Mine Waste as Resource: Indian Mining Scenario of Coal and Non Coal Mining Sector

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Abstract: ***Mother Nature has bestowed India with huge resources of coal, iron ore, bauxite, manganese and limestone. India has one of the lowest per capita availability of land due to population of more than 1.3 billion. The transformation from under developed to developed economy warrants enormous increase in mineral production. This will generate additional huge quantities of waste. The industry is already facing problems related to land acquisition and environmental clearances. Sustainable development of Indian mineral industry requires reprocessing, reuse and recycling of mine waste. To achieve this, economic and innovative mineral processing methods are required which will result in least damage to ecology and environment.***

Keywords: Sustainable Development, Reprocessing, Reuse, Recycling

I. INTRODUCTION

India produces 95 minerals, 4 fuel-related minerals, 10 metallic minerals, 23 non-metallic minerals, 3 atomic minerals and 55 minor minerals (including building and other minerals). It produced 729 million tons of coal, 206 million tons of iron ore, 111 million tons of steel and 3.65 million tones of alumina in 2020.(1) For high value minerals, the quantity of waste produced is many times that of the final product. e.g., each ounce of gold is the result of mining and processing about 12 tons of ore; similarly each tone of copper comes from about 30 tons of ore. (2). According to Mining, Minerals and Sustainable Development Project (MMSD), there are approximately 3500 active mining waste facilities worldwide, consisting of waste rock dumps and tailing dams. The estimated worldwide generation of solid wastes from the primary production of mineral and metal commodities is over 100 billion tons per year and can range from several times the mass of the valuable element, such as iron and aluminium ores, up to millions of times for some scarce elements such as gold ore (3). Apart from causing environmental damage mining waste covers up vast amount of land which is a scares commodity in India. All the nations confirmed their commitment to give priority attention for prevention, minimization, reuse and recycling of waste at the world summit on sustainable development in 2002.

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Management of mining waste is a critical problem and mine operators have to think in order of waste prevention, reuse, recycle, energy recovery and disposal & treatment. Reuse, recycling and rehabilitation of mine waste will not only create financial assets but also decrease the exposure of humans and ecological receptors to contaminated materials (4). In this paper a review of different methods developed and practiced in the area of reuse and recycling of mine waste are discussed with special reference to Indian mining scenario.

II. REUSE AND RECYCLING OF MINING WASTE:

Reuse of mine wastes can be termed as a process that involves the new use or application of the total mine waste or its part without any reprocessing. Whereas, recycling of mine wastes is the practice that extracts new valuable resource ingredients, or uses the waste as feedstock and converts the entire mine waste or its part into a new valuable product or application with some reprocessing. Mine waste includes waste rock, mine water and drainage sludge. Reuse and recycling options of waste rock includes resource of minerals and metals, backfilling material, landscaping material, aggregate in embankment, road, pavement, foundation and building construction, asphalt component, feedstock for cement & concrete and as soil additive. Waste water from mine find use mainly in dust suppression, mineral processing applications, recovery of metals from AMD waters, drinking water, industrial and agricultural use. Processing waste mainly includes mill tailings. Various research in use of mill tailings has confirmed their use as backfill material in underground mines, clay-rich tailings for the manufacturing of bricks, cement, floor tiles, sanitary ware and porcelains, Mn-rich tailings in agro-forestry and as coatings, bauxite tailings as sources of alum, Cu-rich tailings as extenders for paints, Fe-rich tailings mixed with fly ash and sewage sludge as lightweight ceramics and Phosphate-rich tailings for the extraction of phosphoric acid. Bauxite red mud has a very high alkalinity. It can be used in glass and ceramic industry. It can also be used to treat AMD and dairy waste water.(5)
Yesterday's waste can be today's resource. The rejects or leaner grade ores which could not be economically used in the past and were dumped are being mined today because of vastly improved mineral processing technologies. The easiest-to-mine ores have been already exploited, leaving the more complex and less accessible ones. Reprocessing of such ores is gaining popularity as the ore grades and quality have decreased over the decades(7).

The comprehensive utilization of iron ore tailings (IOT) has received increasing attention all over the world. The major utilization of IOTs includes land reclamation , re-extraction of iron or other metals using advanced technology and as raw ingredients in producing infrastructure materials, backfilling materials and fertilizers (8).

III. CASE STUDIES OF REPROCESSING, REUSE AND RECYCLING OF MINING WASTE

3.1 Processed sand

The waste material from coal mining in India comprises mainly of sandstone, bands of clay and other metamorphic rocks. The sandstone ranges from coarse grain to fine grain. The waste rock generated to expose coal is normally backfilled, still a major volume is stacked over non coal area. As the environmental laws for extracting sand from river bed have become stringent, sand is in short supply. Western Coalfields Limited (WCL) which is a subsidiary company of Coal India Limited(CIL), world's largest coal producing company, has started crushing and washing of sandstone from its waste dumps and is now major supplier of sand. This sand is being used for construction of roads and structures. The sand also find use as filling materials in underground mines of nearby region (6). Other subsidiaries of CIL are also launching now sandstone processing for supply of sand from waste dumps. A large portion of land which is presently being occupied by sandstone dumps will be released for better economic use.

3.2 Clay Band Use :

In surface mining method it is possible to mine bands like clay separately and then use them for making bricks, stemming material and potteries. Clay band at Kampti opencast mine in WCL is being used for such purposes.

3.3 Mine Water

The water from underground mines which was initially discharged into local water bodies is now treated and used for drinking and industrial purpose. WCL has established a RO plant of capacity 10,000 liters per hour in Patansaongi village catering to drinking water needs of around 1,00,000 local populace. Additionally, the plant has a bottling facility through which "COAL NEER" brand of packaged drinking water is also being launched. Many subsidiaries of CIL are treating water and are supplying it to local townships and industrial units. Other subsidiaries of CIL have also started treating underground mine water and are supplying it to local townships and industries.

3.4 Eco Park

There are many case studies in the mines of CIL wherein water bodies created from mining are converted to picnic spots. One such case study which has attracted attention of all is Eco park at Saoner underground mines lease hold area of WCL. The park utilizes mine water for gardening, water conservation, boating and amusement purposes. The park showcases several demonstrable technologies such as Solar electrification of water pump, Rain water harvesting, micro irrigation, etc. along with a science park and several adventure rides. The park also has an artificial mine tunnel showcasing different mining job profiles, machinery and methods used in the coal mines. The annual tourist footfall is more than 50,000 (10).

Coal mine waste

Yash Pande and others have carried out study for replacing natural aggregates by thermal power station coal rejects in granular sub-base and bituminous layers in road construction. The study has confirmed coal rejects as an alternative to natural aggregate in road construction works (11).

3.5 Iron Ore Tailings(IOT)

Yelli shetty used iron ore waste from Goa and conducted an experimental study. In the concrete mix, 40% of coarse aggregates were replaced with iron ore tailings and concrete blocks were made for 28 days curing. It resulted in the compressive strength of 21.93MPa to that of granite aggregate of 19.91 MPa. Hence, the increase in the compressive strength was noticed with iron ore tailings with respect to the conventional coarse aggregate (8).

3.6 Iron Ore Waste Rock

Gayana B C reported that the workability of all the concrete mixes increased upto 40%, where natural aggregate in concrete was replacement with iron ore overburden / waste rock along with upward trend in compressive strength (9).

3.7 Fly Ash

Fly ash is produced by coal-fired electric and steam generating plants. It is commonly used in Portland cement concrete for applications in highway construction, in soil improvement, as mineral filler in hot mixed asphalt and in grouts for pavement sub sealing. It is also used in making ash bricks and clinkers for stowing in underground mines (12).

3.8 Blast Furnace slag

Blast furnace slag is generated during the melting process in steel making operations. It is very as a cementitious binder in road construction. It is very commonly used road base material in France. In areas near to steel plants it is also used as aggregate in road construction. (12).

3.9 Waste Dump Mining

The low grade rejects of past which were dumped are now being mined for metal extraction. Common example is of manganese ore. The dumps created near Ramtek in Nagpur district are presently being mined. The grade of the ore is more than 20%.

3.10 Mine waste for production of different types of bricks

It is found from the detailed literature review that there is a lot of scope for utilization of mine waste/industrial waste in the construction industry in the form of manufacturing of bricks, paving blocks, tiles etc. Manufacturing of building bricks without burning of solid fuel is one of the options for reducing the emission of CO2 gas. Srikant etc has given a detailed use of different type of mine waste for producing different types of bricks (13).

IV. CONCLUSION

The ore grades and quality have decreased over the decades. Due to the decreasing grades, more inputs in the form of energy, water, capital and labour are required for the same output and at the same time larger volumes of waste are generated.

Total resource utilization, where all of the material mined is put to good use, is a challenging concept for researchers and miners. To achieve near zero waste production circular economy business model has to be employed for sustainable development of mineral resources. Developed nations should make available innovative technologies to under developed nations so that total resource utilization is possible. After all no nation is self sufficient in there mineral needs.

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