

**UTKALMANI GOPABANDHU INSTITUTE OF
ENGINEERING, ROURKELA**



LESSON PLAN

DEPARTMENT OF CHEMICAL ENGINEERING

LESSON PLAN



SUBJECT CODE : TH-4

NAME : NSP

BRANCH : CH

SEMESTER :Diploma-VI

CREDIT POINTS : 4

NUMBER OF MODULES : 4

CLASSES REQUIRED : 60

PRE-REQUISITE : TO KNOW NATURE OF MEMBRANE, ITS MODULE, FLOW PATTERN, UNDERSTAND CONCEPT OF MEMBRANE, TYPE AND MODULE, CONCEPT OF REVERSE OSMOSIS, NANO FILTRATION, ULTRA FILTRATION, MICRO FILTRATION, GAS SEPARATION AND PERVAPORATION, ION EXCHANGE AND OTHER MEMBRANE PROCESSES IN INDUSTRY

MODULE-I

INTRODUCTION: 1. what is a membrane? 2. Basic principle of membrane separation 3 Classification of membrane processes, 4. Advantages and disadvantages of membrane processes, 5. Major application area of membrane separation, 6. Future processes of membrane separation

Objectives:

To understand the definitions & types of membrane process, Importance of separation process, Advantages and disadvantages of membrane processes.

Session no	Topics to be covered	PRIMARY REFERENCE (BOOKS/NOTES)	EXPECTED QUESTIONS TO BE DISCUSSED
1	Introduction to membrane separation, Importance of separation process	T1, R1	Q.A.(1-6) Q.B.(1-6) Q.C.(1-2)
2	Origin of membrane, Overall idea about membrane	T1	
3	Basic principle of membrane separation	T1, R1	
4	Classification of membrane process	T1, R1	
5	Characteristics of membrane process	R1	
6	Advantages and disadvantages of membrane processes	R1,T1	
7	Major application area of membrane separation	R1	
8	Future processes of membrane separation	T1, R1	

MODULE-II

MEMBRANE TYPE, MODULE, FLOW PATTERN: 1. Types of synthetic membrane 2. Micro porous membrane, Asymmetric membrane, thin film composite, Electrically charged, inorganic membrane, 3. Membrane module- Plate and frame, Tubular, Spiral wound, Hollow fiber, 4. Membrane material and Pore Characteristics, 5. Types of flow pattern

Objectives:

To study Types of synthetic membrane, Thin film composite membrane, Plate and frame module and tubular modules, characteristics and applications, Types of flow patterns.

Session no	Topics to be covered	PRIMARY REFERENCE (BOOKS/NOTES)	EXPECTED QUESTIONS TO BE DISCUSSED
9	Types of synthetic membrane	T1, R1	Q.A.(7-11) Q.B.(7-13) Q.C.(3-5)
10	Micro-porous membrane and Asymmetric membrane	T1, R1	
11	Thin film composite membrane	T1	
12	Electrically charged membrane	T1, R1	
13	Inorganic membrane	R1	
14	Membrane modules	R1,T1	
15	Plate and frame module and tubular modules	R1,T1	

16	Spiral wound module	T1, R1	
17	Hollow fibre module	T1, R1	
18	Types of flow patterns	R1	

MODULE-III

REVERSE OSMOSIS: 1. Concept of Osmosis, Determination of osmotic pressure, Thermodynamic consideration of osmosis, 2. Isotonic solution, 3. High Pressure and low pressure reverse osmosis, 4. Advantages and disadvantages of reverse osmosis Forward Osmosis- Elementary idea and application, 5. Membrane plugging 6. Application of reverse osmosis

Objectives:

To understand the definitions of osmosis, Concept and process Reverse osmosis, Advantages and disadvantages, applications of reverse osmosis.

Session no	Topics to be covered	PRIMARY REFERENCE (BOOKS/NOTES)	EXPECTED QUESTIONS TO BE DISCUSSED
19	Concept of osmosis	T1, R1	Q.A.(12-18) Q.B.(14-19) Q.C.15
20	Determination of osmotic pressure	T1, R1	
21	Thermodynamic consideration of osmosis	T1	
22	Physical significance of chemical potential in osmosis.	T1, R1	
23	Concept and process Reverse osmosis	R1	
24	Basic information on reverse osmosis	R1,T1	
25	High pressure and low pressure reverse osmosis	R1	
26	Advantages and disadvantages of reverse osmosis	T1, R1	
27	Applications of reverse osmosis	T1, R1	
28	Advance Applications of reverse osmosis	R1, T1	

MODULE-IV

NANO FILTRATION, ULTRA FILTRATION, MICRO FILTRATION : 1. Principle of Nano filtration, 2. Process limitation of Nano filtration, 3. Industrial application of Nano filtration, 4. Principle of Ultra filtration and its advantages, 5. Ultra filtration vis-à-vis conventional filtration, 6. Configuration of Ultra filtration unit, 7. Types of devices in Ultra filtration, 8. Factors affecting the performance of Ultra filtration, 9. Industrial application of Ultra filtration, 10. Principle of Micro filtration, 11. Fouling in Micro filtration membrane, 12. Application of Micro filtration

Objectives:

To understand the principle and application of Nano-filtration, Ultrafiltration, Micro-filtration, applications, Configuration of Ultra filtration unit, Types of devices in Ultra filtration, Factors affecting the performance of Ultra filtration

Session no	Topics to be covered	PRIMARY REFERENCE (BOOKS/NOTES)	EXPECTED QUESTIONS TO BE DISCUSSED
29	Principle of Nano-filtration	T1, R1	Q.A.(19-24)

30	Process limitation of Nano-filtration	T1,R1	Q.B.(20-26) Q.C.6 Q.C.(16-20)
31	Industrial application of Nano-filtration	T1	
32	Principle of ultra-filtration and its advantages	T1, R1	
33	Ultrafiltration vs conventional filtration	R1	
34	Configuration of ultrafiltration unit	R1,T1	
35	Types of devices in ultrafiltration	R1	
36	Factors affecting the performance of ultrafiltration	T1, R1	
37	Industrial application of ultra-filtration	T1, R1	
38	Principle of Micro-filtration	R1	
39	Fouling in Micro-filtration	T1, R1	
40	Industrial application of Micro-filtration	T1,R1	

MODULE-V

GAS SEPARATION AND PERVAPORATION: 1. Basic principle of gas separation, 2 Membranes for gas separation and Application of Gas separation, 3. Basic principle of Pervaporation, 4. Membrane characteristics and mass transfer in pervaporation & Application

Objectives:

To understand the principle of gas separation, pervaporation, Membrane characteristics and applications

Session no	Topics to be covered	PRIMARY REFERENCE (BOOKS/NOTES)	EXPECTED QUESTIONS TO BE DISCUSSED
41	Basic principle of gas Separation	T1, R1	Q.A.(25-33) Q.B.(27-36) Q.C.(7-10)
42	Membranes for gas separation	T1,R1	
43	Applications of gas separation	T1	
44	Advanced applications of gas separation	T1, R1	
45	Basic principle of pervaporation	R1	
46	Membrane characteristics	R1,T1	
47	Cross linking methods	R1	
48	Mass transfer in pervaporation	T1, R1	
49	Applications of pervaporation	T1, R1	
50	Advanced applications of pervaporation	R1	

MODULE-VI

ION EXCHANGE AND OTHER MEMBRANE APPLICATION: 1. Principle of Ion exchange, 2. Characteristic of ion exchange resin, 3. Application of ion exchange, 4 Membrane Distillation, 5. Membrane reactors

Objectives:

To understand the basic principle of ion-exchange, Characteristics of ion-exchange membrane, Donnan Exclusion Configuration of Membrane distillation, Membrane reactor and applications.

Session no	Topics to be covered	PRIMARY REFERENCE (BOOKS/NOTES)	EXPECTED QUESTIONS TO BE
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			DISCUSSED
51	Basic principle of ion-exchange	T1, R1	Q.B.(37-38) Q.C.(11-14)
52	Characteristics of ion-exchange membrane	T1,R1	
53	Applications of ion-exchange membrane	T1	
54	Advanced applications of ion-exchange membrane	T1, R1	
55	Donnan Exclusion	R1	
56	Membrane distillation	R1,T1	
57	Configuration of Membrane distillation	R1	
58	Application of Membrane distillation	T1, R1	
59	Membrane reactor	T1, R1	
60	Applications of Membrane reactor	R1	

Course Delivery Plan



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BOOKS FOR REFERENCE: TEXT BOOKS

T1: Membrane Separation Processes by Kausik Nath, PHI Publication.

REFERENCE

R1: Unit Operations of Chemical Engineering by Mc Cabe & Smith, Tata Mc Grawhill Publication

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QUESTION BANK ON NST
6TH SEMESTER, CHEMICAL ENGINEERING
UTKALMANI GOPABANDHU INSTITUTE OF ENGINEERING, ROURKELA
PREPARED BY SATARUPA SAHU

A. 2 MARKS

1. Write down the components of a membrane separation process.
2. What is the importance of membrane separation process?
3. Give two examples of membrane (organic and inorganic).
4. Define membrane.
5. What are the parameters affecting the flux for membrane?
6. Write down the future aspect of membrane separation.
7. Define membrane module and state the types of membrane modules.
8. Write down the types of micro-porous and asymmetric membrane.
9. Write down the differences between micro-porous and asymmetric membrane.
10. Write down the morphology and types of synthetic membranes.
11. Describe the material used and manufacturing method for thin film composite membrane synthesis.
12. Define osmosis with an example.
13. What are the forces required for osmosis process to work?
14. Write down Gibbs free energy equation.
15. Define isotonic solution.
16. Define reverse osmosis.
17. Write down the membrane material and module used for reverse osmosis
18. What is the driving force and transport mechanism for reverse osmosis
19. Why nano-filtration is called as ultra-osmosis?
20. What are the modules used for nano-filtration?
21. Write down the membrane material used for nano-filtration?
22. Write down the membrane materials used for ultra-filtration.
23. Write down the types of fouling in micro-filtration.
24. Write down the membrane materials used for micro-filtration.
25. Define gas Separation?
26. Define pervaporation.
27. Give examples of amorphous and crystalline membrane.
28. What is the necessity of cross-linking?
29. Define swelling degree.
30. Classify ion-exchange membranes.
31. Define Permselectivity.
32. Write down the components used in electro-dialysis process
33. Write down the characteristics of ion-exchange membrane (any two).



B. 5 MARKS

1. Differentiate between equilibrium and rate governed separation.
2. Write down basic principle of membrane separation.
3. What is the active, passive and carrier mediated transport?
4. Classify the membrane process based on driving force.
5. Describe the characteristics of membrane process.
6. Write down the various permeates and retentates for membrane processes.
7. Describe the micro-porous and asymmetric membrane with advantages.
8. Write down the advantages of different membrane modules.
9. Write down the design aspects and advantages of plate and frame membrane module.
10. Write down the design aspects and advantages of tubular membrane module.
11. Write down the design aspects and advantages of spiral wound membrane module.
12. Write down the design aspects and advantages of hollow fibre membrane module.
13. Write down the types of flow patterns involved in membrane process
14. Write down Van't Hoff formula with assumptions.
15. Calculate the osmotic pressure of a solution containing 0.10g mol KCl/1000gH₂O at 25°C.
16. Describe the thermodynamic consideration of osmosis.
17. Describe the physical significance of Gibbs free energy equation in osmosis.
18. Differentiate between high pressure and low pressure reverse osmosis.
19. Describe the advantages and disadvantages of reverse osmosis.
20. Write down the parameters affecting nano-filtration.
21. Write down the advantages of ultra-filtration.
22. Differentiate between ultrafiltration and conventional filtration.
23. Draw the flow diagrams for recycle configuration and tapered configuration.
24. Write down the principle of Micro-filtration.
25. Difference between cross flow and dead-end Micro-filtration
26. Write down the factors affecting fouling in micro-filtration
27. Write down the principle of gas Separation?
28. Write down the type of membranes used in gas-separation.
29. Explain the principle of pervaporation.
30. Write down the type of membranes used in pervaporation
31. Describe the methods of cross-linking.
32. Describe the principle of ion-exchange membranes.
33. Draw the schematic diagram of electro-dialysis process.
34. Write down the chemical equations occurring in ion-exchange membrane.
35. Explain Donnan exclusion principle.
36. Write down manufacturing methods of homogeneous and heterogeneous membrane.
37. Write down the mechanism of membrane distillation.
38. Describe the membrane characteristics of membrane distillation.



C. 10 MARKS

1. Write down the advantages and disadvantages of a membrane separation process.
2. Write down the applications of a membrane separation process.
3. Describe the electrically charged membrane with characteristics and applications.
4. Describe the characteristics of inorganic membrane.
5. Write down the applications, advantages and manufacturing methods of Inorganic membrane.
6. Write down the major application areas of Micro-filtration.
7. Describe the Industrial application of gas Separation.
8. Describe the mass transfer in pervaporation
9. Write down the applications of pervaporation.
10. Write down the applications of ion-exchange membrane
11. Write down the different configuration of membrane distillation
12. Write down the application of membrane distillation
13. Describe the function of membrane in membrane reactor
14. Write down the types of membranes in membrane reactor.
15. Write down the major application areas of reverse osmosis process
16. Describe the Industrial application of Nano-filtration.
17. Write down the type of devices used in ultra-filtration.
18. Describe the factors affecting the performance of ultrafiltration.
19. Write down the major application areas of ultra-filtration process
20. Differentiate between external fouling and internal fouling with diagram.

