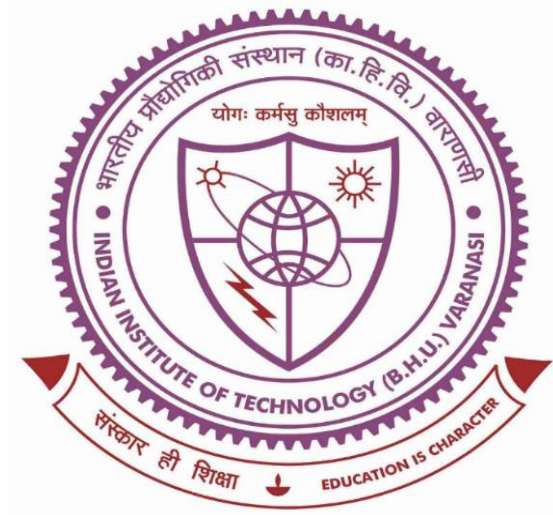


EXTENDED ABSTRACT

UTILIZATION OF ALUMINIUM DROSS TO RECOVER VALUABLE PRODUCTS



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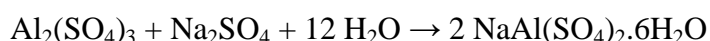
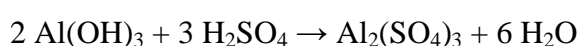
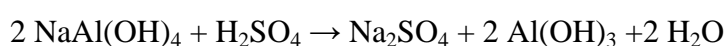
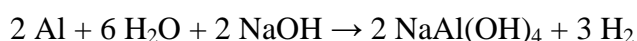
(Prof. K. K. Singh)

Extended Abstract

Aluminium dross is a hazardous industrial by-product generated in primary and secondary aluminium production plants. It is a heterogeneous mixture of metallic aluminium, alumina and salt fluxes, along with the minor presence of nitride and carbide and other trace metals like magnesium and zinc. Aluminium entrapped in the matrix of the oxide is usually present in a significant amount, and thus, aluminium dross can be utilized for the extraction of metallic values from it. The conventional methods of recycling aluminium dross include both the routes: pyrometallurgical and hydrometallurgical.

The present research illustrates the utilization of white aluminium dross for the generation of valuable products: **tamarugite, potash alum, alumina, and hydrogen**. The methodologies described herein explore new dimensions of industrial waste recycling. The recycling approach of aluminium dross is in the hydrometallurgical route.

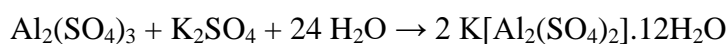
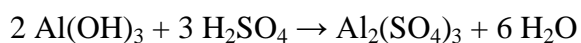
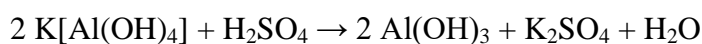
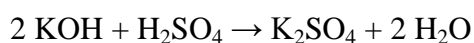
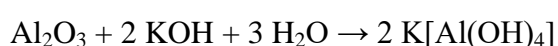
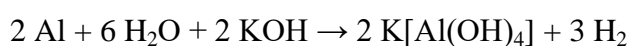
The first important valuable product prepared during this study is tamarugite. Tamarugite has been produced by two methods. In the first method, the leaching experiment was carried out with 3 M sodium hydroxide aqueous solution. The resultant product in the solution is NaAl(OH)_4 . This leached liquor is filtered, and the separation of solid residue is carried out. To this filtered leached liquor, the addition of sulphuric acid is done. After the drop-wise addition of sulphuric acid in the leached liquor, the solution mixture is heated to saturation. The solution is allowed to cool at room temperature for 24 hours. The complete solution gets crystallized into a solid mass of Tamarugite. This solid mass is scrapped out of the glass vessel in which it was crystallized and stored for characterization. The following reactions take place:



In the second method, tamarugite has been produced by the organic solvent precipitation. Leaching aluminium dross fines with sulphuric acid to extract aluminium ions into the solution is carried out. Addition of sodium hydroxide solution to the leached liquor leads to the supply of sodium ions into the solution. The leached liquor is maintained at a higher temperature of 45 °C for 4 hours, whereas organic solvent is maintained at 20 °C. A small shot of leached liquor is taken from the thermostated solution and dropped into the organic solvent and stirred at 400 rpm for 10 minutes. This leads to the precipitation of Tamarugite in the organic solvents.

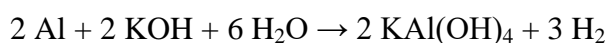
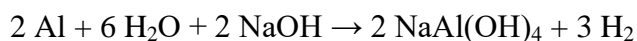
Tamarugite produced from the two methods mentioned above have been subjected to coagulation test. It has been found that the tamarugite performs well as a coagulant, compared to the conventional coagulants like commercial alum. The change in pH of the water samples is also low, even with a higher dosage of the coagulant.

Potash alum, an important industrial product is also generated during this study from white aluminium dross. Leaching experiments were conducted with 3 M potassium hydroxide aqueous solution to produce potash alum. The leached liquor was filtered to separate the residual solid from the solution. With the use of potassium hydroxide solution, the product $K[Al(OH)_4]$ is produced. As mentioned above, 3 M sulphuric acid has been added drop-wise into the leached liquor to provide for the sulphate ions required for the formation of potash alum. However, the precipitation of potash alum does not take place immediately with the addition of sulphuric acid into the leached liquor. The solution mixture is heated to make the solution saturated and subsequently transferred to a cold water bath for 24 hours. This leads to the crystallization of potash alum from the solution. The reactions are given as under:



The resultant potash alum is separated from the solution mixture and dissolved again in distilled water for recrystallization to remove the impurities inherent in it. The final crop of the potash alum is washed with an ethanol solution to protect it from contamination. The characterization of the samples is carried out using XRD, SEM-EDS, ICP-OES, and TGA.

Hydrogen, the next-generation fuel, is also produced using white aluminium dross. When metal comes in contact with water, the formation of hydrogen gas takes place, along with the production of metal oxide/hydroxide. The same is possible with aluminium, but this reaction does not proceed as expected due to the presence of a protective oxide layer on the surface of aluminium. The addition of alkali is done to remove the oxide layer from the surface of aluminium. Under the presence of sodium hydroxide and potassium hydroxide, the surface of alumina is removed, and the metallic aluminium reacts with water to form hydrogen as shown in the following reactions:



As the hydrogen gas evolution from the reaction of aluminium dross fines with alkaline solution takes place, the optimization of the process is done. For this, the variation of temperature of the solution, time of the reaction, the concentration of the solution has been carried out. It has been found that NaOH solutions are effective in evolving hydrogen gas from aluminium dross fines at lower temperatures and both NaOH and KOH solutions function well at higher temperatures. The maximum amount of hydrogen gas is evolved within 60 minutes of commencing the reactions. Increasing the concentration of the solution

increases the overall reaction and subsequently, the amount of gas liberated. Around 1300 mL of hydrogen gas has been reported to evolve with the use of the alkaline solution.

Finally, the aluminium dross residual solid has also been utilized to produce alumina. The residual solid obtained after the leaching of aluminium dross has been heated to 900 °C for 4 hours. This leads to the transformation of the residual solid to alumina. This residual solid can be further used for the production of composite or the extraction of aluminium by the conventional fused salt electrolysis by Hall Heroult Process. This leads to the complete utilization of aluminium dross for the generation of valuable products.