

## Identification of rare earth metal from red mud and extract it.

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**Abstract:** -Red mud is the industrial solid waste from Bayer's process to manufacturing of aluminum oxide. It is also called bauxite residue .Approximally 95%of red mud is produced from the Bayer's process. However, the accumulation of red mud is a big concern of recent time due to significant toxicological impact on the environment .On most research done, found that in some concentration rare earth metal in red mud, which very valuable Even red mud having various application and use .Basically red mud, red naturally .This color arises from iron oxide as well as very PH and alkalinity ranging from 10 to 13 .The component are consist which ferrous oxide. Alumina, titanium oxide are some concentrations. This review paper has shown that use of various methods can apply to recover a valuable rare earth metal from red mud .As well as red mud can be useful to the various application like soil remediation, purification of flue gas, wastewater treatment .In the recent study found that red mud can be used off lab-scale study. The world is facing a deficiency of iron. New methods are invented to iron recover from red mud, hydrometallurgy, and pyro metallurgy continuously discovering. The information which is based on recovered rare earth metal might be useful in future investigation.

Keywords: - Red mud, Iron content in red mud, Rare earth metal.

## INTRODUCTION

Red mud is bauxite residue (solid industrial waste) from the alumina refining of bauxite ore, by the bayers process. Approximately, generates 1-1.5 ton of red mud during operation .day by day increasing the demand of aluminum oxide, the current production rate of red mud reached 2.9 million tones .accumulation of red mud is being major concern due to toxicological, hazardous properties. The management of red mud represents the data that show that massive volume of red generated of red mud and harmful impact on the environment due to disposal in open space. To date, many methods applied to the management of red mud but still no effective methods have been useful well as implemented. In this review, we trying to propose, recover valuable metals from red mud and methods of very essential for red mud management. The red mud having high alkalinity, in between 10-12 also very high amount generated per day. Landfill, deep-sea dumping and storage settling tank, this very common method to the management of red mud . But direct method disposal into open space cause the harmful effect on ecology system .however, red mud having lots application which is very useful, like adsorbents, pollutant removal, building material ( bricks, concrete, cement, and road foundation material,).red mud is being established a secondary raw material which can be valuable rare earth material recover it .Iron, aluminum, titanium, are rare earth material and they some proportion they found in red mud Fe- 14-45%,5-14%Al,1-9%Si,2-12%Ti, in red mud .demand for iron has been increased in globally and proportion iron oxide rate mostly found in red mud .Recovery of metal from red mud is very complicated as compared to mineral phase. Hematite, boehmite,soladilite aluminosilicate is some kind of mineral which very easily recovers it from red mud .Generally the rare earth metal recovered 75.7 Al and 80.7 % Na .This review paper is based on the recovery of earth metal from red mud like iron, alumina, titanium, and process based on environmentally and economically feasible process.

## RARE EARTH METAL CONSIST IN RED MUD

Table.1

Major and minor and trace elements content in the red mud

Major elements	Concentration
Fe	4.52 -50.6
Al	4.42-16.06
Si	2.16-14.86
Ca	0.39-16.72
Ti	0.98-5.34

Minor elements	Concentration
U	50-60
Ca	60-80
V	730
Zr	1230
Sc	54
Cr	497
Mn	85
Y	68

## THE TECHNIQUE USED FOR RECOVERY OF IRON FROM RED MUD

In the past years, continuously iron extraction from red mud, even some process discovered and implemented successfully, like solid state carbothermic reduction acid leaching smelting in the blast furnace, magnetic separation. Due to some content in red mud like Al, S, P, Ca, it is continuously problem to realizing content iron, because high alkalinity it's not suitable for refractory, and accumulation. Many researcher has been studied on that part, the technique which is used to implementation of the method on red mud to recover the metal with zero waste as well as fully recover which is hidden in red mud. This would become very advanced and add value to recover of iron content and make sure it is environmentally and economically acceptable.

In the meanwhile period, iron recovery from red mud, in 2009-2014 search on Google most of the time. and showed most of the patent filed 47% were from china. among all the technique we have settled some of few like direct magnetic separation pyro metallurgical recovery and hydrometallurgical recovery.

### DIRECT MAGNETIC SEPARATION

Recovery of iron from red mud from direct separation process cost compared to pyro metallurgical recovery very less. Whilst maintaining and other metal is extractable form. The process used to generate the value from byproduct from alumina refineries. Red mud is directly introduced to high magnetic separator, low magnetic separator, to production various size of a fraction like high iron oxide fraction, silica, mixture iron, and silica. Application mainly this time and iron corresponding concrete material and general filling. Because of this separation at high concentration HGSM, high gradient super magnetic separation to use. It is more efficient in separating fine material. Initially, red mud charged into the HGSM, Fe recovered 45.46% start as fine powder weight percent of iron from red mud may 10%. But one thing is here, the residue still finds 31.47% of the recycling of the red mud sample.

### PYRO METALLURGY SEPARATION PROCESS OF IRON FROM RED MUD

Among all the process which is recovery method of metal from red mud, pyro metallurgy most important and valuable process. By the help of magnetic separation red mud can be reduced which is very environmentally and economical acceptable. but presence of all component which is very complicated to reduce the iron from red mud. By the help of direct reduction of red mud must get pig iron after magnetic separation. The iron

nuggets produced which is directly reducing carbon pellets and coal at 1400<sup>0</sup>c for half an hour .Approximately, 52. 57% of iron contains this nugget and low amount of Mn, Si, and high concentration s and p but here Fe mineral in the slag and reduced red mud and produced pig iron, that why red mud mixed with flux for reductant and smelting process proceeding only for 15 min. according to morphological study, iron oxide in red mud iron will available 71%. Slag and cast iron can be easily separated after smelting and reduction. Cast iron may generate 2.0- 2.9 %. In the roasting process, all parameters have been discussed very deeply, like temperature, smelting, carbon source, and carbon magnetic condition the red mud is mixed with carbon and additive pressing the mixture in the cylinder. All mixture roasted for among all the process which is recovery method of metal from red mud, pyro metallurgy most important and valuable process. By the help of magnetic separation red mud can be reduced which is very environmentally and economical acceptable .but presence of all component which is very complicated to reduce the iron from red mud. By the help of direct reduction of red mud must get pig iron after magnetic separation. The iron nuggets produced which is directly reducing carbon pellets and coal at 1400 0c for half an hour .Approximately, 52, 57% of iron contains this nugget and low amount of Mn, si, and high concentration s and p but here Fe mineral in the slag and reduced red mud and produced pig iron, that why red mud mixed with flux for reductant and smelting process proceeding only for 15 min. According to morphological study, iron oxide in red mud iron will available 71%. Slag and cast iron can be easily separated after smelting and reduction. Cast iron may generate 2.0- 2.9 %. In the roasting process, all parameters have been discussed very deeply, like temperature, smelting, carbon source, and carbon magnetic condition the red mud is mixed with carbon and additive pressing the mixture in the cylinder. All mixture roasted for 1300<sup>0</sup>C for 110 min. and then quenched with water .completion of milling product then we can use magnetic separator. Whatever residue can be generated can suitable for the building material. The total proportion of iron can available 87.28% with metallization of 97.57 but after recovery get the actual 81.40% .

However, the roasting iron with red mud need to investigation to all mechanism and reaction as well as improve the all condition may get recovery iron content in red mud .in this way to minimize red mud waste and recover the iron. 1300<sup>0</sup>C for 110 min. and then quenched with water .completion of milling product then we can use magnetic separator. Whatever residue can be generated can suitable for the building material. The total proportion of iron can available 87.28% with metallization of 97.57 but after recovery get the actual 81.40% .However the roasting iron with red mud need to investigation to all mechanism and reaction as well improve the all condition may get recovery iron content in red mud .in this way to minimize red mud waste and recover the iron.

## HYDROMETALLURGY SEPARATION PROCESS FOR IRON CONTENT IN THE RED MUD

Like pyro metallurgical process recovery for iron from red mud, research has been done on the hydrometallurgical process. Achieving the iron from red mud approximately 47% at the leaching condition at 1000<sup>0</sup>C. At 24 hours, and with 8N sulfuric acid. In the calcination process, 6M sulfuric acid was used and we achieved the 97% of iron from red mud .after the treatment of the red mud use oxalic acid, iron recovery with the help of UV radiation. 0.7 % iron content which is reduced from reed mud. It's a solubilize in the solution and form ferrous oxalate. With the help of irradiated UV light radiation, the solution obtained with less than 90 percent solution transformation. During the operation remain the residue which helps to formation building material.

But need to study and research the amount of any other material Al, Fe, Ti, Na. In that process usually before the recovery of metal red mud by the help polysulphonated ion exchange membrane of the solution dissolved in HCL solution. Approximately Fe 0.03-15.13%, Al 0.02-16.45%, Na 0.96-31.90%, Ti 0.01-14.23% achieved the metal from red mud .research has been continued on the hydrometallurgical process and try to become enhanced to recover more and more metal from red mud. 0.03% to 97% of iron and valuable metal will get from the hydrometallurgical process. However, they have a low reaction rate and introduction secondary waste this is some drawback which is indicated here.

## RECOVERY OF OTHER METAL

### ALUMINUM

After the iron aluminum percentage in red mud is varies in the range of 4% to 16 %. The main source of alumina is bauxite from Bayer's process. But the additional source of alumina is still investigated from red mud. The portion contained alumina in red mud .the various methods have been applicable to extract alumina from red mud and it's based on either organic or inorganic as well as using bacteria. The hydrothermal process was employed to recover the alumina from red mud and find the result of leached residue containing 0.3 wt. % of alumina could be achieved for the optimal condition for iron red mud. Sulphuric acid, oxalic acid, and citric acid are used for the alumina from red mud, and it's mixed in some proportion either individually or as a mixture. Bacteria and fungi are the responsible acids –producing which are mainly, aspergillum Niger, Penicillium notate,p simplicissium, Trichoderma viride. The recovery of alumina from red 75% by mainly p simplicissium. With the help of fluxing, smelting,

and leaching practice we can recover the alumina from red mud. The researchers have been found that the addition of calcium carbonate and red mud CaO: SiO<sub>2</sub> ratio increased the rate of dissolution of alumina and silicon.

## RARE EARTH METAL

Increased the rate of rare earth metal, investigator try to find more metal from red mud due to its very valuable. The red mud major proportion of contain valuable rare earth metal which is mainly, scandium, gallium, yttrium, uranium and thorium. The price of rare earth oxide in period of in 2010 was \$300/kg and then increased to \$3600 /kg 2011 .Its primary goal to recover rare earth metal from red mud and also use red mud to varies application. It will beneficial for environmental and ecological.

Among the all rare earth metal zirconium, vanadium, gallium are very valuable as well as economy point of is very important. Extraction of pure vanadium from red mud, by the help of the process adsorption from pure solution on activated charcoal approximately 99.9% high recovery from vanadium pentoxide by this process. The process involve mainly precipitation, charcoal, desorption, and calcination to obtain high yield off pure vanadium oxide. Recover of gallium from red mud has been investigated four methods, fractional precipitation, electrochemical deposition, solvent extraction, ion exchange. In this method mainly removing of soladite from red mud using a sulphuric acid at temperature 120<sup>0</sup>C and dissolved hematite, zircon and quartz, and other insoluble material which I present in the red mud solution.

## TITANIUM

In our daily life titanium is a very important rare metal which can be mainly applied such as pigments, paints, sunscreen catalyst. In the form of anatase present in red mud which is the general form of titanium. There are two forms of Ti recovered from the mud, hydrometallurgical and pyro metallurgical. Pig iron is especially involved in pyro-metallurgical methods. Red mud is calcined in between 800<sup>0</sup>C to 1350<sup>0</sup>C temperature as well as smelted out reducing agent by the help of electric furnace and obtained molting iron and slag that mostly proportion contain titanium oxide alumina, silica. After roasting titanium oxide at 1423K for 114 min. Then leaching 363k. due to some drawback in pyro metallurgical methods, having much consumption of energy. So, hydrometallurgical methods have been much investigated.

Some acid is useful to extract titanium like sulphuric acid, hydrochloric acid .3% of H<sub>2</sub>O<sub>2</sub> in 0.5 M H<sub>2</sub>SO<sub>4</sub> and 4M HCL TiO<sub>2</sub> for stripping purpose.60 to 70% titanium was achieved .temperature, acid, concentration this parameter influencing the stripping.

## THE PROCESS WHICH IS COMPLETE UTILIZATION OF RED MUD

In the last few years research has been investigated the process to perfectly utilize red mud and extract valuable rare earth metal within it but having some limitations try to continuously overcome it before it implemented. Extraction from the red mud mainly required transportation for red mud in the plant. So process become so much expensive, therefore utilization methods that can be needed nearby bauxite processing plant. High energy is required when metal is recovered from red mud with the help of pyro metallurgical methods. The composition of pig iron and the quality of slag become very critical at optimum temperature in pyro metallurgy methods. Due to raising the issue of disposal and pollutant hydrometallurgy is become a secondary option. In recent time, some environmentally friendly and green methods are important to processing the red mud. We can make strategically utilization process where the waste of red mud became very less. Selection of utilization process which is based on the complete utilization energy is developed and become valuable.

### RECOVERY OF METAL FOR DIFFERENT PROCESS.

Metal	Methods	Advantage	Disadvantage
Fe	Magnetic separation	Low energy input	Low energy input due fine particle
	hydrometallurgy	Improved efficiency	High energy inputs
	pyromatullugy	Improved efficiency	Usage of organic acid involve the high cost.
Al	Hydrometallurgy	High efficiency	Usage of organic acid
		Green process	Bioleaching process
Ti	Incorporated with iron	Can added be additional value of iron recovery	Higher energy inputs.
REE	Various technique	High efficiency	Introduced high solvent and acid waste.

## CONCLUSION

This review paper mainly represents and investigated that methods which are recovered Al, Si, Ti, rare earth metal from red mud. Two important methods, pyro metallurgy, and hydrometallurgy. It includes red mud in the furnace and feeding red mud back into the alumina refining process but the made result low-efficiency recovery. The rare earth metal, Al, Si, Ti recover from mud helps to reduce the operational cost. Clearly mentioned some point which is needed to further investigation in future, it's very essential to require zero waste and utilization of red mud which are based on very safer and clean and efficient. After recovery of metal waste from red mud should be less and utilization must high. Some techniques must develop that multiple recoveries of metal rather than single recovery methods. The deficiency of demand iron facing globally also concern disposal of red mud it is important to source addition iron in red mud which is become the process environmentally and globally accept.

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