

THERMODYNAMIC ANALYSIS SULFATIZING ROASTING OF STALE NICKEL-COBALT-CONTAINING WASTES FROM OPERATING PLANTS

Kulzira K. Mamyrbayeva, Ph.D., Assoc. Prof. ¹

Almira Kuandykova, MSc. Senior Lecturer ¹

T. A. Chepushtanova, Assoc. Prof., Ph.D., Cand. of Technical Sciences ²

¹Department “Metallurgical Processes, Heat Engineering and Technology of Special Materials”, Mining and Metallurgical Institute, Satbayev University, Almaty, **Kazakhstan**

²Head of Department “Metallurgical Processes, Heat Engineering and Technology of Special Materials”, Mining and Metallurgical Institute, Satbayev University, Almaty, **Kazakhstan**

ABSTRACT

Metallurgy is one of the leaders in terms of the amount of accumulated waste worldwide. Every year the amount of waste placed in dumps, sludge ponds, tailings ponds only grows. However, at present, tailings, slag, dust, etc. of metallurgical enterprises are considered the most promising for secondary use and the extraction of valuable metals from tailings is an important problem in the world.

In Kazakhstan, the technology of processing nickel-cobalt-containing tailings is practically undeveloped. Sokolov-Sarybai Mining Production Association Joint-Stock Company (SSGPO JSC) in Kazakhstan, loses more than 7 thousand tons of nickel and 14 thousand tons of cobalt per year. For processing this type of raw material, a combined technology that includes preliminary roasting and leaching processes is acceptable.

The aim of the work is a thermodynamic analysis of the roasting process of wet magnetic separation (wms) tailings of the SSGPO JSC, containing such main components as nickel, cobalt and iron sulfides.

Thermodynamic analysis of the roasting of wms tailings in the temperature range from 500 to 750°C showed that in the presence of a limited amount of oxygen, the formation of iron sulfides of the following compositions is possible: $\text{Fe}_{0.877}\text{S}$, FeS , Fe_2S_3 , Fe_7S_8 . Nickel and cobalt sulfides are converted into Ni_3S_2 , Ni_3S_4 and $\text{CoS}_{0.89}$, CoS , respectively. In this temperature range, within the homogeneity region, the transformation of cobalt and nickel sulfides also occurs. The calculated values of the Gibbs free energy confirm the possibility of reactions of formation of low-sulfide compounds and the optimal condition for firing is the temperature range of 600-700°C. Depending on the firing conditions, interconversion of iron, nickel and cobalt sulfides occurs.

The results of thermodynamic analysis confirm the possibility of extracting iron, nickel and cobalt from wms tailings in the form of soluble low-sulfide compounds with subsequent extraction from the tailings in the form of individual metal powders. Combined technology for processing this type of raw material will be a good example of the use of circular economy principles.

Keywords: thermodynamic analysis, roasting, nickel sulfide, cobalt sulfide, wastes.