



Payam Noor University

Technical English for Polymer Engineering Students

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امروز کتابخوانی و علم‌آموزی نه تنها یک وظیفه‌ی ملی، که یک واجب دینی است!

مقام معظم رهبری

در عصر حاضر یکی از شاخصه‌های ارزیابی رشد، توسعه و پیشرفت فرهنگی هر کشوری میزان تولید کتاب، مطالعه و کتاب‌خوانی مردم آن مرز و بوم است. ایران اسلامی نیز از دیرباز تاکنون با داشتن تمدنی چندهزارساله و مراکز متعدد علمی، فرهنگی، کتابخانه‌های معتبر، علما و دانشمندان بزرگ با آثار ارزشمند تاریخی، سرآمد دولت‌ها و ملت‌های دیگر بوده و در عرصه فرهنگ و تمدن جهانی به‌سان خورشیدی تابناک همچنان می‌درخشد و با فرزندان نیک‌نهاد خویش هنرنمایی می‌کند. چه کسی است که در دنیا با دانشمندان فرزانه و نام‌آور ایرانی همچون ابوعلی سینا، ابوریحان بیرونی، فارابی، خوارزمی و ... همچنین شاعران برجسته‌ای نظیر فردوسی، سعدی، مولوی، حافظ و ... آشنا نباشد و در مقابل عظمت آنها سر تعظیم فرود نیاورد. تمامی این افتخارات ارزشمند، برگرفته از میزان عشق و علاقه فراوان ملت ما به فراگیری علم و دانش از طریق خواندن و مطالعه منابع و کتاب‌های گوناگون است. به شکرانه الهی، تاریخ و گذشته ما، همیشه درخشان و پر بار است. ولی اکنون در این زمینه در چه جایگاهی قرار داریم؟ آمار و ارقام ارائه‌شده از سوی مجامع و سازمان‌های فرهنگی در مورد سرانه مطالعه هر ایرانی، برایمان چندان امیدوارکننده نمی‌باشد.

کتاب، دروازه‌ای به سوی گستره دانش و معرفت است و کتاب خوب، یکی از بهترین ابزارهای کمال بشری است. همه دستاوردهای بشر در سراسر عمر جهان، تا آنجا که قابل کتابت بوده است، در میان دست‌نوشته‌هایی است که انسان‌ها پدید آورده و می‌آورند. در این مجموعه بی‌نظیر، تعالیم الهی، درس‌های پیامبران به بشر، و همچنین علوم مختلفی است که سعادت بشر بدون آگاهی از آنها امکان‌پذیر نیست. کسی که با دنیای زیبا و زندگی‌بخش کتاب ارتباط ندارد بی‌شک از مهم‌ترین دستاورد انسانی و نیز از بیشترین معارف الهی و بشری محروم است. با این دیدگاه، به‌روشنی می‌توان ارزش و مفهوم رمزی عمیق در این حقیقت تاریخی را دریافت که اولین خطاب خداوند متعال به پیامبر گرامی اسلام (ص) این است که «بخوان!» و در اولین سوره‌ای که بر آن فرستاده عظیم‌الشان خداوند، فرود آمده، نام «قلم» به تجلیل یاد

شده است: «إِقْرَأْ وَرَبُّكَ الْأَكْرَمُ. الَّذِي عَلَّمَ بِالْقَلَمِ» در اهمیت عنصر کتاب برای تکامل جامعه انسانی، همین بس که تمامی ادیان آسمانی و رجال بزرگ تاریخ بشری، از طریق کتاب جاودانه مانده‌اند.

دانشگاه پیام‌نور با گستره جغرافیایی ایران شمول خود با هدف آموزش برای همه، همه‌جا و همه‌وقت، به‌عنوان دانشگاهی کتاب‌محور در نظام آموزش عالی کشورمان، افتخار دارد جایگاه اندیشه‌سازی و خردورزی بخش عظیمی از جوانان جویای علم این مرز و بوم باشد. تلاش فراوانی در ایام طولانی فعالیت این دانشگاه انجام پذیرفته تا با بهره‌گیری از تجربه‌های گرانقدر استادان و صاحب‌نظران برجسته کشورمان، کتاب‌ها و منابع آموزشی درسی شاخص و خودآموز تولید شود. در آینده هم، این مهم با هدف ارتقای سطح علمی، روزآمدی و توجه بیشتر به نیازهای مخاطبان دانشگاه پیام‌نور با جدیت ادامه خواهد داشت. به‌طور قطع استفاده از نظرات استادان، صاحب‌نظران و دانشجویان محترم، ما را در انجام این وظیفه مهم و خطیر یاری‌رسان خواهد بود. پیشاپیش از تمامی عزیزانی که با نقد، تصحیح و پیشنهادهای خود ما را در انجام این وظیفه خطیر یاری می‌رسانند، سپاسگزاری می‌نماییم. لازم است از تمامی اندیشمندانی که تاکنون دانشگاه پیام‌نور را منزلگه اندیشه‌سازی خود دانسته و ما را در تولید کتاب و محتوای آموزشی درسی یاری نموده‌اند، صمیمانه قدردانی گردد. موفقیت و بهروزی تمامی دانشجویان و دانش‌پژوهان عزیز آرزوی همیشگی ما است.

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Preface

Chemical Engineering is a dynamic and continually evolving discipline that serves as the backbone of numerous industries, ranging from pharmaceuticals and energy to materials science and environmental engineering. As polymer chemical engineers, we are entrusted with addressing some of the world's most pressing challenges, including the development of sustainable processes, the creation of innovative materials, and the assurance of safe and efficient production of essential goods.

The book *Technical English for Polymer Chemical Engineering Students* has been designed to familiarize students, professionals, and enthusiasts with the essential vocabulary and concepts required to excel in this multifaceted field. Language is a powerful instrument that shapes our understanding and communication of complex ideas. In the domain of chemical engineering, mastery of specialized terminology is crucial for effective collaboration, problem-solving, and innovation.

This book is more than a mere glossary of terms; it is, in fact, a comprehensive guide that addresses fundamental principles as well as emerging trends in polymer chemical engineering. Each chapter has been carefully structured to provide readers with a clear and concise understanding of key concepts, illustrated through examples and real-world applications.

In addition to technical proficiency, this book emphasizes the importance of

staying current with the latest advancements and industrial practices. The field of polymer chemical engineering is in constant transformation, driven by new discoveries and technologies that continually reshape its landscape. By remaining informed and adaptable, we can contribute to the development of sustainable solutions and advance progress within our discipline.

This book highlights the significance of learning specialized English for students of polymer chemical engineering. Proficiency in technical English opens the door to a vast body of scientific literature, research publications, and international collaborations. It enables readers to engage with the global scientific community, access cutting-edge knowledge, and share their insights and innovations on an international stage.

The book comprises fourteen chapters, each containing a specialized technical text accompanied by key and commonly used terms, their Persian equivalents, English synonyms, and a practical example sentence. In addition, reading comprehension exercises, multiple-choice questions, fill-in-the-blank activities, and English-to-Persian translation exercises have been designed for each chapter. The answers to all exercises are provided in the appendix, organized by chapter.

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Chapter 1

The Emergence and Evolution of Polymer Engineering

Keywords

1. **Breakthrough** (noun, /'breikθru:/) – پیشرفت غیرمنتظره، دستاورد بزرگ
 - **Synonyms:** discovery, advance, innovation
 - **Example:** The first **breakthroughs** in polymer science came in the late nineteenth century.
2. **Champion** (verb, /'tʃæmpiən/) – حمایت کردن، دفاع کردن
 - **Synonyms:** advocate, support, promote
 - **Example:** The idea of giant molecules was **championed** by the German chemist Hermann Staudinger.
 - **Other forms:** champion (noun)
3. **Contribute** (verb, /kən'tribju:t/) – مشارکت کردن، سهمیم بودن
 - **Synonyms:** add to, advance, play a part in
 - **Example:** Over the past few decades, Iranian researchers have **contributed** to areas such as advanced membranes.
 - **Other forms:** contribution (noun), contributor (noun)
4. **Create** (verb, /kri'eit/) – خلق کردن، ایجاد کردن
 - **Synonyms:** produce, make, design
 - **Example:** Polymer engineering combines chemistry and physics to **create** products with precise properties.
 - **Other forms:** creation (noun), creative (adjective)

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5. **Emphasis** (noun, /'emfəsis/) – تأکید، تمرکز
 - **Synonyms:** focus, importance, stress
 - **Example:** The **emphasis** in polymer engineering is on shaping the polymer into useful forms.
 - **Other forms:** emphasize (verb)
6. **Engineering** (noun, /,endʒɪ'nɪərɪŋ/) – مهندسی
 - **Synonyms:** design, application, construction
 - **Example:** The shift from chemistry to **engineering** marked the birth of the modern polymer industry.
 - **Other forms:** engineer (noun, verb)
7. **Establish** (verb, /ɪ'stæblɪʃ/) – تاسیس کردن، برقرار کردن
 - **Synonyms:** found, set up, create
 - **Example:** Universities in Iran were among the pioneers to **establish** Departments of Polymer Engineering.
 - **Other forms:** establishment (noun)
8. **Explain** (verb, /ɪk'spleɪn/) – توضیح دادن
 - **Synonyms:** describe, clarify, define
 - **Example:** Humans used natural polymers long before chemistry could **explain** their structure.
 - **Other forms:** explanation (noun)
9. **Giant** (adjective, /'dʒaɪənt/) – غول‌پیکر، بسیار بزرگ
 - **Synonyms:** huge, enormous, massive
 - **Example:** Chemists realized that substances like rubber were made of **giant** chains of repeating units.
 - **Other forms:** giant (noun)
10. **Household** (adjective, /'haʊshəʊld/) – خانگی
 - **Synonyms:** domestic
 - **Example:** Bakelite opened the door to mass-produced electrical insulators and **household** goods.
 - **Other forms:** household (noun)
11. **Industry** (noun, /'ɪndəstri/) – صنعت
 - **Synonyms:** manufacturing, business, trade
 - **Example:** The path from natural materials to modern plastics is a story of science, **industry**, and creativity.
 - **Other forms:** industrial (adjective)

12. **Lightweight** (adjective, /'laɪtweɪt/) – سبک‌وزن
- **Synonyms:** light, low-density
 - **Example:** Today, polymer engineers design **lightweight** components for airplanes.
13. **Manufacture** (verb, /ˌmænjʊ'fæktʃər/) – تولید کردن، ساختن
- **Synonyms:** produce, make, fabricate
 - **Example:** The new processes allowed companies to **manufacture** plastics on a massive scale.
 - **Other forms:** manufacturing (noun), manufacturer (noun)
14. **Material** (noun, /mə'tɪəriəl/) – ماده
- **Synonyms:** substance, stuff, component
 - **Example:** The need for stronger and more versatile **materials** pushed scientists to explore new substances.
 - **Other forms:** materialize (verb)
15. **Membrane** (noun, /'membreɪn/) – غشاء
- **Synonyms:** film, layer, barrier
 - **Example:** Polymer engineers design high-performance **membranes** for water purification.
16. **Petrochemical** (adjective, /ˌpetrəʊ'kemɪkl/) – پتروشیمیایی
- **Synonyms:** petroleum-based
 - **Example:** Specialists in Iran now work in industries ranging from **petrochemicals** to coatings.
 - **Other forms:** petrochemicals (noun)
17. **Precise** (adjective, /prɪ'saɪs/) – دقیق
- **Synonyms:** exact, accurate, specific
 - **Example:** This discipline creates products with **precise** properties for specific uses.
 - **Other forms:** precision (noun), precisely (adverb)
18. **Revolution** (noun, /ˌrevə'lʊ:ʃn/) – انقلاب، تحول
- **Synonyms:** transformation, major change
 - **Example:** Staudinger's idea was a **revolution** in the field of chemistry.
 - **Other forms:** revolutionary (adjective), revolutionize (verb)

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19. **Rubber** (noun, /'rʌbər/) – لاستیک، کائوچو
- **Synonyms:** elastomer
 - **Example:** Natural **rubber** was a useful material, but it had limits such as becoming sticky in heat.
 - **Other forms:** rubbery (adjective)
20. **Science** (noun, /'saɪəns/) – علم، دانش
- **Synonyms:** knowledge, study
 - **Example:** Early milestones in polymer **science** came in the late nineteenth century.
 - **Other forms:** scientific (adjective), scientist (noun)
21. **Specialist** (noun, /'speʃəlɪst/) – متخصص
- **Synonyms:** expert, professional
 - **Example:** University programs trained **specialists** who now work in various polymer industries.
 - **Other forms:** specialize (verb), specialty (noun)
22. **Sticky** (adjective, /'stɪki/) – چسبناک
- **Synonyms:** adhesive, tacky, gummy
 - **Example:** Natural rubber had the problem of becoming **sticky** in hot weather.
 - **Other forms:** stick (verb), stickiness (noun)
23. **Sustainable** (adjective, /sə'steɪnəbl/) – پایدار
- **Synonyms:** long-lasting, eco-friendly, viable
 - **Example:** Modern research often focuses on creating **sustainable** polymers that are environmentally friendly.
 - **Other forms:** sustainability (noun), sustain (verb)
24. **Waterproof** (adjective, /'wɔ:təpru:f/) – ضدآب
- **Synonyms:** water-resistant, impermeable
 - **Example:** One of the earliest uses for natural rubber was to create simple **waterproof** fabrics.
 - **Other forms:** waterproofing (noun), waterproof (verb)

1. Reading

1.1. Introduction

Polymers are everywhere in modern life. From the light but strong frames of smartphones to the soft contact lenses that help millions see clearly, polymers shape the way we live. Yet only a little more than a century ago, the word polymer was almost unknown. The path from natural materials like rubber, silk, and cellulose to today's advanced engineering plastics is a story of science, industry, and creativity.

1.2. From Natural Materials to Engineered Substances

Humans have used natural polymers for thousands of years. Wood for building, cotton for clothing, and natural rubber for simple waterproofing were all part of daily life long before chemistry explained their structure. But these materials had limits. Natural rubber became brittle in cold weather and sticky in heat; silk and wool were expensive and hard to produce. The need for stronger, cheaper, and more versatile materials pushed scientists to explore new ways of making substances with tailored properties.

1.3. Early Milestones in Polymer Science

The first breakthroughs came in the late nineteenth and early twentieth centuries. Chemists began to realize that substances like cellulose or rubber were not small molecules, but giant chains of repeating units. This idea, championed by the German chemist Hermann Staudinger, was revolutionary and earned him the Nobel Prize in 1953. At the same time, industrial chemists were creating the first synthetic polymers. Bakelite, discovered in 1907, became the world's first fully synthetic plastic, opening the door to mass-produced electrical insulators, radios, and household goods. Soon after, materials such as nylon, polyethylene, and polystyrene appeared, each offering a unique combination of strength, flexibility, and cost those natural materials could not match.

1.4. From Chemistry to Engineering

As these discoveries multiplied, the focus gradually shifted from simply

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making new polymers to understanding how to process and design them for specific uses. This shift marked the birth of polymer engineering—a discipline that combines chemistry, physics, and mechanical design to create products with precise properties. Today, polymer engineers design lightweight components for airplanes, high-performance membranes for clean water, and biodegradable packaging that reduces environmental impact. The emphasis is not only on synthesizing the polymer but also on shaping it into useful forms and predicting its long-term behavior.

1.5. Development of Polymer Engineering in Iran

In Iran, the academic path of polymer science began in the late twentieth century, following the rapid global growth of plastics and synthetic fibers. Universities such as Amirkabir University of Technology (Tehran Polytechnic) and the University of Tehran were among the pioneers in establishing Departments of Polymer Engineering. These programs trained specialists who now work in industries ranging from petrochemicals and coatings to biomedical materials. Over the past few decades, Iranian researchers have contributed to areas such as advanced membranes, nanocomposites, and environmentally friendly polymers, linking local needs with international progress.

1.6. Key Figures and Continuing Influence

The foundation of polymer engineering rests on the work of visionary scientists. Hermann Staudinger's concept of macromolecules, Wallace Carothers' development of nylon, and Karl Ziegler's catalytic methods for polyethylene production all shaped the field we know today. Their ideas continue to guide modern research, from smart materials that respond to temperature or pH to 3D-printed polymers for medical implants. Understanding these beginnings helps students see that polymer engineering is not just a set of manufacturing techniques—it is a creative and evolving branch of science that connects fundamental chemistry with real-world solutions.

1.7. Conclusion

In conclusion, the field of polymer engineering has grown from its roots in the study of natural materials into a vital and sophisticated branch of modern technology. This evolution was driven by a critical shift from purely scientific discovery to an engineering focus on processing, design, and application. The foundational concepts of pioneers like Staudinger and Carothers have paved the way for today's advanced materials, from life-saving medical devices to sustainable technologies. Understanding this history shows that polymer engineering is a dynamic field that bridges the gap between molecular science and the practical, real-world solutions that shape our daily lives.

References

1. Canevarolo, S. V. (2025). *Polymer Science: A Textbook for Engineers and Technologists*. Hanser Publishers.
2. Long, T. E., Bortner, M. J., Moore, R. B., & Matson, J. B. (2025). *Polymer Chemistry: Principles and Practice*. ACS Institute.

Exercises for Chapter 1

I. Read each statement carefully. Write (T) for true or (F) for false in the parenthesis provided.

1. Humans began using synthetic polymers thousands of years ago. ()
2. Natural rubber becomes sticky in cold weather. ()
3. Hermann Staudinger received the Nobel Prize in 1953 for his work on macromolecules. ()
4. Bakelite was the world's first natural plastic. ()
5. Polymer engineering focuses only on synthesizing new polymers. ()
6. Polymer engineering combines chemistry, physics, and mechanical design. ()
7. The development of polymer engineering in Iran began in the early nineteenth century. ()

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8. Amirkabir University of Technology was a pioneer in establishing Polymer Engineering in Iran. ()
9. Wallace Carothers is known for developing methods for polyethylene production. ()
10. Understanding the history of polymers shows it's an evolving branch of science. ()
11. The main limitation of natural polymers was their consistent properties in all conditions. ()
12. Nylon and polystyrene are examples of natural polymers. ()
13. Polymer engineers design products like high-performance membranes for clean water. ()
14. The conclusion states that polymer engineering is a static field with few new developments. ()
15. Bakelite was discovered in 1907. ()
16. Iranian researchers have contributed to the field of nanocomposites. ()
17. Karl Ziegler's work was related to the development of nylon. ()
18. The shift from chemistry to engineering happened as the focus moved to processing and design. ()
19. 3D-printed polymers for medical implants are mentioned as an area of modern research. ()
20. The conclusion states that polymer engineering connects molecular science with real-world solutions. ()

II. Choose the correct answer from the options provided.

1. Which of the following is a limitation of natural rubber mentioned in the text?
 - a) It was too strong
 - b) It was too expensive
 - c) It became brittle in the cold
 - d) It was difficult to find

2. Who is credited with championing the concept of polymers as giant chains of repeating units?
 - a) Wallace Carothers
 - b) Karl Ziegler
 - c) Hermann Staudinger
 - d) The text does not say
3. What was the world's first fully synthetic plastic?
 - a) Nylon
 - b) Polystyrene
 - c) Bakelite
 - d) Polyethylene
4. Polymer engineering is described as a discipline that combines chemistry, physics, and...
 - a) Biology
 - b) Mechanical design
 - c) Computer science
 - d) Geology
5. According to the text, when did the academic path of polymer science begin in Iran?
 - a) Early nineteenth century
 - b) Late twentieth century
 - c) Early twentieth century
 - d) The text does not specify
6. Which material was developed by Wallace Carothers?
 - a) Bakelite
 - b) Polyethylene
 - c) Nylon
 - d) Polystyrene
7. The main focus of polymer engineering, as opposed to polymer chemistry, is on...
 - a) Only discovering new molecules
 - b) Naming new materials
 - c) Processing, design, and specific uses
 - d) Studying natural polymers exclusively
8. Which of the following is NOT mentioned as an area of contribution by Iranian researchers?
 - a) Advanced membranes
 - b) Nanocomposites
 - c) Natural rubber production
 - d) Environmentally friendly polymers