DEVELOPMENT OF INDUSTRIAL TECHNOLOGY FOR THE PRODUCTION OF MOLYBDENUM POWDERS AND COMPACT PRODUCTS FROM COPPER-MOLYBDENUM ORE PROCESSING WASTE

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Abstract

This article explores an industrial method for producing molybdenum powders and compact products from copper-molybdenum ore processing waste. The study focuses on efficient recovery techniques using flotation, roasting, and hydrogen reduction. A complete process flow is outlined, including powder formation, compaction, and sintering. The influence of microstructure, sintering parameters, and purification steps is discussed, alongside a literature overview and industrial ap

plications.

Keywords

Molybdenum, powder metallurgy, copper ore waste, hydrogen reduction, sintering, recycling, composite materials.

1. Introduction

Molybdenum is a refractory metal with exceptional mechanical, chemical, and thermal properties. Due to its scarcity in pure ores, the recycling and processing of molybdenum-containing waste—particularly from copper-molybdenum ores—has become an important direction in sustainable metallurgy. This paper presents a detailed technological process for extracting and processing molybdenum from such waste.

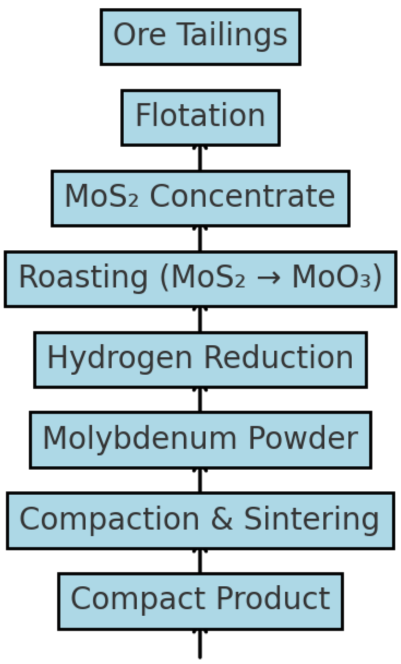
2. Characteristics of Raw Materials

Copper-molybdenum ores processed for copper production leave behind tailings containing molybdenite (MoS_2), silica, and other minerals. These wastes typically contain:

- Molybdenum (Mo): 0.1–0.5%
- Copper (Cu): up to 0.3%
- Sulfur (S), Silica (SiO_2), Iron (Fe) as impurities

3. Technological Process Overview

The industrial route for molybdenum powder includes several stages from ore tailings to compact product.



4. Chemical Reactions and Processes

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Key chemical reactions:

Roasting:

$2MoS_2 + 7O_2 \rightarrow 2MoO_3 + 4SO_2\uparrow$

Reduction:

$MoO_3 + 3H_2 \rightarrow Mo + 3H_2O\uparrow$

5. Powder Characterization

Produced molybdenum powder typically exhibits:

- Particle size: 1–10 µm
- Purity: ≥99.5% Mo
- Apparent density: 2.0 g/cm³

Table 1: Chemical Composition of Molybdenum Powder

Element	Content (%)
Mo	99.5
Fe	0.02
Cu	0.01
S	0.01

6. Compaction and Sintering

Cold isostatic pressing (200–300 MPa) is used for powder shaping. Vacuum sintering at 1800–2000 °C yields dense products with >98% theoretical density. The sintered molybdenum components exhibit high hardness, corrosion resistance, and mechanical strength.

7. Applications of Molybdenum Products

Typical application sectors include:

- Aerospace (heat shields, nozzles)
- Electronics (electrodes, thermal sinks)

- Metallurgy (crucibles, high-temp tools)
- Nuclear energy (control rods, structural parts)

8. Environmental and Economic Benefits

Utilizing copper-molybdenum waste:

- Reduces environmental load from tailings
- Lowers energy cost compared to primary extraction
- Enhances circular economy by reusing valuable metals

9. Future Research Directions

Future improvements include:

- Nanostructured molybdenum powder synthesis
- Plasma reduction and selective leaching
- AI-optimized sintering and quality control
- Hybrid materials (Mo + WC, TiC) for extreme uses

10. Conclusion

The development of industrial technology for molybdenum powder production from ore waste presents an efficient, sustainable, and economically feasible route. Proper process optimization ensures high-quality powder and compact products suited for advanced industrial applications.

References

1. Gupta C.K., Krishnamurthy N. (2004). Extractive Metallurgy of Molybdenum. CRC Press.
2. Habashi F. (1997). Handbook of Extractive Metallurgy. Wiley-VCH.
3. Wang Y. et al. (2021). Recovery of molybdenum from tailings. J. of Sustainable Metallurgy, 7(3), 488–499.
4. Zhang L. et al. (2020). Hydrogen Reduction of MoO_3 to Mo Powder. Metall. Trans. B, 51(2), 879–888.
5. Lee J. et al. (2019). Sintering Behavior of Molybdenum Powders. Powder Metallurgy, 62(4), 212–220.

ISSN 2181-

6. Nikitin D.V., Recycling of Copper-Molybdenum Waste for Molybdenum Production. // Materials Science Forum. – 2021. – Vol. 1035. – P. 45–50.
7. Ivanov A.A., Powder Metallurgy. - Moscow: Metallurgy, 2018. - 320 p.
8. Kuznetsov V.P., Technology of Metals and Alloys. - St. Petersburg: Polytechnic, 2020. - 280 p.
9. Lebedev G.I., Production of powders of refractory metals. - M.: Science, 2017. - 256 p.
10. Popov V.M., Secondary Processing of Non-Ferrous Metallurgy Waste. - St. Petersburg: UrSU, 2019. - 310 p.
11. Sidorov N.P., Reduction of molybdenum oxides in a hydrogen environment. // Metals. - 2021. - No. - P. 45-52.
12. Petrov Yu.A., Compact materials based on molybdenum. // Material Science Journal. - 2020. - Vol. 15. - No2. - P. 120-128.
13. Guryev V.V., Energy-Efficient Technologies of Powder Metallurgy. Novosibirsk: SO RAN, 2018. - 295 p.
14. Solovyov I.K., Molybdenum and its alloys: properties and applications. Moscow: Mashinostroyeniye, 2019. - 348 p.
15. Trofimov A.I., Modern methods of processing copper-molybdenum ores. // Mining Journal. - 2022. - No. - P. 60-67.