Imam Khomeini International University
Vol. 3, No. 4, Winter 2019, pp. 30-32

نشریه مهندسی منابع معدنی
Journal of Mineral Resources Engineering (JMRE)

DOI: 10.30479/jmre.2019.1586

Optimization Of Effectives Of Parameters On Acid Leaching Of Silica Sand For Use In Glass Industry

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(Received: 13 Jun. 2018, Accepted: 03 Oct. 2018)

Abstract: In this paper, the removal of iron oxide (Fe2O3) from silica sand samples of Cheshin mine with acid leaching (H2SO4) has been investigated under various experimental conditions. The silica sample used for leaching process contains 96.23% SiO2, 0.13% Fe2O3, and 1.67% Al2O3. The parameters affecting the process were investigated through designing experiments by Taguchi method in Minitab software. The parameters studied were: pH value, solid content, and pulp temperature. Mineralogical studies indicated that the silica sand sample contains pyrite, and iron oxide and iron hydroxide minerals such as hematite, goethite, and limonite. The results of acid leaching process indicated that the iron removal would increase by decreasing pH from 2 to 1. Also, the amount of iron in silica sand would decrease as the solid content and the temperature were increased from 50% to 70% and 40 °C to 80 °C, respectively. The highest iron removal rate was obtained under the optimum conditions including pH=1, temperature degree =80 °C, and the solid content of 70%. Therefore, the final processed sample contained 98.50% SiO2, 0.031% iron oxide (Fe2O3), 0.70% Al2O3, and 0.32% CaO, which is suitable for producing cup glass, glassware, and borosilicate crystal.

Keywords: Silica sand, Iron Oxide, Acid leaching, Glass industry, Effective parameters.

INTRODUCTION

Silica is one of the main materials, which are used in glass production. Iron oxide (Fe2O3) causes the green color to be produced in the glass, and so, it's necessary to be reduced before using. According to the type of produced glass, the iron oxide content varies from 0.07% (to produce glass containers) and 0.01% (to produce crystals and optical glasses) [1]. There are various methods to remove silicon iron, of which the more common are crushing, aggregation, scrubbing, washing and grinding, gravity separation (shaking and spiral stacking), flotation, magnetic separation, and acid leaching [2,3]. In some cases, to reduce the consumption of acidic solvents and to devaluate the operating costs and decreasing environmental problems, preprocessing operations such as magnetic separation [4,5] or new methods, such as bioacid

leaching before acidification are also used [6]. In this paper, removal of iron oxide from silica sand samples of Cheshin mine in Zanjan by acid leaching with sulfuric acid in glass industries is investigated.

MATERIAL AND METHODS

MATERIALS

Silica samples are prepared from Cheshin Mine,Zanjan. The Sulfuric acid (98%) of Zanjan Acid Sazan Co. is used to adjust pH and for the process of acid leaching.

METHODS

SAMPLING AND PREPARATION

In order to conduct identification studies and acid leaching tests, samples were taken from the mine site, fronts and depots. The grinding of the sample was done in two stages of jaw and cone crushing up to dimensions of d_{100} = 2710 microns and a bar mill with a diameter d_{80}=327 microns in one stage, and then, with the help of a rifle and cone, the sample was uniformly divided.

MINERALOGY STUDIES

To study mineralogy, a 2 – kilogram sample is prepared and is divided to 8 dimension zones, which are +500, +300, +250, +180, +150, +125, +75 and – 75 microns. According to thin and polish sections, the iron minerals in silica are as pyrite, iron oxides and iron hydroxides that are represented as Hematite, Goethite and limonite. Due to mineralogy and liberation degree, the silica is 80% free under the size of 125 microns.

ACID LEACHING TESTS

To test acid leaching, a specific amount of sample is solved into 2-liter container of distilled water. By using a stirrer and a hot plate, the temperature is fixed and the sulfuric acid (95%) is added to pulp to control Ph. Acid leaching tests are conducted in different temperatures, solid percentage and pH of pulp during 30 minutes and 800 rpm. The acid leaching pulp is filtered after each test. The filtration cake is analyzed after drying out and weighting.

In this paper, the designing of test with the Taguchi method in Minitab 17 software is used to analyze the different variable and the interaction of pulp temperature, pulp pH and pulp solid percentage, in high, low and center level on iron removal rate (as a response).

FINDING and ARGUMETS

THE CHEMICAL ANALYSIS (AAS)

Based on the analysis carried out by the atomic absorption device, the iron oxide content of the sample was determined to be 0.13%. This ore contains 96.2% SiO_2 and 1.67% Al_2O_3.

ACID LEACHING TESTS

Based on the results obtained from the initial experiments and the design of the experiments, the pH and the solid percentage are, respectively the most and the least effective factors in the removal of iron. At pH 1, the highest amount of iron removal is achieved. The amount of iron oxide is reduced from about 0.095 to about 0.04% when pH is decreased from 2 to 1, by increasing pulp temperature from 40 to 80 °C, the amount of iron oxide is reduced from about 0.08% to about 0.66% and by increasing the percentage of Solid pulp from 50 to 70 percent, it has dropped from about 0.75-0.67 percent.

CONCLUSIONS

Temperature has a significant influence on iron removal efficiency. As the temperature increased, the iron removal efficiency was increased and the optimum temperature for reducing iron in acid leaching process was obtained at 80 °C. The amount of iron removal increased with increasing pulp solids content. However, the effect of pH on iron removal was higher than solids and temperature. Under optimal conditions, the highest iron removal rate was obtained when if pH=1, temperature= 80 °C and solids content of pulp =70%. In this condition, silica sand contains 0.031% iron oxide, which is suitable for glass jars, glassware and

borosilicate crystals.

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