

X. Suggested Reading

- Bird, Stewart, Lightfoot 2002. *Transport Phenomena*, John Wiley & Sons.
- Bodh Raj 2012. *Introduction to Transport Phenomena*, PHI.
- Christie J. 1993. *Transport Process and Unit Operations*. Prentice-Hall of India Private Limited, New Delhi ISBN 0-13-045253-X.
- Coulson JM and Richardson JF. 1999. *Chemical Engineering*. Vol. II, IV. ThePergamon Press.
- Earle RL. 1985. *Unit Operations in Food Processing*. Pergamon Press.
- Holman JP 1992. *Heat Transfer*. McGraw Hill.
- Jorge Welte-Chanes, Jorge F and Velez-Ruiz 2002. *Transport Phenomena in Food Processing*. CRC Press ISBN: 9781566769938 Geankoplis.
- McCabe WL and Smith JC 1999. *Unit Operations of Chemical Engineering*. McGraw Hill.
- Plawsky, Joel L 2014. *Transport Phenomena Fundamentals*, CRC Press, ISBN: 978-1-4665-5535-8, 1466555351.

I. Course Title : Unit Operations in Food Process Engineering

II. Course Code : PFE 502

III. Credit Hours : 2+1

IV. Aim of the course

To acquaint and equip the students with different unit operations applicable in food industries.

V. Theory

Unit I

Review of basic engineering mathematics. Units and dimensions. Mass and energy balance. Principles of fluid flow. Heat transfer: Conduction, convection and radiation. Heat exchangers and their designs.

Unit II

Drying and dehydration: Psychrometry, theories of drying, EMC, equipment for drying of solid, pastes and liquid foods. Evaporation: Components, heat and mass balance in single and multiple effect evaporators, equipment and applications, steam economy. Thermal processing: Blanching, pasteurization and sterilization, death rate kinetics, process time calculations, sterilization equipment.

Unit III

Refrigeration and freezing: Principles, freezing curve, freezing time calculation, freezing equipment, cold chain.

Unit IV

Mechanical separation: Principle and equipment involved in sieving, filtration, sedimentation and centrifugation, cyclone separation. Material handling: Conveyors and elevators, components and design considerations for belt, chain, bucket and screw conveyors.

Unit V

Size reduction: Principles of size reduction, size reduction laws. Size reduction equipment: Jaw crusher, gyratory crusher, roller mill, hammer mill.

VI. Practical

Study of fluid flow properties. Study of heat exchangers, functional design of heat



exchangers. Application of psychrometric chart. Determination of EMC. Study of driers. Solving problems on single and multiple effect evaporator. Elevating and conveying equipments. Size reduction equipments. Cleaning and sorting equipment. Sieve analysis. Kinetics of fruits and vegetables dehydration. Calculation of refrigeration load, solving of numerical problems. Visit to related food industry.

VII. Learning outcome

The students will get knowledge on various unit operations, backbone of all food processes. Knowledge on basic principles of thermal food processes, size reduction and separation operations involved in food processing and related equipment will prepare students to solve problems related with food processing. This will help students to solve problems of post-production processes and will also enhance employability in food industries.

VIII. Lecture Schedule

S.No.	Topic	No. of Lectures
1.	Calculations of material balance related to various food processes	3
2.	Study of energy balance for processing operation and related parameters	3
3.	Study of fluid statics, fluid dynamics, flow characteristics	2
4.	Introduction to heat transfer, modes of heat transfer, heat conduction	2
5.	Introduction to Psychometrics basics	2
6.	Study of Dehydration, EMC, Mechanism of drying constant rate period, Falling rate period	2
7.	Study of drying equipments	2
8.	Evaporation, types of evaporators, Flow arrangements Mass and energy balance, Steam economy	2
9.	Thermal processing: Blanching, pasteurization and sterilization, death rate kinetics, process time calculations, sterilization equipment.	3
10.	Refrigeration and freezing: Principles, freezing curve, freezing time calculation, freezing equipment, cold chain.	2
11.	Mechanical separation: Principle and equipment involved in sieving, filtration, sedimentation and centrifugation, cyclone separation.	2
12.	Material handling: Conveyors and elevators, components and design considerations for belt, chain, bucket and screw conveyors.	2
13.	Study of principles involved in the size reduction and separation. Equipment used	3
	Total	30

IX. List of Practicals

S.No.	Topic	No. of Practicals
1.	Use of units, dimensions and basic mathematical applications	1
2.	To judge the students ability for solving mass balance problems	2
3.	To judge the students ability for solving Energy balance problems	2
4.	To assess the flow rate of fluids through pipes and channels	1
5.	To verify the Bernoulli's Equation	1
6.	To Study heat exchangers and calculation of log mean temperature difference	1
7.	To solve the heat transfer problems	2
8.	To study different dryers used in drying of biological materials	1
9.	To study single effect and multi effect evaporators	1
10.	To calculate the thermal process time using trapezoidal/ Simpson's formulae	1



S.No.	Topic	No. of Practicals
11.	To find the graphical solution for calculation of thermal process time	1
12.	To study different separation equipments	1
13.	To study the size reduction equipments	1
	Total	16

X. Suggested Reading

- Berk. 2018. *Food Process Engineering and Technology*, Academic Press, ISBN: 978-0-12-812018-7
- Brennan JG, Butters JR, Cowell ND and Lilly AEI. 1990. *Food Engineering Operations*. Elsevier.
- Fellows P 1988. *Food Processing Technology: Principle and Practice*. VCH Publ.
- McCabe WL and Smith JC. 1999. *Unit Operations of Chemical Engineering*. McGraw Hill.
- Sahay KM and Singh KK. 1994. *Unit Operation of Agricultural Processing*. Vikas Publ. House.
- Singh RP and Heldman DR. 1993. *Introduction to Food Engineering*. Academic Press.
- Smith. 2011. *Introduction to Food Process Engineering*, Springer.
- Toledo. 2007. *Fundamentals of Food Process Engineering*, Springer.
- Varzakas. 2015. *Food Engineering Handbook*, CRC press.

I. Course Title : Field Crops Process Engineering

II. Course Code : PFE 503

III. Credit Hours : 2+1

IV. Aim of the course

To acquaint and equip the students with the post harvest technology of cereals, pulses and oilseeds with special emphasis on equipment used in the milling and processing.

V. Theory

Unit I

Production and utilization of cereals and pulses, grain structure of major cereals, pulses and oilseeds and their milling fractions. Grain quality standards and physico-chemical methods for evaluation of quality of flours.

Unit II

Pre-milling treatments and their effects on milling quality. Parboiling and drying, conventional, modern and integrated rice milling operations. Wheat roller flour milling. Processes for milling of corn, oats, barley, gram, pulses, paddy and flour milling equipment. Layout of milling plants.

Unit III

Dal mills, handling and storage of by-products and their utilization. Storage of milled products. Expeller and solvent extraction processing. Assessment of processed product quality.

Unit IV

Packaging of processed products. Design characteristics of milling equipment, selection, installation and their performance. Quality standards for various processed products. Value added products of cereals, pulses and oilseeds.