PRELIMINARY CYANIDATION OF GOLD ORE FROM ZAVVARIAN

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Abstract—Zavvarian area is located about 60 km south-west of Qom city, Iran. Due to high potential of the region, representative sample was prepared and then several primary cyanidation experiments were carried out. Screening and assaying tests showed that there exists a considerable amount of gold within all size distribution ranges. The mean value of grade was measured about 1.9 g/t for this ore. Degree of freedom was found to be -74 micron by considering the fact that most gold particles existed within size distribution finer than 74 micron. According to chemical analysis, elements of Au, Ag, Hg, and As comprise 2 ppm, 13 ppm, 25 ppm, and 1600 ppm of the sample, respectively. Based on the microscopic studies (polished and thin sections), XRD, and XRF, the main minerals included quartz, and tourmaline and other minor minerals were feldspar, chlorite, muscovite, hydrous iron oxides/hydroxides, limonite, and goethite. Cyanidation tests were conducted in order to determine the optimum value of the effective parameters including particle size, pH, cyanide concentration and leaching time. The optimum condition for particle size, pH, cyanide concentration and leaching time were determined as 74 micron, 10.58, 3 kg/t and 24 hours, respectively. The results showed that gold recovery of 93.36% was achieved at the optimum condition.

Keywords: Cyanidation, Gold, Zavvarian, pH.

1. INTRODUCTION
Cyanidation is a common method in gold extraction industries due to its high efficiency, inexpensive operation, and easy accessibility [1,5]. The oxidation of gold is a prerequisite for dissolution in the alkaline cyanide lixiviant [9]. In the presence of cyanide (CN), gold forms a cyano complex [Au(CN)₂⁻] when it is oxidized [9,8]. Elsner's equation (Eq. 1) shows the dissolution of gold in alkaline cyanide solution and the role of oxygen in gold cyanidation [5].

\[ 4Au + 8NaCN + O_2 + 2H_2O \rightarrow 4NaAu(CN)_2 + 2H_2O \] (1)

Gold dissolution by cyanide was introduced since beginning of 19th century; however, it did not economically applied into practice until the late 1980. First cyanidation process was used for gold extraction from amalgamation method's residues. Then, it was applied for all gold-bearing ores due to its high productivity [2,7,6]. Sharafabad gold ore cyanidation showed that gold particles changes in the range of 65-250 micron. Also, the grade of gold were 5.7 g/t in the representative sample. The maximum recovery of gold in cyanidation experiments was obtained 96.76% under optimum conditions of \( d_{85}=75 \text{micron}, \text{pH}=11 \), and leaching time of 20 hours [3]. Tuzlar gold cyanidation showed that the sample includes 2 g/t gold inside. Cyanidation leaching, roll bottle, and column methods were carried out for gold dissolution whereby the recovery of gold were obtained 94%, 59%, and 70%, respectively. Also, gold recovery through active carbon and ion exchange by zinc foil was obtained 99.87% and 95.4%, respectively [4].

Zavvarian area is located about 60 km south-west of Qom city and about 5 km of Salafchegan. The study area includes 300 km² of the region which ends from north to Salafchegan and Marvar village, from west to Koushk and Salehabad village, from south to Sakht Hesar Mountain, and from east to Sorkh Hesar Mountain. In the scope of this work, due to presence of 2 g/t gold in the ore, cyanidation experiments were carried out for Zavvarian gold ore in order to examine gold leaching feasibility in this region and optimize the effective parameters including particle size, pH, chemical material consumption, and dissolution time.

II. MATERIAL AND METHODS
In order to perform cyanidation studies, four effective parameters were optimized in 4 levels through classic method (keeping constant 3 parameters and changing 1 parameter at the same time). Then, responses were examined for gold recovery and consumption amount of cyanide by titration using silver nitrate. Experiments were conducted for samples obtained through wet grinding stage by using ball mill. Solid percent of 33% was kept constant during all the experiments (1kg of sample with 2 lit of water). Due to the high influence of pH on the process, pH value was regularly controlled using pH meter. Hydrate lime and sulfuric acid (15%) were used for increasing and decreasing pH value, respectively. Sodium cyanide with industrial purity was used as dissolution agent of gold. Gold distribution in solid and liquid phases was determined by ICP method. After each rest,