

2

U N I T

Green chemistry

START WITH CHEMICALS

PROGRESS WITH CHEMICALS



Learning objectives

After studying this unit, you'll be able to:

- define cleaner production and explain its benefits and importance
- describe the chemical and physical properties of sulfuric acid and know what to do if exposure to sulfuric acid occurs
- talk about wastewater discharge standards
- describe the major achievements of Min Enze
- have a general understanding of gas hydrates

FORWARD WITH CHEMICALS



START WITH CHEMICALS

Match the environmental protection activities with their definitions.

1 zero emission

A a business strategy that focuses on making profits through environmentally friendly operating processes

2 wastewater treatment

B the action or process of turning waste into reusable material

3 waste recycling

C the removal of impurities from wastewater before it reaches natural bodies of water such as rivers, lakes, and oceans

4 green production

D when motor vehicles or combustion engines, including industrial machinery, produce no atmospheric pollutants



Cleaner production

- ¹ Although the traditional chemical industry has brought great improvements to human life, it also presents problems. The most serious problem is pollution. About 13 tons of **hazardous** waste is generated every second in the U.S. That is more than 400 million tons of hazardous waste every year. It was reported that air pollution cost the U.S. about five percent of its yearly GDP. Despite this high economic cost, the country is still failing to meet its pollution control goals.
- ² How to solve the problem of pollution? Cleaner production can be an environmental management **option**.
- ³ Cleaner production, sometimes also called pollution prevention, is the continuous
- application of an **integrated** preventive environmental **strategy** to processes, products, and services. Its goal is to increase overall efficiency while reducing risks to humans and the environment. Cleaner production can be applied to the processes in any industry, to the products themselves, and to various services provided in society. For production processes, cleaner production involves one or more of the following: 1) **conserving** raw materials and energy; 2) **eliminating toxic** and dangerous raw materials; 3) reducing the quantity and toxicity of **emissions** and waste at source during the production process.
- ⁴ Practice has proven that prevention is better than cure. Through the practice of pollution



control, an after-the-event, react-and-treat **approach**, people have gradually realized that the prevention of industrial pollution cannot rely only on the treatment of end pollution. To **fundamentally** solve the problem of pollution, we must turn to cleaner production because it tries to **anticipate** and prevent pollution first. Cleaner production aims to **minimize** or avoid practices such as waste treatment, **diluting** waste to **comply** with regulations, and transferring hazardous or toxic **substances** from one **medium** to another.

- 5 The promotion of cleaner production will not only reduce resource **consumption** and waste generation, but also lead to the **restoration** of our damaged environment, which ensures more **sustainable** development.

Words & Phrases

Words

hazardous /'hæzərdəs/ *adj.* 有害的，危险的
 option /'ɔ:pʃən/ *n.* 选择
 integrated /'ɪntɪɡreɪtɪd/ *adj.* 综合的，整体的
 strategy /'strætɪdʒi/ *n.* 战略，策略
 conserve /kən'sɜ:rv/ *v.* 节省，节约
 eliminate /'ɪlɪməneɪt/ *v.* 消除，根除
 toxic /'tɔ:ksɪk/ *adj.* 有毒的
 emission /'ɪmɪʃən/ *n.* 排放物，散发物
 approach /ə'prəʊtʃ/ *n.* 方式，方法
 fundamentally /ˌfʌndə'mentəli/ *adv.* 根本上，基本上
 anticipate /æ'n'tɪsəpeɪt/ *v.* 预见，预料
 minimize /'mɪnəmaɪz/ *v.* 把……减至最小量（程度）
 dilute /dɪ'lu:t/ *v.* 稀释
 comply /kəm'plaɪ/ *v.* 遵守，服从
 substance /'sʌbstəns/ *n.* 物质
 medium /'mi:diəm/ *n.* 媒质，介质
 consumption /kən'sʌmpʃən/ *n.* 消耗
 restoration /ˌrestə'reɪʃən/ *n.* 恢复
 sustainable /sə'steɪnəbəl/ *adj.* 不破坏环境的，可持续的

Phrases

cleaner production 清洁生产
 at source 在源头，在开端
 sustainable development 可持续发展

Note

GDP (gross domestic product): 国内生产总值。一个国家（或地区）所有常住机构单位在一定时期内生产的全部最终产品的价值总量。

PROGRESS WITH CHEMICALS

Intensive reading

Task 1 Words Choose the appropriate meaning of each word according to the text.

1 hazardous

- A. dangerous and likely to harm people's health
- B. extremely bad in quality or in one's performance

2 integrated

- A. able to be used or shared by people of all races
- B. combining many different groups, ideas, or parts in a way that works well

3 strategy

- A. the process to achieve sth.
- B. a well-planned action or series of actions for achieving an aim

4 toxic

- A. relating to or caused by a poison
- B. relating to an odor of sth.

5 anticipate

- A. to stop sth. from happening
- B. to expect an event or situation to happen, and do sth. to prepare for it

6 dilute

- A. to make a liquid weaker by adding water or another liquid
- B. to make a quality, belief, etc. weaker or less effective, especially by adding sth.

Grammar note

英语中有两种语态，一是主动语态，一是被动语态。被动语态是由“be + 过去分词”构成的，时间通过 be 表现出来。使用被动语态的情况主要包括：1) 动作的承受者（或结果）是谈话的中心；2) 动作的执行者很模糊（如指 people、one 等）。

Task 2 Grammar Fill in the blanks with the passive voice of the verbs or verbal phrases in brackets. Pay attention to the tense.

- 1 This problem _____ (deal with) next week.
- 2 The method of wastewater treatment _____ (use) for a long time.
- 3 A wind farm _____ (build) in this area three years ago.
- 4 It _____ (suggest) we turn to cleaner production as soon as possible.
- 5 He _____ (believe) to have made an important discovery in chemistry.
- 6 He said that the big conference _____ (put off) to the next month.



Task 3 Reading comprehension Decide whether the following statements are true (T) or false (F).

- 1 The traditional chemical industry has brought many benefits to our life.
- 2 Cleaner production can be applied to processes, products, and services provided in society.
- 3 Cleaner production is an environmental strategy that reduces pollution at source.
- 4 Pollution prevention and pollution control are similar pollution treatment approaches to cleaner production.
- 5 Waste treatment, diluting waste, and transferring hazardous substances from one medium to another are all cleaner production practices.
- 6 Cleaner production is helpful for sustainable development.

Task 4 Translation Translate the sentences from the text into Chinese.

1 Despite this high economic cost, the country is still failing to meet its pollution control goals.

2 Cleaner production can be applied to the processes in any industry, to the products themselves, and to various services provided in society.

3 Practice has proven that prevention is better than cure.

4 The promotion of cleaner production will not only reduce resource consumption and waste generation, but also lead to the restoration of our damaged environment, which ensures more sustainable development.



Hazardous chemical safety cards

化成一语

想了解化学品，你可以通过查阅该化学品的安全说明书获得相关信息。这些信息一般包括化学分子式、物理和化学特点、健康危害、急救方法等。

Hazard label

Corrosive

Product name, molecular formula, and CAS number

Sulfuric acid
H₂SO₄
CAS No. 7664-93-9

Physical and chemical properties

Melting point (°C): 10.36
Boiling point (°C): 338
Density (Relative to water): 1.84
Vapor density (Relative to air): 3.4
Molecular weight: 98.08

Health hazards

Sulfuric acid is corrosive to all body tissues. Inhalation of vapor may cause serious lung damage. Contact with eyes may result in total loss of vision. Ingestion of the acid, particularly that of high concentration, may cause severe injury and even death.

First aid for inhalation exposure

- 1.1 Move the victim to the fresh air.
Emergency personnel should avoid self-exposure to sulfuric acid.
- 1.2 Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If the victim does not breathe, provide artificial respiration. If their breathing is labored, provide oxygen or other respiratory support.
- 1.3 Call the local hospital for advice about giving medicines or other invasive procedures.
- 1.4 Rush to a hospital.

First aid for eye exposure

- 2.1 Remove the victim from exposure. Emergency personnel should avoid self-exposure to sulfuric acid.
- 2.2 Remove contaminated clothing as soon as possible.
- 2.3 Flush the eye(s) with lukewarm water for at least 15 minutes while holding eyelids apart.
- 2.4 Call the local hospital for advice.
- 2.5 Rush to a hospital.

First aid for ingestion exposure

- 3.1 Do not induce vomiting.
- 3.2 Rinse the mouth with a large amount of water.
Instruct the victim not to swallow the water.
- 3.3 Call the local hospital for advice about giving medicines or other invasive procedures.
- 3.4 Give the victim water or milk according to their physical wellness. Please note that water or milk should be given only if the victim is conscious.
- 3.5 Rush to a hospital.

Task 1 Words Choose the appropriate meaning of each word according to the text.

1 property

- A. things, especially valuable things, that are owned by sb.
- B. a quality or power that belongs naturally to sth.

2 vision

- A. the ability to see
- B. the ability to think about and plan for the future

3 severe

- A. serious and unpleasant
- B. very strict or extreme

4 victim

- A. sb. who has been affected by a bad situation such as an accident or illness
- B. sb. who experiments with sth.

5 detect

- A. to notice or discover sth.
- B. to touch and feel sth.

6 conscious

- A. noticing or realizing sth.
- B. awake and able to understand what is happening around you

Task 2 Reading comprehension Check (✓) the first aid measures mentioned in the text.

- 1** Move the person who has breathed in the vapor of sulfuric acid to the fresh air.
- 2** Evaluate vital signs including pulse and respiratory rate and take proper measures accordingly if inhalation of sulfuric acid vapor has occurred.
- 3** Remove their contaminated clothing as soon as possible if sulfuric acid has come into contact with a person's eye(s).
- 4** If eye exposure has occurred, eyes should be flushed with cold water immediately.
- 5** Clean their mouth with a lot of water if a person has ingested some sulfuric acid.
- 6** Give some water or milk to the person who has swallowed sulfuric acid even if they are unconscious.

Words & Phrases

Words

- corrosive /kə'rouʃɪv/ *adj.* 腐蚀性的
- property /'prɒ:pərti/ *n.* 特征, 特点
- vapor /'veɪpər/ *n.* 蒸气
- tissue /'tɪʃu:/ *n.* 组织
- inhalation /ɪnhə'leɪʃən/ *n.* 呼吸
- vision /'vɪʒən/ *n.* 视力, 视觉
- ingestion /ɪn'dʒestʃən/ *n.* 摄食
- concentration /kənsən'treɪʃən/ *n.* 密度
- severe /sə'veɪr/ *adj.* 很严重的
- exposure /ɪk'spəʊʒər/ *n.* 暴露
- victim /'vɪktɪm/ *n.* 受害者
- evaluate /ɪ'veljueɪt/ *v.* 评估
- trauma /'traʊmə/ *n.* 损伤, 外伤
- detect /dɪ'tekt/ *v.* 发现
- oxygen /'ɒksɪdʒən/ *n.* 氧
- contaminated /kən'tæmɪneɪtɪd/ *adj.* 被污染的
- lukewarm /lu:k'wɔ:rm/ *adj.* 微温的, 温热的
- induce /ɪn'du:s/ *v.* 诱发
- vomit /'vɒ:mɪt/ *v.* 呕吐
- rinse /rɪns/ *v.* 冲洗
- conscious /'kɒnʃəs/ *adj.* 有意识的, 神志清醒的

Phrases

- molecular formula 分子式
- sulfuric acid 硫酸
- melting point 熔点
- boiling point 沸点
- molecular weight 分子量
- first aid 急救, 急救护理
- CPR 心肺复苏术
- artificial respiration 人工呼吸
- invasive procedure 侵入性操作

Wastewater discharge standards

化成一语

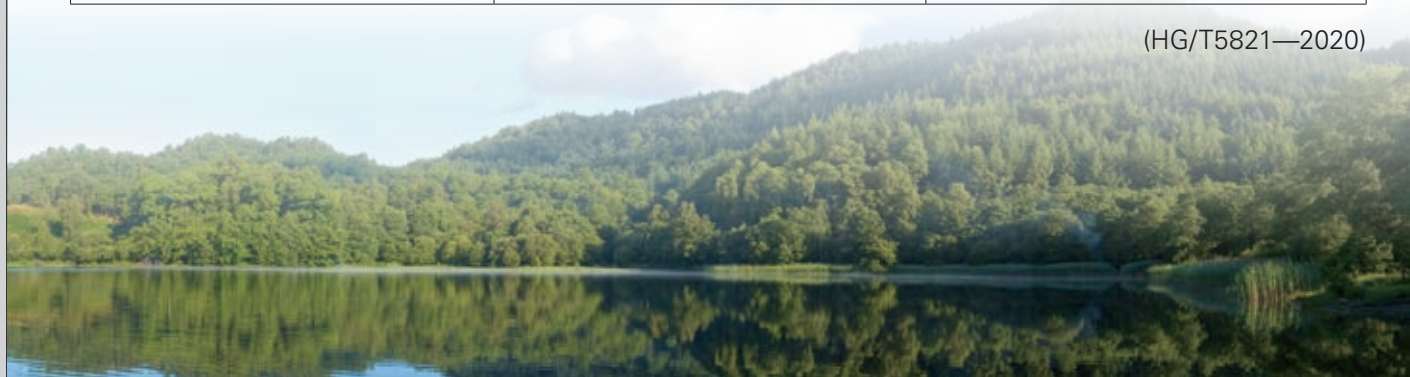
在化工企业运行过程中，不可避免会产生废水。操作人员应充分掌握污染物种类、测试方法、监控位置等信息，才能妥善处理废水，减少环境污染和原材料浪费。要掌握污染物的信息，你可以通过查阅污染物排放标准等获取相关信息。

In chemical production, a large amount of industrial wastewater is produced, which contains a variety of harmful substances. If it is discharged into the environment without meeting the required discharge standards, it will pollute the environment, and seriously endanger people's health. Therefore, the

discharge of wastewater needs to be carried out in strict accordance with national standards. In the following table from Technical Specifications for Composite Wastewater Treatment in the Chemical Industry Park, you can see some requirements for the discharge of wastewater.

Separate pretreatment of composite wastewater		Recommended indexes for discharged wastewater
Process units	Main pollutants to be removed	
Coagulating sedimentation and filtration	Suspended solids, colloidal particles, heavy metal ions	Suspended solids (SS) < 400 mg/L 6 < pH < 9 BOD ₅ /COD > 0.3 Oil content < 20 mg/L Chloride < 3,000 mg/L
Adsorption, microelectrolysis, advanced oxidation	Refractory substances	
Oil separation, gas floatation, oil removal by gravity	Oils	
Neutralization reaction	Acid, alkali	
Hydrolytic acidification, coagulation + hydrolytic acidification	Refractory pollutants, suspended solids	/
Electrodialysis, reverse osmosis, ion exchange	Salts, heavy metal ions	/

(HG/T5821—2020)



Task 1 Words Fill in the blanks with the correct form of the words in the boxes.

discharge

specification

composite

index

filtration

oxidation

- 1 The _____ of harmful chemicals into drinking water is banned.
- 2 The _____ system provides people with clean air free from fumes.
- 3 The plane's body is made of some _____ materials.
- 4 The pipes are covered with rust due to the _____ of the topmost layer.
- 5 These machines were made according to up-to-date technical _____.
- 6 The test provides parents with a reliable _____ of their child's progress.

Task 2 Reading comprehension Decide whether the following statements are true (T) or false (F).

- 1 Advanced oxidation is one of the processes to remove oils in wastewater.
- 2 In order to remove acid and alkali in composite water, neutralization reaction is required.
- 3 The suspended solids in the discharged wastewater from the chemical industry park shall be less than 500 mg/L.
- 4 Chloride in wastewater shall be less than 3,000 mg/L.
- 5 In order to remove heavy metal ions, only the process of ion exchange can be used.

Words & Phrases

Words

discharge /'dɪstʃɑːrdʒ/ *n.* 排放

specification /ˌspesɪfɪ'keɪʃən/ *n.* 规格说明, 明细规范

composite /kəm'pəːzət/ *adj.* 混合成的, 复合的

pretreatment /ˌpri:'tri:tment/ *n.* 预处理

index /'ɪndeks/ *n.* 指标

filtration /fɪl'treɪʃən/ *n.* 过滤, 筛选

ion /'aɪən/ *n.* 离子

adsorption /əd'sɔːrʃən/ *n.* 吸附

microelectrolysis /'maɪkrəʊ,ɪlek'trɑ:lɪsɪs/ *n.* 微电解

oxidation /ˌɑːksə'deɪʃən/ *n.* 氧化

acid /'æsɪd/ *n.* 酸

alkali /'ælkəlaɪ/ *n.* 碱

chloride /'klɔːraɪd/ *n.* 氯化物

electrodialysis /ɪˌlektroʊdaɪ'æɪlɪsɪs/ *n.* 电渗析

Phrases

coagulating sedimentation 混凝沉淀

suspended solid 悬浮固体

colloidal particle 胶体颗粒

heavy metal 重金属

refractory substance 难降解物质

oil separation 隔油

gas floatation 气浮

oil removal 除油

neutralization reaction 中和反应

hydrolytic acidification 水解酸化

reverse osmosis 反渗透

ion exchange 离子交换

Min Enze

¹ Min Enze (1924—2016) was the founder of applied catalysis for petroleum refining, the forerunner of independent innovation in petrochemical technology, and a pioneer of green chemistry in China.

² Min was born in Chengdu, Sichuan Province. He graduated from National Central University (now Nanjing University) in 1946, majoring in chemical engineering. In 1951, he obtained his doctorate from the Ohio State University in the U.S. After that, he worked in the U.S. for four years. He returned to China in 1955 and devoted himself to the technological innovation of petroleum in the country.

³ From 1956, Min Enze successfully developed cracking catalysts, including spherical aluminum silicate catalysts for aviation fuel, and micro-spherical Si-Al catalysts for the production of petrol, diesel and liquefied petroleum gases. Toward the



end of the 1960s, Min developed a series of zeolite materials for cracking catalysts. These innovations were testament (证明) to the technological revolution in China's refining industry.

They also triggered (引起) large increases in petroleum product yields. Throughout the 1970s and 1980s, Min led the development of manufacturing technologies for new generations of cracking catalysts.

⁴ Min also led a research project to develop green chemical technologies. His team developed a novel hydrogenation process by combining amorphous Ni-based alloy catalysts and a magnetically stabilized bed reaction.

⁵ Min was elected a member of the Chinese Academy of Sciences in 1980. In 2007, he received the State Pre-eminent Science and Technology Award, the most prestigious (有威望的) scientific prize awarded in China.

Task Reading comprehension Fill in the blanks in the table.

Min Enze	
Educational history	<ul style="list-style-type: none"> Graduated from 1 _____ in 1946 Received his doctorate from 2 _____ in 1951
Achievements	In the development of cracking catalysts: <ul style="list-style-type: none"> Developed spherical aluminum silicate catalysts for 3 _____ Developed micro-spherical Si-Al catalysts for 4 _____ Developed a series of 5 _____ for cracking catalysts Developed 6 _____ for new generations of cracking catalysts
	In the development of green chemical technologies: Developed a(n) 7 _____ by combining amorphous Ni-based alloy catalysts and a magnetically stabilized bed reaction
Honors received	<ul style="list-style-type: none"> Elected a member of the Chinese Academy of Sciences in 8 _____ Received the State Pre-eminent Science and Technology Award in 2007

Gas hydrates

Gas hydrates consist of molecules of natural gas enclosed within a solid lattice of water molecules. They form when methane, the chief constituent of natural gas, and water freeze at high pressures and relatively low temperatures. These conditions occur in the shallow part of marine sedimentary sections on many continental margins. When brought to the earth's surface, one cubic meter of gas hydrate releases 164 cubic meters of natural gas. Methane that forms hydrates can be both biogenic, created by biological activity in sediments, and thermogenic, created by geological processes deeper within the earth. Once assumed to be rare, gas hydrates are now thought to exist in vast volumes and to contain 7,000—20,000 trillion cubic meters of methane. The formation thickness can be several hundred meters.



My Learning Log

- I know the benefits of cleaner production are...
- When exposure to sulfuric acid occurs, I know the measures to deal with it are...
- I know wastewater discharge standards include...
- I know the achievements Min Enze made include...
- I know gas hydrates are...