RECOVERY OF GERMANIUM FROM COPPER SLAG USING SILICOTHERMIC PROCESS

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ABSTRACT

The depletion of primary raw materials and the demand in High Tech has played a big role in finding new ways of getting raw materials including recycling. Germanium being a semi-conductor currently in high demand is being sourced from secondary materials. The purpose of this project was to recover Germanium from copper slag in the presence of pure silicon using the carbothermic reduction process. The experiment was designed using Minitab software with Taguchi as the tool for statistical analysis and to design the experiment. The working temperature was kept constant at 1350 degrees Celsius and the mass of silicon, slag basicity and residence time in the furnace were investigated with the response being recovery of germanium to determine the optimum conditions under which there is a high recovery of Germanium as per the conducted experiments. The findings of this experiment are that the conditions that yield a high recovery of Germanium are 0,008 mass of pure silicon, 0,8 basicity and the optimum time was found to be 120 minutes. In this investigation targeted to meet the sustainable research and development goal of implementation of circular economy by virtue of recycling metallurgical waste that goal. Moreover, from the carbothermic reduction cobalt and copper were recovered consequently. The optimum conditions were tested using the main effects, interaction, and sensitivity to noise ratio plots all from Taguchi.

Keywords: Pure silicon, Germanium recovery, copper slag

INTRODUCTION

Germanium is a rare and critical element in modern technology. It is the next generation of electronics and renewable energy applications. It was discovered by a German chemist in 1886 in silver ores, upon further investigation it found that it is also a by-product of zinc, coal and copper processing. Copper ores smelting leads to copper slag production as one of the main products using pyrometallurgy process [1]. This material is generally considered as a secondary source valued metallic that can be extracted because of their economic concentrations. For that reason, copper slag can be processed as a secondary raw material because of substantial amount of copper and other valuable metals present [2, 3]. Many investigations have been conducted using different approaches and processes to recover these metals and gave promising results [4]. It was found that the transition of the basic slag was favored by $CaO\text{-}Fe_3O_4\text{-}Cu_2O$ which made the viscosity and conductivity difficult to understand because of the allegations that the viscosity and the conductivity in basic slags correlate if the slag contain $FeO\text{-}SiO_2$ and that the influence of commonly found compounds $CaO\text{-}Fe_3O_4\text{-}Cu_2O$ on the viscosity and conductivity are of great impact [5]. The production of one ton of refined copper is typically accompanied by the generation of 2.0–3.0 tons of copper slag [6]. The copper slag from Katanga province in the Democratic Republic of Congo was found to contain

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