

**Book Review**  
**Fundamentals of Membrane Separation Technology authored**  
**by Zhan Wang**

Mohd Nazri Mohd Sokri

Energy Engineering Department, Faculty of Chemical and Energy Engineering,  
Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia

Submitted: 03/01/2026. Revised edition: 03/02/2026. Accepted: 03/02/2026. Available online: 21/04/2026

---

## **ABSTRACT**

This review evaluates *Fundamentals of Membrane Separation Technology* (Elsevier; 2024), authored by Prof. Zhan Wang [1], a senior membrane scientist from the Beijing University of Technology who has extensively contributed to polymeric membranes, membrane fabrication, and industrial membrane applications. It summarizes scope and structure, highlights the book's major contributions to membrane science and engineering, comments on clarity and organization, notes teaching value and industrial usefulness. It also incorporates recent industrial trends such as digital monitoring, energy efficiency, hybrid processes, and sustainability considerations. The book offers a comprehensive treatment of membrane science, materials, fabrication, modeling, and applications, making it a valuable resource for graduate education and professional practice. While comprehensive, the book could include more quantitative case studies, expanded diagrams, and deeper coverage of emerging digital tools. Nevertheless, the book remains an authoritative and contemporary reference for students, researchers, and engineers across water treatment, bioprocessing, chemical processing, and environmental engineering.

---

## **1.0 BOOK SUMMARY**

Prof. Zhan Wang, a faculty member of the Beijing University of Technology, has built a distinguished career as a researcher, educator, and contributor in the fields of membrane separation, nanomaterials, and surface science. His extensive experience in membrane materials, polymer chemistry, and advanced fabrication methods including phase inversion, thermally induced phase separation, and interfacial polymerization makes him exceptionally well-qualified to author a comprehensive book on this subject. His expertise also spans practical industrial membrane applications such as water purification, gas separation, and bioprocessing, further reinforcing the relevance and authority of his work.

When viewed alongside other well-known references in the field, such as Mulder's *Membrane Technology and Applications*, Winston and Ng's *Membrane Technology and Engineering for Water Treatment*, and the updated editions of Baker's *Membrane Technology and Applications*, Wang's book distinguishes itself through its stronger emphasis on materials science and fabrication techniques, its expanded discussion of industrial developments particularly within the Asian and Chinese context, its inclusion of clearly structured learning objectives and end-of-chapter exercises, and its comprehensive

coverage of all major membrane processes including microfiltration, ultrafiltration, nanofiltration, reverse osmosis, pervaporation, gas separation, electrodialysis, and membrane bioreactors within a single, consolidated volume.

The book is designed as a complete, course-ready reference for membrane separation technologies. It combines theory, materials science, fabrication methods, performance testing, fouling and cleaning, device/module design, and real-world applications. The chapters follow a consistent pattern: learning objectives, core concepts, mathematical models, materials and preparation, characterization, module types, applications, end-of-chapter problems, and references. Primary readers include graduate students and instructors in chemical or environmental engineering, and industry practitioners working in water treatment, pharmaceuticals, food and beverage, petrochemical, and gas processing.

The first chapter introduces the historical development of membrane technology, compares energy requirements for different processes, explains classification systems, and outlines future research priorities. It also provides context on why membrane technology is considered a critical solution for energy efficiency and environmental sustainability. The second chapter focuses on materials and preparation, defining membrane types such as porous, dense, symmetric, asymmetric, and composite. It explores the chemical and physical properties of polymeric and inorganic materials, detailing how these properties influence performance. Fabrication techniques such as phase inversion, thermally induced phase separation (TIPS), coating, plasma polymerization, sol-gel, and sintering are explained with their advantages, limitations, and typical applications. This chapter also addresses defect analysis and characterization methods, including scanning electron microscopy (SEM), atomic force microscopy (AFM), and bubble-point testing, which are essential for quality control.

Chapters three to ten provide in-depth coverage of specific processes. Microfiltration and ultrafiltration chapters explain principles of size-based separation, operating modes such as dead-end and cross-flow, fouling mechanisms, hydrodynamic considerations, and module configurations like hollow fiber and spiral-wound designs. Nanofiltration and reverse osmosis chapters delve into solution-diffusion mechanisms, osmotic pressure calculations, irreversible thermodynamics, and pretreatment strategies to prevent scaling and fouling. They also discuss module arrays, energy recovery devices, and economic considerations for large-scale desalination. Pervaporation and gas separation chapters focus on non-aqueous separations, highlighting polymeric and hybrid membranes, performance metrics such as permeability and selectivity, and industrial uses in chemical and petrochemical sectors. The electrodialysis chapter examines ion-exchange membranes, electrochemical driving forces, stack design, and applications in water softening and brine treatment. The final chapter on membrane reactors emphasizes membrane bioreactors for wastewater treatment, including kinetic models, fouling control strategies, aeration systems, and integration with biological processes.

Throughout these chapters, the book integrates materials, process design, and device engineering with real-world applications in pharmaceuticals, food processing, electronics, municipal water treatment, and industrial wastewater reuse. To provide readers with a quick reference, the following [Table 1](#) consolidates the key focus areas and key highlights of each chapter.

**Table 1.** Overview of Chapters and Key Highlights

Chapter	Title	Key Focus Areas	Chapter Highlights
1	Introduction	History, classification, energy comparison, future trends	Positions membrane technology within global sustainability needs and outlines key future research directions.
2	Materials and Preparation	Membrane types, materials, fabrication methods, defects, characterization	Links membrane chemistry and fabrication to performance, indicating the importance of material selection and structural control.
3	Microfiltration (MF)	Principles, fouling models, module design, industrial applications	Highlights microfiltration's essential role in clarification and pretreatment, emphasizing fouling behaviour and module configuration.
4	Ultrafiltration (UF)	Operating modes, flux models, hydrodynamics, cleaning strategies	Shows how ultrafiltration enables macromolecule separation with flux-control strategies important for bioprocessing and wastewater reuse.
5	Nanofiltration (NF)	Separation mechanisms, material selection, pretreatment	Emphasizes nanofiltration's selective ion and micropollutant removal, relying on charge-based mechanisms and effective pretreatment.
6	Reverse Osmosis (RO)	Osmotic pressure, thermodynamics, module arrays, economic analysis	Provides essential insights into energy use, array optimization, and cost factors central to large-scale desalination.
7	Pervaporation (PV)	Non-aqueous separation, polymeric/inorganic membranes	Demonstrates pervaporation's value in solvent dehydration and organic separation through selective sorption-diffusion behaviour.
8	Gas Separation (GS)	Transport models, performance metrics, hybrid membranes	Highlights gas separation membranes in hydrogen recovery and gas upgrading, addressing permeability - selectivity optimization.
9	Electrodialysis (ED)	Ion-exchange membranes, electrochemical principles	Shows electrodialysis efficiency in desalting and ion recovery, driven by membrane charge properties and stack configuration.
10	Membrane Bio-Reactors (MBR)	Membrane bioreactors, fouling control, wastewater treatment	Emphasizes membrane bioreactor's compact design and high-quality effluent, supported by effective fouling mitigation strategies.

\* Corresponding to: M.N.M. Sokri (email: [nazrisokri@utm.my](mailto:nazrisokri@utm.my))  
 DOI: <https://doi.org/10.11113/jamst.v30n1.341>

## 2.0 BOOK CONTRIBUTIONS AND SUGGESTED IMPROVEMENTS

The book makes several important contributions. It provides comprehensive coverage from fundamentals to industrial practice, integrates materials and processes by linking membrane chemistry and structure to performance and module design, offers a diverse modeling toolkit that includes classical and modern models for flux prediction and fouling analysis, and demonstrates application breadth through practical examples across multiple sectors.

Building on this broad scope, the book further illustrates its practical relevance by showing how microfiltration supports clarification processes in the food and beverage industry (Chapter 3), how ultrafiltration enables protein concentration and enzyme recovery in bioprocessing (Chapter 4), how nanofiltration facilitates dye removal and pharmaceutical wastewater treatment (Chapter 5), how reverse osmosis underpins large-scale desalination and industrial water recycling (Chapter 6), how pervaporation drives solvent dehydration and selective organic separations (Chapter 7), how gas separation membranes contribute to hydrogen recovery and natural-gas upgrading (Chapter 8), how electrodialysis is applied to brine concentration and chemical production (Chapter 9), and how membrane bioreactors enhance municipal and industrial wastewater treatment through integrated biological - membrane operations (Chapter 10).

The book is also highly aligned with today's industrial priorities, as it places strong emphasis on sustainability and circular economy practices through its treatment of water reuse, energy efficiency, and zero liquid discharge strategies in Chapters 6, 9, and 10, while simultaneously addressing process intensification trends by demonstrating how pervaporation, gas separation, and membrane bioreactor systems can be integrated into hybrid and compact designs that reduce energy and footprint requirements. In addition, although only briefly discussed, the book acknowledges the growing importance of digital operation by highlighting the need for advanced monitoring, data driven modelling, and smart control systems in modern membrane plants, and it also reflects current materials innovation priorities by presenting emerging developments in green solvents and next-generation membrane materials, including inorganic membranes, metal-organic frameworks, graphene oxide structures, and biomimetic membranes.

To provide clearer attribution of the book's strengths, several of its major contributions can be linked directly to specific chapters. For example, the detailed discussion of economic considerations, energy consumption, and process integration is primarily addressed in Chapter 6 (Reverse Osmosis), where the author explains array configuration, pretreatment strategies, energy-recovery devices, and cost-performance relationships essential for large-scale desalination. Similarly, the emphasis on process optimization and lifecycle performance in wastewater treatment is elaborated in Chapter 10 (Membrane Reactors), which discusses aeration strategies, fouling mitigation, and system resilience in MBR operations. The book's strong linkage between material properties, membrane structure, and process performance is developed through Chapters 2-4, which connect membrane chemistry and fabrication methods to practical performance outcomes in MF and UF applications. In addition, the breadth of cross-sector industrial applications is showcased throughout Chapters 3-10, where each major membrane process is contextualized with real operational examples from the food, biotechnology, water, chemical, and energy industries, as described in the previous paragraph. These explicit

chapter-level connections strengthen the book's role as both a foundational text and an applied reference for researchers and practitioners.

Nonetheless, the book could be improved by adding beginner-friendly concept boxes for thermodynamics and transport, including more diagrams and flowcharts to explain complex models and fabrication steps, and presenting quantitative case studies with performance and cost data. The coverage of sustainability and digitalization trends could also be expanded to reflect current industry priorities.

This book is well-suited for graduate courses and as a reference for engineers. Its structured chapters, learning objectives, and end-of-chapter problems make it ideal for academic use, allowing instructors to design lectures and assignments based on clearly defined topics. The inclusion of mathematical models and practical examples supports research projects and advanced coursework, while the detailed descriptions of fabrication methods and characterization techniques can serve as laboratory guides for students.

From an industrial perspective, the book provides actionable insights for engineers and technical managers. It explains pretreatment strategies to protect membranes, offers guidance on optimizing hydrodynamic conditions to reduce fouling, and describes cleaning protocols for maintaining long-term performance. The discussion of module configurations, such as spiral-wound, hollow fiber, and plate-and-frame—helps practitioners select the most suitable design for specific applications. Additionally, the coverage of economic considerations and process integration makes the book valuable for decision-making in large-scale water treatment, desalination, and chemical processing plants.

### **3.0 FINAL REMARKS**

*Fundamentals of Membrane Separation Technology* is a highly recommended resource for academic libraries, postgraduate programs, and industry professionals. It offers a strong foundation in membrane science and engineering, supported by practical insights and updated material trends. While additional visuals, case studies, and sustainability topics would enhance its utility, the book remains an authoritative reference for anyone engaged in water treatment, desalination, pharmaceutical processing, and advanced separation technologies.

### **REFERENCES**

- [1] Wang, Z. (2024). *Fundamentals of membrane separation technology*. Elsevier. <https://doi.org/10.1016/C2022-0-02878-6>