International Journal of Offshore and Polar Engineering (ISSN 1053-5381)

Vol. 25, No. 1, March 2015, pp. 71–78

http://www.isope.org/publications

Optimization of the Existing Methods for Recovery of Base Metals from Polymetallic Nodules

Miguel Pelegrín Rodriguez
CEDINIQ, Moa, Cuba

Ruben Aja
CIPIMM, Havana, Cuba

Ramón Causse Miyares
Interoceanmetal Joint Organization, Szczecin, Poland

The Interoceanmetal Joint Organization (IOM) has been involved in extensive research aimed at improving and optimizing the basic technological process for metal extraction from polymetallic nodules (PN). A new approach to the application of existing methods for extraction of base metals from PN, developed by CEDINIQ-CIPIMM in Cuba, involves additional studies on the sulfuric acid pressure leaching with molasses and pyrite used as reducing agents. The developed technology allows reaching high efficiency recovery of base metals (Ni, Cu, Co, Zn, and Mn), as well as the possibility of using the existing installation and infrastructure of the acid pressure leaching nickel plant in Moa, Cuba. This paper describes the method and the results obtained from the preparation of the crude slurry, pressure acid leaching in the presence of molasses and pyrite as reducing agents, direct metal extraction by resin-in-pulp, metal sulphide precipitation, crystallization and precipitation of manganese, extraction and separation of base metals with an organic solvent, and extraction of additional useful components such as molybdenum, precious metals, platinum group metals, and rare earth elements.

INTRODUCTION

Base metals such as nickel, cobalt, copper, zinc, and others have been extracted from laterite ores for over 100 years, beginning with processing of garnierite ores from New Caledonia (Dalvi et al., 2004). Although the world's nickel supply has so far been based on sulphides, it is predicted that the expansion in production capacity of base metals during the next 20 years will primarily involve processing of marine polymetallic nodules (PN) due to: (a) the world's demand for metals continuing to rise, mainly from the demand from rapidly developing economies of countries such as China and Brazil; (b) increasing demand on account of the needs of electronics and emerging technologies (e.g., "green economy"); and (c) land resources becoming depleted and their exploitation hampered by environmental concerns. Polymetallic nodules, which are a form of laterite ore, contain oxidized forms of, for example, nickel, copper, cobalt, manganese, iron, titanium, zinc, and certain rare earth elements (REE).

So far, IOM has been involved in research aimed at optimizing three technologies of base metal extraction from PN:

1. Pyro-hydrometallurgical technology: In this regard, the Chemical Technical Metallurgical University in Sofia, Bulgaria carried out research aimed at improving and optimizing selective recovery of metals by using thermal processing (Ore-Electric Smelting Furnace – BMD) and subsequent treatment of Cu-Ni-Co complex alloy (Abramov, 2011). The percentage recovery of Ni, Co, Mn, and Fe obtained was 92.07, 93.67, 97.97, and 94.97, respectively.

2. When pursuing optimization of PN hydrometallurgical processing, TSNIGRI Institute in Moscow, Russia has developed a technology of selective metal leaching from PN using sulfur dioxide (Romanchuk, 2011). The percentage recovery of Ni, Cu, Co, Mn, and Fe arrived at was 97.5, 92.55, 95.88, 97.80, and 9.96, respectively.

3. CEDINIQ-CIPIMM in Moa, Cuba has developed a new approach to the existing methods for base metal (Ni, Co, Cu, Zn, Mn) recovery from PN (Pelegrín, 2011; Pelegrín et al., 2010). The approach involves additional studies on sulfuric acid autoclave processing technology using molasses and pyrite as reducing agents (Matos, 1997). The percentage recovery of Ni, Cu, Co, Mn, Fe, and Zn was 94.4, 93.9, 97.0, 96.6, 9.8, and 93.5, respectively.

The focus of this paper is on the third method of PN processing technology. In 2010, CIPIMM and CEDINIQ, the research centers of the Cuban nickel industry, were involved in studies on optimization of processing of PN collected from the seabed of the Clarion-Clipperton Zone (CCZ). The technology developed is based on sulfuric acid pressure leaching (PAL) used at the Moa processing facility, with molasses and pyrite as reducing agents.

When developing the technology, the Cuban researchers considered the following factors (Chalkley and Toirac, 1997; Kerfoot and Cordingley, 1997; Pelegrín, 2011; Pelegrín et al., 2010):

• Cuba is the IOM sponsoring state situated at the shortest distance to the PN deposits in the Pacific's CCZ (as shown in Fig. 1). The country has a facility using one of the most effective technologies of laterite processing (direct ore sulfuric acid leaching under pressure), and the facility is accompanied by a refinery. This is a site where future PN processing could take place.

Received November 14, 2013; updated and further revised manuscript received by the editors March 26, 2014. The original version (prior to the final updated and revised manuscript) was presented at the Tenth ISOPE Ocean Mining Symposium (OMS-2013), Szczecin, Poland, September 22–26, 2013.

KEY WORDS: Polymetallic nodules, acid leaching, molasses, pyrite, sulfur dioxide.