities and functions of entrepreneur and barriers in entrepreneurship
 - Sole proprietorship and partnership forms of business organisations
 - Schemes of assistance by entrepreneurial support agencies at National, State, District level: NSIC, NRDC, DC:MSME, SIDBI, NABARD, Commercial Banks, SFC's TCO, KVIB, DIC, Technology Business Incubator (TBI) and Science and Technology Entrepreneur Parks (STEP)

2. Market Survey and Opportunity Identification (17 periods)
 - Scanning of business environment
 - Salient features of National and State industrial policies and resultant business opportunities
 - Types and conduct of market survey
 - Assessment of demand and supply in potential areas of growth
 - Identifying business opportunity
 - Considerations in product selection

3. Project report Preparation (14 periods)
 - Preliminary project report
 - Detailed project report including technical, economic and market feasibility
 - Common errors in project report preparations
 - Exercises on preparation of project report

SECTION –B MANAGEMENT

4. Introduction to Management (06 periods)

- Definitions and importance of management
- Functions of management: Importance and Process of planning, organising, staffing, directing and controlling
- Principles of management (Henri Fayol, F.W. Taylor)
- Concept and structure of an organisation
- Types of industrial organisations
 - a) Line organisation
 - b) Line and staff organisation
 - c) Functional Organisation

5. Leadership and Motivation (05 periods)

a) Leadership

- Definition and Need
- Qualities and functions of a leader
- Manager Vs leader
- Types of leadership

b) Motivation

- Definitions and characteristics
- Factors affecting motivation
- Theories of motivation (Maslow, Herzberg, McGregor)

6. Management Scope in Different Areas (10 periods)

a) Human Resource Management

- Introduction and objective
- Introduction to Man power planning, recruitment and selection
- Introduction to performance appraisal methods

b) Material and Store Management

- Introduction functions, and objectives
- ABC Analysis and EOQ

c) Marketing and sales

- Introduction, importance, and its functions
- Physical distribution
- Introduction to promotion mix

- Sales promotion
- d) Financial Management
- Introductions, importance and its functions
 - Elementary knowledge of income tax, sales tax, excise duty, custom duty and VAT
7. Miscellaneous Topics (05 periods)
- a) Customer Relation Management (CRM)
- Definition and need
 - Types of CRM
- b) Total Quality Management (TQM)
- Statistical process control
 - Total employees Involvement
 - Just in time (JIT)
- c) Intellectual Property Right (IPR)
- Introductions, definition and its importance
 - Infringement related to patents, copy right, trade mark

Note: In addition, different activities like conduct of entrepreneurship awareness camp extension lecturers by outside experts, interactions sessions with entrepreneurs and industrial visits may also be organised.

INSTRUCTIONAL STRATEGY

Some of the topics may be taught using question/answer, assignment or seminar method. The teacher will discuss stories and case studies with students, which in turn will develop appropriate managerial and entrepreneurial qualities in the students. In addition, expert lecturers may also be arranged from outside experts and students may be taken to nearby industrial organisations on visit. Approach extracted reading and handouts may be provided.

RECOMMENDED BOOKS

1. A Handbook of Entrepreneurship, Edited by BS Rathore and Dr JS Saini; Aapga Publications, Panchkula (Haryana)
2. Entrepreneurship Development published by Tata McGraw Hill Publishing Company Ltd., New Delhi
3. Entrepreneurship Development in India by CB Gupta and P Srinivasan; Sultan Chand and Sons, New Delhi
4. Entrepreneurship Development - Small Business Enterprises by Poornima M Charantimath; Pearson Education, New Delhi
5. Entrepreneurship : New Venture Creation by David H Holt; Prentice Hall of India Pvt. Ltd., New Delhi
6. Handbook of Small Scale Industry by PM Bhandari

7. Principles and Practice of Management by L M Prasad; Sultan Chand & Sons, New Delhi.
8. Entrepreneurship Development & management By V.K. Joshi, Jagdamba Publication, New Delhi

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Pds)	Marks Allotted (%)
1	23	30
2	17	20
3	14	15
4	6	10
5	5	05
6	10	15
7	5	05
Total	80	100

5.6 MASS TRANSFER OPERATIONS

L T P
6 - 4

RATIONALE

In this subject the basic concepts of mass transfer are covered to enable the students to understand working of various mass transfer equipment like distillation column, gas absorption column, dryers, cooling towers and extraction column etc. which are used in industries for purification of products.

DETAILED CONTENTS

1. Mass Transfer (20 hrs)

Definition of diffusion, Rate of diffusion in Mass Transfer, Fick's law, diffusion in the gas phase-Equimolecular counter diffusion, diffusion through a stationary gas (Stefan's Law), Comparison of mass transfer in equimolecular counter diffusion and in diffusion through a stationary gas, Mass Transfer Coefficient. Film theory and penetration theory of Mass Transfer, Diffusion in solids, Knudsen diffusion.

2. Gas Absorption (20 hrs)

Condition of equilibrium between liquid and gas, mechanism of absorption two film theory. Diffusion of a gas through a stagnant gas, diffusion in liquid phase, rate of absorption, relation between film and overall coefficients, rate of absorption in terms of mole fraction, factors affecting transfer coefficients.

Packed Tower

Properties of tower packing, types of packing, Channeling, Limiting flow rates-Loading and Flooding Capacity of packed tower, Material balance and design equation, operating line. Concept of transfer unit, capacity of packed tower.

Material balance and design equation, height of column based on conditions in gas film, based on condition in liquid film, height of column based on overall coefficient, the operating line and graphical integration for height of column. Concept of transfer unit. H.E.T.P. for packed column of distillation, relation of H.T.U. to H.E.T.P.. Derivation of the following relations

$$1. \quad \frac{1}{K_G a} = \frac{1}{K_G a} + \frac{m}{K_L a}$$

$$\text{II.} \quad \frac{l}{K_L a} = \frac{l}{K_L a} + \frac{m}{K_G a}$$

3. Distillation (30 hrs)

- a) Various distillation methods
 - i) Equilibrium or flash distillation
 - ii) Differential distillation
 - iii) Batch distillation
 - iv) Vacuum and Steam distillation
 - v) Azeotropic and Extractive distillation.
- b) Types of distillation columns
 - i) Perforated plate or sieve plate column
 - ii) Bubble cap plate column
 - iii) Packed column and fractionating column accessories.
- c) Boiling point diagrams

Raoult's law; Henry's law, Relative volatility, constant boiling mixtures, equilibrium diagram and construction of equilibrium diagram, Fractionating column calculation- Heat & material balance, Reflux ratio, equilibrium plate, Location of feed plate. Sub cooled reflux; effect of reflux ratio, Total reflux, Minimum reflux ratio Entrainment; Mc-Cabfe Thiele diagram-section above and below feed plate; Intersection of operating line. Location of q-line, derivation of q line, optimum reflux ratio, calculation of no. of equilibrium plates by Mc-Cable Thiele diagram. Overall plate efficiency.

4. Extraction (08 hrs)

- i) Applications of this extraction
- ii) Choice of solvent
- iii) Steps of extraction operation
- iv) Solid Liquid extraction, construction and description of
 - Stationary solid bed open tank and closed tanks
 - Moving solid bed Basket type oil seed extractor or Bollman extractor
 - Rotocel extractor
- v) Liquid extractor; description and construction of
 - Mixer settler extraction system
 - Spray and packed extraction tower
 - Agitated tower extractor

- Perforated plate and baffle towers.

5. Humidification (10 hrs)

Definition and calculation of

- i) Humidity
- ii) Percentage humidity
- iii) Relative humidity
- iv) Humid volume
- v) Humid heat
- vi) Enthalpy and its calculation
- vii) Dry bulb and wet bulb-temp
- viii) Adiabatic saturation temperature
- ix) Use of humidity chart. Dew point, simple numerical problem using humidity chart, construction and description of cooling towers (Natural and induced draft)

6. Drying (08 hrs)

General drying behaviour-Critical moisture content, equilibrium moisture contents, description and construction of dryer.

- i) Tray dryer
- ii) Screen conveyor dryer
- iii) Rotary dryer.

NOTE:- At least one question from each topic

LIST OF PRACTICALS

1. To study the rate of drying in a vacuum dryer
2. To determine the pounds of volatile compounds distilled per unit pounds of steam distilled in a steam distillation operation
3. To determine rate of setting of crystals in a crystallizer
4. To study the rate of drying in rotary dryer
5. To determine drying rate for a wet materials
6. To determine drying rate for a wet material in a traydryer
7. To study packed tower in various industries
8. To study various extractors in solvent extraction plant
9. To study a spray pond in a sugar and other industries for cooling system
10. To find out the drying characteristics of given sample and draw drying rate curve by infra-red moisture meter and rapid moisture meter
11. To study sketch and operation of strip chart recorder and directing pen recorder

INSTRUCTIONAL STRATEGY

Field visit will make the students familiar with different types of column (packed/tray) and different types of packings/trays used in the column. This will also make the students aware of auxiliary equipment/manholes/supports used for the columns. Along with the theoretical part, emphasis should be given to problem solving and practices especially for distillation column, absorption and humidification.

RECOMMENDED BOOKS

1. Mass Transfer Operations by Trebel
2. Unit Operation by McCabe and Smith
3. Mass Transfer I & II by Bhattacharya
4. Mass Transfer by Gavanl
5. Mass Transfer by Badger

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	20	10
2	20	20
3	30	40
4	08	10
5	10	10
6	08	10
Total	96	100