Environmental and Waste Management (ISSN : 0971-9407)
Eds. - A. Bandopadhyay, N.G. Goswami and P.R. Rao

Red mud pollution problems : Some observations

S.N. DAS, R.S. THAKUR and H.S. RAY
Regional Research Laboratory (CSIR), Bhubaneswar - 751 013

ABSTRACT

The problem of pollution caused by red mud disposal and alternatively its utilisation has remained unsolved eversince industrial production of alumina from bauxite started as a commercial venture in 1860. Indigenous efforts to utilise this collosal waste have been limited since R&D efforts in this direction lacked coordination and adequate funding. In this paper the scientific and technological approaches to tackle this problem have been discussed and few conventional as well as novel approaches are presented. While looking for economics of alumina production, ecology has totally been ignored and time has come to realign our thinking and planning process to find a tangible solution.

Keywords : Red mud disposal, Red mud utilisation, Bauxite alumina.

INTRODUCTION

Red mud is an undesirable aspect in the production of an important and lucrative metal. Worldwide aluminium metal and its alloys are finding increasing applications in replacing iron, wood and plastics which are used in consumer goods. There are nearly 3,000 applications of aluminium in the international market. However, in India this versatile metal is being used for only about 200 items. Per capita consumption of the metal in India is about 0.5 kg which is quite low compared to USA (27.5 kg) and Japan (29.4 kg). With development the market for aluminium is bound to grow. The light weight and recyclability makes aluminium a particularly attractive material. However, aluminium production is tinted with red mud generation which poses a complex technological challenge.

Bauxite was first discovered in France near the village called Les Baux de Province in 1822 by a chemist named Berthier. A few miles away from this

place on August 03, 1888 a German patent No. 43977 was issued for 'A process for the production of aluminium hydroxide'. The process was developed by Austrian chemist Karl Joseph Bayer. From that day we are accumulating red mud on this planet at an ever increasing rate. Even after more than 100 years, the industry has not come up with any viable alternate method of producing aluminium from bauxite which does not generate this waste product, red mud. This is because none of the alternate processes can produce alumina at a cheaper rate than the Bayer's process.

Environmentally sound and sustainable development is the demand of the day. In this perspective the concept of cleaner technology is gaining ground. Recognising its importance, the concept of cleaner technology is advocated through various approaches, i.e., low and no waste technology, environmentally sound technology, waste recycling, residue utilisation and residue recovery technology. As mentioned above, in this case no change for greener technology is possible unless this solid waste and pollutant is utilised.

GRAVITY OF THE PROBLEM

Red mud, a waste and pollutant is produced at a rate of twice the amount of the desired end product, i.e., aluminium. Currently the world and Indian figures for generation of red mud are around 66 million and 2 million tons per year respectively. One of the estimates made in 1988 stated that there is enough bauxite in the world for the industry to continue for 500 years at the current rate of increasing consumption of 7% per annum. This prediction may increase to 1,000 years or so with newly found bauxite reserves. For the last 100 years we have been accumulating red mud at an ever increasing rate and if we continue doing this for a minimum of 1,000 years then there will be a crisis. Nearly 90% of the mined bauxite is treated through Bayer's process generating red mud. The red mud is disposed of mainly by dumping on land in man made dams and dykes or in a few cases, natural valleys. A small percentage (nearly 10%) is disposed of in the sea after taking utmost care of the ecosystem. Of late, dry stacking system is being preferred over the earlier one of pond disposal. However, what ever may be the mode of disposal, it creates following environmental problems:

1. Because of seepage of alkaline liquor into the ground, there may be possible contamination of the ground water. It is well known that ground water problems are often slow to develop and remedial measures are even slower in producing effects.
2. Spills due to cracked pipe lines or containment dam failure.
3. Red mud can cause dust pollution in arid regions. Because it is mostly a

fine dust containing particles of the order of 300 mesh, thus there can be unhealthy conditions around the storage tanks in windy and summer seasons. It is more so with dry stacking.

4. Red mud storage leads to reduction in availability of usable land or sequestering arable land. Some Jamaican studies reveal that each year bauxite processing in Jamaica generates enough red mud to burry 700 football ground and their goal posts. The waste which is dangerous to people, plants and animals is enough to burry 3 sq. kms of farm land a year to a depth of 4 meters. Moreover, caustic soda seeping from two of the biggest ponds contaminated some shallow wells and ground water.
5. Progressive accumulation at a point has an asthetic impact. For one million tons of alumina plant which is a typical capacity of a modern economically profitable plant, nearly 4-5 times of red mud slurry will be discharged. However, many plants in the world are of capacity from 0.1-2 million tons. As a thumb rule under similar circumstances, the increase of production by 50% brings down the capital investment by 15-20% which further encourages production at a point leading to further accumulation of red mud. The devastation of land thus becomes location specific, often going beyond demption.

If red mud is disposed in the sea, then it creates problem to marine flora and fauna and also changes the physico-chemical conditions of the area by reacting with magnesium of the sea water and creating additional finely divided solids.

RED MUD : POTENTIAL RAW MATERIAL OF FURTHER PROCESSING

The total amount of red mud available at present in the world at known sites is 1 billion tons. So the supply of red mud as a raw material for recovery of metal values or recycling will never be a problem for centuries to come. Pollution caused and the ecological ill balance will be pressing to find a way out (i) by revegetating the abandoned ponds and (ii) utilising this waste red mud.

Vegetating the abandoned ponds is not an attractive proposition because a pollutant covered or stored is not the solution but temporarily pushing the problem out sight. A lot of work has been done in this regard with variable claims. However, it is certain that red mud as such does not contain any food or nutrient for plants. Some of the standard nutrients like NPK and humus or organic matters have to be supplied from external sources to sustain plants on red mud. It has only water retention and water channeling properties which can be made use of. With a considerably high cost we can cover and retain this pollutant. If we do

not get rid of red mud then there can be no worthwhile R&D to improve the level except to leave for the nature to develop a top soil on it which takes between 200-600 years.

Red Mud Utilisation

Red mud utilisation is challenging proposition for the following reasons:

1. It contains substantial amount of metal values. Average analysis of red mud is: Fe_2O_3 24-55, Al_2O_3 14-24, TiO_2 4-18, SiO_2 6-7 and Na_2O 4-5%. Complete and complex processing of red mud may give iron 8 million tons, aluminium 3 million tons and titanium 1.9 million tons. Dumping this much metal values along with pollutant alkali is not a far sighted vision.
2. One factor with regard to alkali content in red mud which is not usually mentioned is that red mud can not be washed off of alkali in one or two seasons. It keeps on hydrolysing as many times as it is washed. Thus natural washing off of alkali is not possible over a long period of time.
3. If one comes out with a process now, one has ready stock of red mud of 1 billion tons in the world and 30 million tons in India.

Status

With all said and done, there are very few R&D groups working in this area. What so ever importance have been given, it was for construction materials, bricks, aggregates, door panels etc. All these have practical difficulties in application.

Bricks

In India there are only five or six sites of red mud generation. They can not be the source of millions of bricks required all over the country since bricks carried beyond 20 km becomes uneconomical as of today. However, these bricks can be used locally to start with. Increasing the cost of conventional bricks and awareness of environmental crisis may change the scenario. Making of conventional bricks spoils thousands of acres of fertile land and top soil. One has to strike a balance or choose between economy and ecology.

THE SOLUTIONS

Individual approach for iron, alumina, titania or cement production out of the red mud are well established. Global technologies are also available for complex

processing of red mud and zero waste processes. Yet following things should be done meticulously:

1. All Indian red mud should be characterised for specific utilisation. For example, Malco red mud is ideal for extraction of iron; Hindalco red mud is rich in boehmite alumina etc. These should be explored for specific uses and feasibility report for technical as well as commercial exploitation should be worked out.
2. Zero waste technology suitable for Indian red muds should be sorted out and techno-economic fusibility reports should be prepared.

NEEDS AND SUPPORTS

a) The pool of aluminium industries.

b) Ministry of Environment and Forests/State or Federal Governments.

c) Environmentalists/Scientists.

One should join hands and make a point convincingly at appropriate platforms so that adequate funds should be diverted for the earnest R&D efforts to find a solution to this nagging problem.

DETRIMENTAL FACTORS IN R&D

Social Factors

(i) Pollution is a slow process and is not marked till it manifests into a disaster.

(ii) The dumping sites are away from habitation and the temporary habitation developed in and around the sites are those of the polluting industry itself.

(iii) The society prefers conventional products like bricks which have proven track records. The effect of ageing on the red mud bricks have not been properly investigated so far.

Technical Factors

R&D in this field do not give encouraging results since these wastes have been produced by using the best available technology and in order to use the waste, a better technology has to be evolved which is a Herculean task.

Physico-chemical characteristics of red muds vary depending on the source of bauxite, processing and disposal parameters etc. Therefore, the characteristics of red mud are industry specific varying, of course, within a range while the fluctuations are considerable. Any change in the process conditions for improv-

ing purity, crystal structure or precipitation conditions of alumina invariably changes the physico-chemical character of the red mud generated. Not only different industries have different kinds of red mud, same industry may generate red mud of varying composition during a course of time. This factor may not be very much detrimental while going for bricks or construction materials. But it poses a challenging problem when we are working for the recovery of metal values or any other use where physico-chemical characteristics are more important.

The misnomer about R&D funding is also prevailing very much. As such we spend very megre amount on R&D and the funding agency expects very high returns on very low investments which is against the standard economic norms. By spending Rs.10 lakhs one can not get a process which will give him Rs.100 crores or so. A realistic example is of the pilot plant scale venture in nickel metallurgy where many technical details were already known. Approximately Rs.3 crores are spent for coming up to pilot plant level and for commercial venture it needs much more time and money. Another point is of threshold expenditure. Spending Rs.10,000 each on 100 R&D groups will not fetch any result whereas spending the whole amount for 2-3 specifically devoted groups may give tangible results.

CONCLUSION

1. The industries and the Government have to come closer to find a solution to the problem by taking care of required finances.

2. Between ecology and economy, one should prefer ecology for the sake of coming generations and should not create more wastes at a point. On the contrary, there should be more number of plants at different places. This will generate an infrastructure which can be used otherwise for the development of the area.

3. The problem should have a solution which is specific to a country since the technology developed elsewhere can not be applied in this place. The problem is entirely site specific and needs local R&D efforts.

4. The problem should be attended to urgently within a given time frame in order to nip it at the budding stage rather than allow it to grow beyond manageable proportions.