

Abstract

**ENVIRONMENTAL IMPACT AND EMISSION CONTROL IN
PYROMETALLURGICAL COPPER PRODUCTION**

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Abstract

Copper is one of the most important industrial metals due to its excellent electrical and thermal conductivity and its wide application in various industrial sectors. It is produced from primary and secondary raw materials using pyrometallurgical and hydrometallurgical processes. The main environmental problems in the refined copper production industry are air, water and soil pollution, as well as the generation of hazardous waste. However, copper production, particularly during roasting, smelting, converting, and refining operations, represents a significant source of air pollution. Given the growing environmental concerns and stricter regulatory requirements, it is essential to analyse copper production technologies and their contribution to atmospheric emissions, with a particular focus on particulate matter, metal-containing dust, and gaseous pollutants, as well as to evaluate the application of Best Available Techniques (BAT) for emission prevention and control. Best Available Techniques (BAT) for pyrometallurgical copper production include a combination of process optimization measures and advanced emission control technologies aimed at reducing atmospheric emissions, improving energy efficiency, and minimizing waste generation. This study was conducted as a literature review based on scientific publications, technical reports, and relevant regulatory documents related to copper production and environmental protection. The review showed that pyrometallurgical processes for copper production are the dominant source of atmospheric pollution. Sulphur dioxide (SO₂) was identified as the main gaseous pollutant, while particulate matter may contain trace amounts of heavy metals and metalloids such as lead (Pb), cadmium (Cd), arsenic (As), mercury (Hg), and nickel (Ni). These pollutants can adversely affect air quality, ecosystems, and human health, particularly in areas surrounding smelting facilities. In addition to air emissions, copper production generates solid and liquid waste streams that require appropriate management to prevent secondary environmental contamination.

The analysed literature indicates that the implementation of BAT significantly reduces the environmental impact of copper production. Effective measures include the use of: enclosed

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furnaces and sealed process systems to prevent fugitive emissions of dust and gases; efficient gas collection systems with centralized extraction from roasting, smelting, converting, and refining operations; application of high-efficiency dust removal technologies such as electrostatic precipitators (ESP), baghouse filters, and cyclones; wet gas cleaning systems for the removal of fine particulate matter and acid gases; recovery of sulphur dioxide (SO₂) through sulphuric acid production plants; optimization of process parameters, including temperature control and oxygen-enriched smelting, to improve process efficiency and reduce emissions; continuous monitoring and automatic control of emissions and process conditions; recycling and reuse of process dust, slag, and other by-products whenever technically feasible; use of energy-efficient technologies and heat recovery systems; proper treatment and management of wastewater and hazardous solid waste generated during the process. Modern emission control systems can achieve pollutant removal efficiencies exceeding 99%, contributing substantially to environmental protection.

In conclusion, understanding the technological stages of copper production and their associated emissions is essential for improving production efficiency and minimizing environmental impacts. The continuous application of BAT, environmental monitoring, and compliance with environmental standards are key factors in achieving sustainable copper production while meeting the increasing global demand for this strategically important metal.

Keywords: copper production, air pollution, sulphur dioxide, particulate matter, best available techniques

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