

Purification of Silica from Tin Tailing by Acid Leaching Methods

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Abstract—Tin mining will leave industrial waste in the form of tin tailings. Physically, the main content of tin tailing is sand that can hardly be utilized for agricultural purposes. Tailings contain only a small amount of nutrients and may contain toxic compounds. In this article we developed a method of purifying silica from tin tailings sand by acid leaching method. Silica is a material that can be used for various purposes such as in the process of thermal treatment, building construction, and bioengineering. Based on the results of XRF analysis, acid compounds can increase the purity of Si element in tin tailings and reduce metal elements. The x-ray diffraction patterns also confirmed that the dominant crystal phase in the purified sands was α -SiO₂. The highest silica content was obtained on the use of nitric acid with silica concentration of 90.40%.

Keywords—Tin, Tailing, Silica, Leaching

I. INTRODUCTION

The high level of tin mining activities in the Bangka Belitung Islands has a positive impact on the provincial economy but on the other hand it also has a negative impact on the environment [1], [2], [3]. When a tin mining site has been carried out, there will be a basin called *kulong*, overburden (pile of clay from the excavation), and tailings. Tailings are mining industry wastes from the process of washing mining materials. In large quantities tailings will kill plants because they only have low nutrients and contain toxic substances. Several tailings land remediation methods such as phytoremediation [4], fertilizer application [5], and microbial distribution have been developed [6]. But in some cases, the appearance of heavy metals in plants planted on land is still unavoidable and is still above the permissible threshold. Thus the use of tailings land as an agricultural area requires a very rigorous evaluation and requires high costs before being declared suitable for use [7].

Physically the composition of tin tailing waste is composed of sand (about more than 80 - 95%), and in small amounts including clay and dust [8], [9]. Through chemical analysis it is known that sand in the tin tailing area is dominated by SiO₂ (silica) [8]. Silica is a compound that is widely used for various applications such as in the rubber

industry, cement, ceramics, solar cells, and also in computer devices. Especially in the current era of nanotechnology, silica plays an important role because it has unique properties in terms of structure and electrical properties. Based on these advantages, in this paper we will develop the initial method of purifying silica from tailings. The method we use is an acid leaching method that aims to remove impurity elements, especially metals that are easily corroded by acid.

II. METHODS

The tailing sand used in this study came from the post-tin mining land in Sungailiat, Bangka. Before leaching, the tailing sand is washed and dried at a temperature of 110°C to remove macro impurities. Then tailing sand is crushed and sieved using a 200 mesh sieve. Fine tailing sand is then characterized using XRF (*x-ray fluorescence*) to determine its composition as initial information on the tailing sand content used. The leaching process is carried out through tailing sand dissolution in a variety of impurity solvent acids, namely: sulfuric acid, nitric acid and phosphoric acid. This variation of solvent acid is carried out to determine the effectiveness of acid types in removing impurities in sand tailings. The acid concentrations that will be used are 5%, 10% and 15%, respectively. Leaching time is 3 hours and leaching is carried out at room temperature. The leaching results are then filtered and the residue is washed and dried in an oven 110°C. After drying, the composition of post leaching sand tailings was observed using XRF and XRD (*x-ray diffraction*).

III. RESULTS AND DISCUSSION

The results of the XRF analysis for the silica content of tailings sand are shown in Fig. 1. In the graph it appears that the tailings sand content depends on the type of acid used. Raw tin tailing sand contains 89.35% silica with the remaining other compounds are Al₂O₃, K₂O, CaO, TiO₂ and etc.

In the leaching process using sulfuric acid, the higher the concentration of sulfuric acid, the lower the level of silica in

the sand tailing. At 5%-H₂SO₄ the silica concentration reached 89.47%, 10%-H₂SO₄ silica concentration reached 89.36%, while for 15%-H₂SO₄ only reached 89.21%. The decrease in silica concentration in the tailings sand along with the increase in sulfuric acid concentration occurred due to the appearance of SO₃ compounds in the sample in quite high levels reaching 0.85%. Even though, the raw tailing sand does not contain the compound. Thus the appearance of SO₃ compound in the sand is caused by the use of sulfuric acid.

The interesting thing is that leaching using nitric acid. The higher concentration of nitric acid, the higher level of silica in the sand tailing. The level of silica in the leaching process reached the highest value of 90.40% for 15% nitric acid concentration. The silica levels for 5%-HNO₃ and 10%-HNO₃ were 89.35% and 89.42%, respectively. This increase

due to nitric acid can effectively reduce impurity compounds such as Al₂O₃, P₂O₅, and TiO₂.

As for the use of phosphoric acid, the higher the concentration of acid there will be a decrease in the level of silica in the sand tailing. In 5%-H₃PO₄ silica levels reached 90.24% while for 10% -H₃PO₄ and 15% -H₃PO₄ were 89.66% and 89.65% respectively. Therefore, based on these results it is possible for further research to find the optimum point of phosphoric acid levels that can produce the highest amount of silica. The decrease in silica content in the leaching process was caused by the formation of P₂O₅ compound in tailing sand due to the use of phosphoric acid. The higher the concentration of acid used, the higher P₂O₅ oxide is formed. Sequentially the levels of P₂O₅ compounds due to the use of sulfuric acid at low to high concentrations were 0.86%, 1.00%, and 1.27%. However, phosphoric acid can effectively reduce impurities such as Al₂O₃.

To confirm the phase formed, XRD analysis was performed for each type of leaching acid and the results were shown in Fig. 2. Almost all of the samples in this study had identical patterns. Through the comparison of XRD spectrum patterns with databases using PANalytical X'Pert High Score

Plus software, it can be concluded that the samples in this study, both before leaching and after leaching, were dominated by the alpha-silica phase (Ref. : 01-078-1253). Thus it can be concluded that acid leaching method does not change the silica phase in the tailing sand.

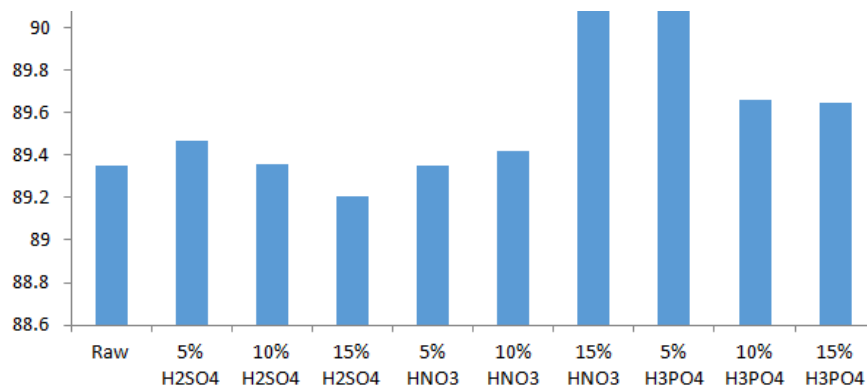


Fig. 1. Silica concentration in tailings sand before and after leaching

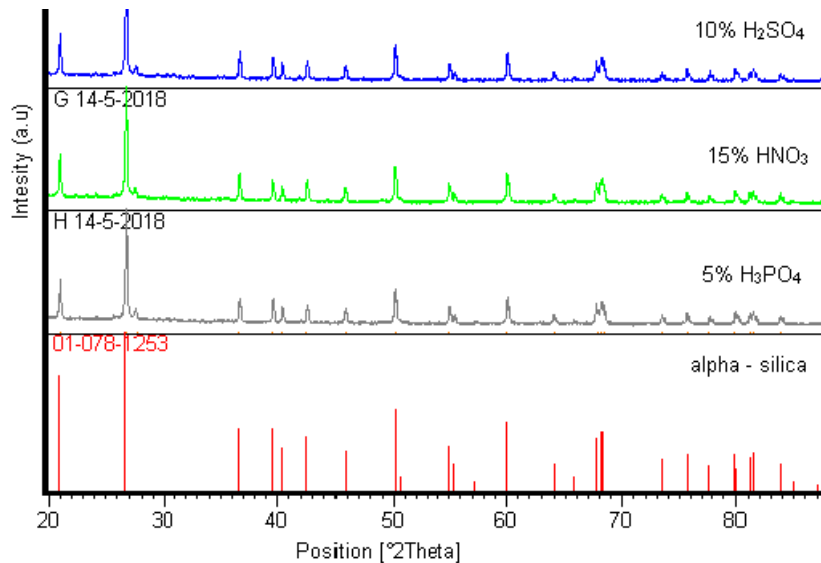


Fig. 2. XRD pattern of tailing sand before and after leaching

IV. CONCLUSIONS

Sand tailings contain high amounts of silica (> 85%). The leaching process can increase the level of silica in sand tailings and reduce the amount of impurity compounds in sand tailing. The higher concentration of sulfuric acid and phosphoric acid used, the lower silica concentration because they can form SO₃ and P₂O₅ impurity compounds. However nitric acid has a different pattern. The higher the concentration of nitric acid, the higher the level of silica obtained. The highest silica content obtained in this study was 90.40% obtained through the use of 15%-HNO₃. Based on XRD analysis, it can be concluded that the leaching process does not change the silica phase in sand tailing. Sand tailings contain high amounts of silica (> 85%). The leaching process can increase the level of silica in sand tailings and reduce the amount of impurity compounds in sand tailing. The higher concentration of sulfuric acid and phosphoric acid used, the lower silica concentration because they can form SO₃ and P₂O₅ impurity compounds. However nitric acid has a different pattern. The higher the concentration of nitric acid, the higher the level of silica obtained. The highest silica content obtained in this study was 90.40% obtained through the use of 15%-HNO₃. Based on XRD analysis, it can be concluded that the leaching process does not change the silica phase in sand tailing.

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