

德立

无废工艺 工业发展
新模式 ●



ISBN 7-302-0056
X·8 定价: 4.

x7 C

无废工艺

—— 工业发展新模式

席德立



C1488832A

清华大学出版社

x7/17

内 容 摘 要

合理利用资源和保护环境是当今人类的迫切任务。新发展起来的无废工艺是实现社会和自然和谐统一的工业发展新模式。

本书结合具体的工业部门,如矿产、黑色冶金、有色冶金、石油炼制、化学工业以及电力工业详细地介绍了无废工艺的主要内容。

全书共分七章:第一章工业发展及其生态后果;第二章自然资源及其利用;第三章无废工艺的理论基础;第四章实现无废工艺的主要途径;第五章主要工业部门创建无废生产的方向和进展;第六章创建无废工业区;第七章无废工艺的经济评价。

本书内容充实,叙述流畅、生动。

本书除作为环保专业的教材外,还可为从事工业及环保规划、设计和工艺研究的人员参考。

无 废 工 艺

——工业发展新模式

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清华大学出版社出版

北京 清华园

北京昌平环球科技印刷厂印刷

新华书店总店科技发行所发行

☆

开本: 850×1168 1/32 印张: 9.5 字数: 244 千字

1990年2月第1版 1990年2月第1次印刷

印数: 0001—3000

ISBN 7-302-00507-9/X·8

定价: 4.60 元

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摘 要

类的迫切任务。新发展起来的无废工
展新模式。

黑色冶金、有色冶金、石油炼制、
废工艺的主要内容。

生态后果；第二章自然资源及其利
实现无废工艺的主要途径；第五章
；第六章创建无废工业区；第七章

〔为从事工业及环保规划、设计和工

艺

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士出版

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印刷厂印刷

行所发行

9.5 字数：244 千字

1982 年 2 月第 1 次印刷

3000

787/96×129

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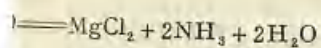
(在人类即将跨入21世纪发展历史, 就会发现, 近百年来, 工业发展所取得的成就, 了在此之前所积累的总和。相差不大, 从17世纪中叶蒸汽机的发明, 引起了产业革命, 出现了一个新的生产领域: 电磁现象, 奠定了现代技术的基础, 向新的能源形式——电力, 路, 机器的使用范围越来越广, 面貌迅速改观。在工业发展展。)

工业生产固然提高了人类的生活水平, 特别是最近四五十年以来, 越来越多的发展中国家开始走上了一条新的格局。如果说过去, 对自然单方面索取的关系, 价。环境污染和资源耗竭就候。

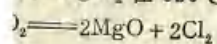
工业造成了全球性的污染, 的工业企业, 源源不断地排固体废料。城市居民最不可的饮水和充足的阳光, 日益区, 由于农业生产越来越多

全代替氨碱法流程。

转变成优质化肥硝酸铵或磷酸铵。从此时将固体 NH_4Cl 与 MgO 一起在 350°C 下

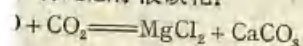


反应， MgCl_2 在 650°C 下氧化，生成氯气



NaCl 代替食盐作原料，副产氯化亚钾复和二氧化碳饱和，使氨浓度达到65克/升，该溶液在 -10°C 下加进钾石盐，此时 NaCl 溶解进入溶液，而 KCl 则不溶，与亚钾产品。这种复合肥料含30% KCl ，钾后的溶液进一步制取纯碱。这样，4吨氯化亚钾。

MgCO_3 代替石灰石。白云石煅烧时得到用此处理分离 NaHCO_3 后滤液，滤液中，蒸馏时可溶组分是 CaCl_2 和 NaCl ， MgO ，将此悬浮液碳化：



CO_3 。分离 CaCO_3 后，溶液中的主要组分浓时先析出固体 NaCl ，随后结晶出过程中，而 $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ 是制备金属镁

某些有机胺可降低 NaHCO_3 的溶解度，-75%提高到90—95%，同时可减少且目前由于胺的价格较高，所以这一

纯碱，同时副产碳酸钾、氧化铝和水

泥。这一过程从原料到工艺完全不同于氨碱法，可基本实现无废生产，在前一章中已介绍过。

(2) 蒸馏废液和废渣的综合利用和无害化处理

① 从蒸馏废液中回收 CaCl_2 和 NaCl 。蒸馏废液澄清后先除去 SO_4^{2-} ，然后蒸发，使 NaCl 析出，洗涤后离心脱水，作为食盐产品或回用于制碱。母液含 CaCl_2 (32—38%)，可直接作为产品提供给用户，也可继续蒸浓，进一步除去 NaCl ，最后得到固体产品 $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ 。 CaCl_2 在化学工业中可用作气体和液体的吸湿剂，在建材中作混凝土的添加剂。研究表明，在水泥炉料中加入 CaCl_2 ，可使煅烧温度下降350—500 $^\circ\text{C}$ ，相应地节约燃料30%。此外在较低温度下生成的水泥熟料较易磨细，用此水泥配制的混凝土标号较高。

② 利用碱渣生产水泥等建材。利用蒸馏废液中的不溶固渣、盐泥和石灰石煅烧下料等制碱废渣生产水泥的关键在于满足脱氯要求及适当的配料比，以保证产品质量和降低能耗。

碱渣还可和附近化工厂排放的含硫酸的废水按一定比例混合，生成碱渣· β -二水石膏，经不同的热处理后可得到不同的碱渣石膏，如碱渣· α -半水石膏，用来制成室内装饰材料。

③ 碱渣制钙镁肥。这种钙镁肥料可代替石灰作为酸性土壤的土壤改良剂，并能增加土地肥力，使水稻、花生、大豆、玉米、大麦等作物增产。制法是将蒸馏废液先浓密至固液比为1:10，再压滤。在压滤机上洗去部分 Cl^- ，滤饼含水分5%，与白垩下料按1:(2—3)的比例混合，粉碎后干燥。

④ 碱渣制家禽饲料添加剂。废渣中的氯化物脱除到4%以下后，用于作家禽饲料无机盐添加剂，使家禽提高产蛋率。

(3) 其它措施

① 建立循环用水系统。将净化后的废水用于溶盐，部分蒸馏废液用于消化生石灰。投加干的生石灰代替石灰乳蒸氨，水冷改风冷，以减少用水量。

VERIFICATION

I, Wenli.Zhang of 601, Building B-2, Northern Territory, Dongsheng Technology Park, Haidian District, Beijing 100192, China, hereby declare that I am conversant with the Chinese and English languages and am a competent translator thereof. I declare further that to the best of my knowledge and belief the following 无废工艺 工业发展新模式 *New Development Mode of Waste-Free Process Industry* is a true and correct translation.

All statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true. I further understand that willful false statements and the like are punishable by fine or imprisonment, or both under Section 1001 of Title 18 of the United States Code. I declare under penalty of perjury that the foregoing is true and correct.

Dated this 11 day of Nov. 2022.

Signature:

Name:

WenLi Zhang
WenLi Zhang

Xi Deli

Waste-Free Technological Processes **A New Mode of
Industrial
Development●**

ISBN 7-302-00507-9
X · 8 Price: 4.60 yuan

Waste-Free Technological Processes

-A New Mode of Industrial Development

Xi Deli



Tsinghua University Press

27/17

Summary of Content

It is an urgent task for mankind today to make rational use of resources and protect the environment. The newly developed waste-free technological processes are a new industrial development mode for realizing the harmony and unity of society and nature.

This book introduces in detail the main contents of waste-free technological processes in specific industrial sectors, such as minerals, ferrous metallurgy, nonferrous metallurgy, petroleum refining, chemicals and electric power.

The book is divided into seven chapters: Chapter I Industrial Development and Its Ecological Consequences; Chapter II Natural Resources and Their Utilization; Chapter III Theoretical Basis of Waste-Free Technological Processes; Chapter IV Main Ways to Realize Waste-Free Technological Processes; Chapter V Direction and Progress of Establishing Waste-Free Production in Major Industrial Sectors; Chapter VI Establishing Waste-free Industrial Zones; and Chapter VII Economic Evaluation of Waste-Free Technological Processes.

The book is rich in content, and smooth and vivid in narration.

The book can not only serve as a teaching material for environmental protection majors, but also be used as a reference for personnel engaged in industrial and environmental protection planning, design and technological process research.

Waste-Free Technological Processes

—A New Mode of Industrial Development

Xi Deli



Published by Tsinghua University Press

BeijingTsinghua Campus

Printed by Beijing Changping Global Technology Printing Factory

Distributed by Technology Distribution Agency of Xinhua Bookstore Headoffice



Format: 850 X 1168 1/32 Printed sheets: 9.5 Number of words: 244 thousand

1st edition in February 1990 1st printing in February 1990

Number of printed copies: 0001—3000

ISBN: 7-302-00507-9/X • 8

Price: 4.60 yuan

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Sludge This process is completely different from ammonia-soda process from raw materials to technological process, and can basically enable waste-free production, which has been introduced in the previous chapter.

(2) Comprehensive Utilization and Harmless Treatment of Distillation Waste Liquor and Waste Residue

① Recovery of CaCl_2 and NaCl from Distillation Waste Liquor After clarification, the distillation waste liquor is first treated to remove SO_4^{2-} , next evaporated to separate out NaCl , then washed and centrifugally dewatered, and finally is used as a salt product or reused in alkali production. The mother liquor contains CaCl_2 (32–38%), and may be directly provided to users as a product, or be continuously evaporated to further remove NaCl , and finally a solid product $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ is obtained. The CaCl_2 may be used as a hygroscopic agent for gas and liquid in chemical industry and as an additive for concrete, a building material. The research indicates that adding CaCl_2 into cement burden can reduce the calcination temperature by 350-500°C, thereby correspondingly saving fuel by 30%. In addition, the cement clinker produced at a lower temperature is easy to grind, and the concrete prepared with this cement has a higher grade.

② For making use of alkali residues to produce cement and other building materials, and making use of waste residues in alkali production, such as insoluble solid residues in distillation waste liquor, brine sludge and limestone calcination tailings, to produce cement, the key lies in meeting dechlorination requirements and proper proportioning ratios so as to ensure product quality and reduce energy consumption.

Alkali residues may also be mixed with sulfuric acid-containing wastewater discharged from nearby chemical plants in a certain ratio to produce alkali residue • β -dihydrate gypsum. By different heat treatments, different alkali residue gypsum can be obtained, such as alkali residue • α -hemihydrate gypsum, which can be used as interior decoration materials.

③ Preparation of Calcium–Magnesium Fertilizers from Alkali Residues This kind of calcium-magnesium fertilizer may replace lime as a conditioner for acidic soil, and can increase the land fertility and the yield of rice, peanuts, soybeans, corn, barley and other crops. According to the preparation method, the distillation waste liquor is first thickened until the solid-liquid ratio is 1 : 10, and then filtered by a filter press. Part of Cl^- is washed off on the filter press, and the filter cake contains 5% water, which is mixed with chalk tailings at a ratio of 1 : (2-3), crushed and then dried.

④ Preparation of Poultry Feed Additive from Alkali Residues After the chloride in the waste residue is removed to below 4%, the residue can be used as an inorganic salt additive for poultry feed to improve the laying rate of poultry.

(3) Other Measures

① Establishment of a water circulating system. Using the purified wastewater to dissolve salt, and part of the distillation waste liquor to digest quicklime. Using the dry quicklime to replace lime milk in ammonia distillation, and changing water cooling to air cooling to reduce water consumption.