



## Special Issue Reprint

# Advances in Understanding of Unit Operations in Non-ferrous Extractive Metallurgy 2021

www.mdpi.com/books/reprint/5773

Edited by Srecko Stopic Bernd Friedrich

ISBN 978-3-0365-4573-8 (Hardback) ISBN 978-3-0365-4574-5 (PDF)

Unit metallurgical operations processes are usually separated into three categories: 1) hydrometallurgy (leaching, mixing, neutralization, precipitation, cementation, and crystallization); 2) pyrometallurgy (roasting and smelting); and 3) electrometallurgy (aqueous electrolysis and molten salt electrolysis). In hydrometallurgy, the aimed metal is first transferred from ores and concentrates to a solution using a selective dissolution (leaching or dry digestion) under an atmospheric pressure below 100 °C and under a high pressure (40-50 bar) and high temperature (below 270°C) in an autoclave. The purification of the obtained solution was performed using neutralization agents such as sodium hydroxide and calcium carbonate or more selective precipitation agents such as sodium carbonate and oxalic acid. The separation of metals is possible using a liquid/liquid process (solvent extraction in mixersettler) and solid-liquid (filtration in filter-press under high pressure). Crystallization is the process by which a metallic compound is converted from a liquid into a solid crystalline state via a supersaturated solution. The final step is metal production using electrochemical methods (aqueous electrolysis for basic metals such as copper, zinc, silver, and molten salt electrolysis for rare earth elements and aluminum). Advanced processes, such as ultrasonic spray pyrolysis and microwave-assisted leaching, can be combined with reduction processes in order to produce metallic powders.



Order Your Print Copy You can order print copies at www.mdpi.com/books/reprint/5773



# MDPINBOOKS Publishing Open Access Books & Series

MDPI Books offers quality open access book publishing to promote the exchange of ideas and knowledge in a globalized world. MDPI Books encompasses all the benefits of open access – high availability and visibility, as well as wide and rapid dissemination. With MDPI Books, you can complement the digital version of your work with a high quality printed counterpart.



#### **Open Access**

Your scholarly work is accessible worldwide without any restrictions. All authors retain the copyright for their work distributed under the terms of the Creative Commons Attribution License.



#### **Author Focus**

Authors and editors profit from MDPI's over two decades of experience in open access publishing, our customized personal support throughout the entire publication process, and competitive processing charges as well as unique contributor discounts on book purchases.



#### **High Quality & Rapid Publication**

MDPI ensures a thorough review for all published items and provides a fast publication procedure. State-of-the-art research and time-sensitive topics are released with a minimum amount of delay.



ᆔ

#### High Visibility

Due to our global network and well-known channel partners, we ensure maximum visibility and broad dissemination. Title information of books is sent to international indexing databases and archives, such as the Directory of Open Access Books (DOAB), and the Verzeichnis Lieferbarer Bücher (VLB).

## Print on Demand and Multiple Formats

MDPI Books are available for purchase and to read online at any time. Our print-on-demand service offers a sustainable, cost-effective and fast way to publish MDPI Books printed versions.

MDPI AG Grosspeteranlage 5 4052 Basel Switzerland Tel: +41 61 683 77 34 www.mdpi.com/books books@mdpi.com

