4.1 UNIT OPERATIONS - II

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RATIONALE

A thorough knowledge of unit operations is essential for the study of polymer science and plastic processing. This course acquaints the students with the Fundamentals of thermodynamics, heat transfer and mass transfer.

DETAILED CONTENTS

1. Thermodynamics (14 hrs)

Thermodynamic system, surrounding, property, process, cycle, homogenous and heterogeneous system, thermodynamic equilibrium, ideal gas.

- Correlation and estimation of physical properties;, specific heat at constant pressure and constant volume, heat of reaction, heat of combustion etc.

- First law of thermodynamics: various forms of energy, internal energy, enthalpy, potential energy, kinetic energy, Heat and work. Isometric, isothermal, isobaric, isentropic, adiabatic and polytropic processes. Simple problems

- Second law of thermodynamics: Entropy change and its calculations for open and closed systems, carnot cycle, simple problems for calculation of entropy change.

2. Heat Transfer (17 hrs)

- Concept of heat transfer

- Modes of heat transfer. Conduction, Convection and Radiation; conduction through single, plane walls, composite walls, conduction through cylinders, calculation of heat' load; Fourier's law, thermal conductivity (without heat generation)

- Convection: Natural and forced convection, concept of heat transfer coefficient, LMTD, importance and significance of Reynolds number, Prandtl number, Nusselt number and Grashoff number

- Radiation : _Kirchoff’s law, emmissive power, Wein's displacement law, StefanBoltmqn's Law; emissivity, absorptivity, black body and grey body radiation; simple problems

- Boiling, condensation and evaporation

- Introduction to heat exchangers and its types, Parallel flow and counter flow heat exchangers

- Evaporators, condensers – their construction and applications

3. Mass Transfer (17 hrs)

- Introduction to mass transfer operations and classification. Mass transfer coefficient. Mass transfer by molecular diffusion. Correlation of mass transfer coefficient (two film theory, penetration theory). Interphase mass transfer

- Terminology related to psychometry. Humidification and dehumidification. Constructional "details of humidification and dehumidification column and their applications in industry. Principle of drying and drying equipment

- Distillation: Various distillation methods: batch distillation, vacuum distillation, azeotropic and extractive distillation; various types of distillation columns and their constructional features

- Introduction to. absorption and adsorption. Difference between absorption and adsorption equipments used like packed bed column, sieve column

LIST OF PRACTICALS

1. To measure the thermal conductivity of insulating materials
2. To determine overall heat transfer co-efficient in, a double pipe heat exchanger in parallel and counter flow heat exchange modes
3. Measurement of emissivity of test surfaces
4. To prove Stefan- Boltman's Law
5. To measure diffusivity of solids in liquid or gas
6. To perform an experiment on batch distillation unit and calculate xf, xd and effectiveness
7. To perform an experiment on humidification column
8. To determine the drying characteristics of a given substance (drying rate measurement) and draw the drying curve.

9. To carry out the calibration of a temperature measuring device on temperature calibration test rig
10. To calibrate Bourdon gauge on pressure calibration test rig.

RECOMMENDED BOOKS

1. Unit Operations – Vol. I by Chatterjee, Khanna Publishers, New Delhi
2. Unit Operations – Vol. II by Chatterjee, Khanna Publishers, New Delhi
3. Chemical Engineering Thermodynamics by Dodge, McGraw Hill Publication
4. Introduction to Chemical Engineering Thermodynamics by Smith and Vanness
5. Heat Transfer by Kreith
6. Heat Transfer by DQ Kern
7. Mass Transfer Operations by Treybal

4.2 DESIGN OF DIES AND MOULDS - I

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RATIONALE

A diploma holder in plastic technology is engaged in manufacturing plastic components for which design of moulds and dies is essential. This subject will impart them requisite knowledge and skill in design of moulds and dies.

DETAILED CONTENTS

1. Basic concept of mould designing, shrinkage, flash line, taper and draft (3 hrs)

2. Materials used for dies and moulds and their characteristics (3 hrs)

3. General design considerations for various types of moulds (3 hrs)

4. Machining methods - general introduction to lathe machine, grinder, shaper, milling, spark erosion, CNC wirecut (5 hrs)

5. Impressions – Core and cavity. Types of cavity and core, their advantages and disadvantages. Bolster plate and its types, guide piller, guide bush, register ring and their types. Mould clamping – direct, indirect (6 hrs)

6. Parting surface – Types of parting surface, selection of parting surface (5 hrs)

7. Feed system (12 hrs)
   - Runners – Sprue, runners and its types, balancing of runners, size of runners
   - Gates – Types of gates, size of gates

8. Ejection system – Ejector grid, ejector plate assembly (11 hrs)

9. Cooling system – Cooling methods, cooling circuits for an integer and insert core cavity moulds e.g. U-type, rectangular and Z-type (7 hrs)

10. Injection mould – Types of moulds; 2-plate mould, 3-plate mould, split mould, runnerless mould (9 hrs)

LIST OF PRACTICALS

1. To design and draw various mould parts
2. To design and draw a two plate injection mould

3. To design and draw a three plate injection mould
4. To design and draw a split mould
5. To design and draw a runnerless mould

Note: Maximum 10 sheets will be prepared by the students

RECOMMENDED BOOKS

1. Injection Mould Design by R.C.W Pye; Longman Scientific and Technical Publication
2. Plastic Mould Engineering Hand Book by J. Harry Don Bose and Mayne I pribble, Van Nostrand Reinhold Company Publication
3. Injection Moulding Handbook by Dominick V Rosato and Donald V Rosato
4. Plastic Engineering Handbook by Joel Frados; Van Nostrand Reinhold Company Publication
5. Plastic Engineering by RJ Crawford; Maxwell Macmillan International edition Publication

4.3 ENGINEERING AND SPECIALITY POLYMERS

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RATIONALE

This subject gives a detailed description of polymeric materials in category of thermoplastics, thermosets and thermoplastic elastomers. The students acquires the knowledge of advanced engineering and speciality polymers so that he/she can select the right type of materials for processing to make the product.

DETAILED CONTENTS

1. Advanced thermosets, epoxies, poly urethanes (6 hrs)

2. Engineering thermoplastics – poly carbonates, polyamides, PEEK, poly phenylene oxide, acetals (8 hrs)

3. Reinforced plastics – principles of composite reinforcement, effect of reinforcement on strength of plastics. Role and nature of binders and coupling agents, properties and applications of fibres in reinforcement (glass and carbon). Miscellaneous fillers (Talc, mica, glass beads). Properties and applications of FRPs (un-saturated polyesters, epoxies, PU, nylon) (10 hrs)

4. Polyblends and alloys – Definition, advantages of polymers, blends and alloys, role of composition, properties and applications of parameters for compability, PVC – Nitrile rubber, ABS-PVC and PP-EPDM (6 hrs)

5. High performance polymers – polytetrafluroethylene, Teflon, polysulphones, liquid crystalline polymers (8 hrs)

6. Preliminary concept of new materials such as conducting polymers, bio-polymers, onto-electronic plastics, nano-polymeric materials and plastics in biomedical applications, interpenetrating polymer networks, polymer concretes (10 hrs)

RECOMMENDED BOOKS

1. Polymer Science & Technology by Premamoy Ghosh
1. Polymer Blends and Alloys by Arends
2. Polymers Science & Technology by JR Fried
3. Plastics Materials by Brydson, PHI Publication
4. Engineering Polymers by Dyson, PHI Publication
5. Polymer Materials and Processing by Jean Michael Charrier

4.4 PLASTIC PROCESSING TECHNIQUES - I

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RATIONALE

The purpose of this subject is to equip the students with the knowledge of plastic processing machineries and injection moulding. This subject develops the competence of the students in major industrially practiced processing techniques.

DETAILED CONTENTS

1. Introduction to polymer processing. Polymer melt flow, melt flow processes (5 hrs)

2. Preheating/drying of plastics raw materials before processing. Kneaders (5 hrs)

3. Basic theoretical concepts and their relationship to processing. How rheological properties relate to moulding conditions, effect of shear, orientation and crystallinity (5 hrs)

4. Introduction, principles, process variables, mechanical, electrical, electronics control system, moulding cycle (5 hrs)

5. Basic principles of operations of injections moulding machinery/types of injection moulding machines, description with detailed construction (10 hrs)

6. Parts and functions, general specifications, construction, start up and shut down procedures, cylinder nozzles, interaction of moulding variables, press capacity, projected areas, shot weight, optimization of cycles flow. (10 hrs)

7. Selection of machine – study and analysis of specifications sheet, literature supplied by machine manufacturers, hand operated, semi-automatic and CNC injection molding machines (10 hrs)

8. Defects in injection molding products, their causes and remedies (4 hrs)

9. Injection molding of thermosets (5 hrs)

10. Post processing operation – engraving, metallisation, painting, electroplating, encapsulation (5 hrs)

LIST OF PRACTICALS

1. To draw the layout of plastic processing laboratory
2. To produce small components on hand operated injection molding machine (at least 10 components each on 2/3 different moulds)
3. To study the specifications of automatic injection molding machine
4. To study the specifications of CNC injection molding machine
5. To produce small components on semi-automatic/automatic injection molding machine after setting process variables
6. To produce small components on vertical hydraulic injection moulding machine
7. To produce components on CNC injection moulding machine after programming for different components

RECOMMENDED BOOKS

1. Polymer Processing by DH Morton Jones
2. Plastic Engineering Handbook by Joel Frados
3. Plastic Engineering Handbook by ML Berins
4. Injection Molding Handbook by Rosato
5. Injection Molding Handbook by AS Athalye

4.5 PROCESS INSTRUMENTATION

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RATIONALE

This subject gives the knowledge of various instruments used to measure various process parameters. This course will impart knowledge on working principle, construction, repair and use of these instruments

DETAILED CONTENTS

1. Introduction (30 hrs)

   Importance of instrument in chemical process industry, general classification of instruments, indicating and recording type instruments, static and dynamic characteristics of instrument, description and construction details, working principle, range and application of following instrument:

   a) Pressure and vacuum gauge: liquid column gauge, bourden tube gauge

   b) Thermometer and Pyrometer: liquid expansion thermometer, bimetallic thermometer, thermocouple, resistance thermometer, optical and radiation pyrometer

   c) Liquid level meter: visual indicator, float actuated level meter, static pressure instrument

   d) Flow meters: Orifice, venturi, pitot tube, rotameter

   e) Analysers: pH meter, chemical composition analyzer, various types of analyzer i.e. oxygen analyzer, infra red analyzer, orsat analyzer

2. Transmission (4 hrs)

   Pneumatic and electrical transmission (Induction Transmission only) and their field of application

3. Process Instrumentation (9 hrs)

   Recording instruments indicating and recording instruments

   Transmission of instrument reading, control centre, instrument diagram, instrumentation in modern chemical plant

4. Basic concept of process control, types of controllers and control valves (5 hrs)

LIST OF PRACTICALS

1. Calibration of pressure gauge/vacuum gauge
2. Calibration of resistance thermometer
3. Calibration of thermocouple
4. Characteristics of a flapper nozzle system
5. Study of on-off controller for temperature control
6. Study of constructional detail of chart recorder
7. Study of constructional details of strip chart recorder
8. Study the composition analysis using pH meter/conductivity meter

RECOMMENDED BOOKS

1. Industrial Instrumentation by Donald P Eckman, Wiley Eastern Publication
2. Principles of Industrial Instrumentation by D Patranabis, Tata McGraw Hill Publication
3. Process System Analysis and Control by Coughnour, McGraw Hill Publication
4. Industrial Instrumentation by SK Singh, Tata McGraw Hill Publication

4.6 MINOR PROJECT WORK

L	T	P
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Minor project work aims at exposing the students to field practices, size and scale of operation and work culture at practical sites. For this purpose, students during middle of the course, are required to be sent for a period of 4 weeks at different work sites. Some of the good industries are suggested by the expert group as follows:

1. Flex Industries, Noida
2. Revex Industries Ltd, Bhiwadi, Rajasthan
3. Apex Plastics Pvt. Ltd, Bhiwadi, Rajasthan
4. Revex Plasticizers Pvt.Ltd, Bhiwadi, Rajasthan
5. Haryana Plastic and Engineering Work, New Delhi
6. Vam Organic Chemical Ltd., Gajraula, Moradabad
7. Blow Plast Industries, New Delhi
8. Machino Plastic Ltd, Gurgaon
9. Minda Industries Ltd., Delhi
10. Super Cassettes Industries, Noida
11. Surya PET, New Delhi
12. Sumi Matherson Innovative Engineering Ltd., Noida
13. Evershine Moulders Ltd., Noida
14. Pramod Plastics Pvt. Ltd., New Delhi
15. Joshi Auto Industries Ltd., Mathura Road, Faridabad
16. Paradise Plastic Enterprises Ltd., Noida
17. Hitkari Industries Ltd., Parwanoo, Distt. Solan, HP
18. Polyplastics, Industrial Area, Yamunanagar, Punjab

As a minor project activity, each student is supposed to study the material and technology used at site and prepare a detailed project report of the observation of process seen by him/her. These students should be supervised and guided by respective subject teachers. Each teacher may guide a group of four to five students.

The teacher along with field supervisors will conduct performance assessment of students. This minor project work will carry 200 marks. 100 marks will be given by Industrial/field supervisors and 100 marks by the teacher supervising this training. The components of evaluation will include the following:

a)	Punctuality and regularity	15%
b)	Initiative in learning new things	15%
c)	Relationship with workers	15%
d)	Industrial training report	55%