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Case Report

Generation of Wealth from Waste, Case Study of Reuse of Mine Water and Processed Sand

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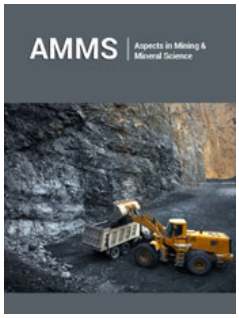

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Abstract

As the development of the mining industries often regulates the resource acquisition potential and economic growth of the countries, it is one of the most prominent earning sources. Based on the different characteristics of the mining industries, this industry might be categorized under geophysical industries or chemical industries. Every process of production of resources generates by-products like wastewater and fine aggregates (sand). The present paper discusses a case of the waste management initiatives taken for a specific plant indicating waste to wealth creation in terms of alternate resource quantification and providing social sustainability.

Keywords: Economic power; Water stressed; Over exploited; Sand scarcity

Introduction

The Indian construction industry is the engine of the Indian economy. The Indian construction sector is responsible for propelling the country's overall development as good infrastructure is the basis for all other projects, and it enjoys prime attention from the government. It is the second largest employment provider sector after agriculture in India. By 2022, India is expected to become the world's 3rd largest construction market. To this end, the government of India has been developing and implementing policies that ensure the time-bound creation of world-class infrastructure within the nation - from power plants to bridges to dams, roads, and other urban development projects. The Indian government plans to spend about $1.4 trillion worth of investment on the country's infrastructure. Initiatives like "Housing for All" and the "Smart City Mission" are also major efforts by the government of India to reduce bottlenecks in the infrastructure sector. To make India a 5 trillion economy by 2025, construction industry contribution will be enormous [1]. India has only four percent of the world's freshwater resources. More than 60% of India's water needs are met by groundwater. We are rapidly losing groundwater and we'll be in trouble if it continues at this pace. Due to over exploitation, ground water tables are going down drastically in most areas [2]. A rural woman in Rajasthan walks over 2.5 kilometres to reach a water source, according to a report by the National Commission for Women [3]. This is probably an underestimation, but the bottom line is that we are facing water scarcity. The government has laid out an ambitious plan to provide piped water connection to every rural household by 2024. Improving water catchment and harvesting, recycling, improving irrigation and agricultural practices, improving distribution infrastructures are some of the solutions [4].

Sand refers to loosen granular materials that are produced as a result of the disintegration of rocks. Sand is considered one of the most consumed natural resources, being essential to many industries, including building construction, glass, electronics, plastics and water filtration [5]. Sand is an increasingly valuable commodity and is essential to the economies of countries around the world. The analysis indicates that extracting sand at a greater rate than that at which it is naturally replenished has adverse consequences for fauna and flora. Further, illicit mining

activities compound environmental damages and result in conflict, the loss of taxes/royalties. Sand and gravel production is dominated by the United States, Netherlands, Spain, Turkey, and India (Table 1). Among the countries that import the greatest amounts mention can be made of Canada, China, Belgium, Luxembourg, Singapore, and Germany [6]. The Ministry of Environment, Forest & Climate Change formulated the Sustainable Sand Management Guidelines 2016 which focuses on the Management of Sand Mining in the Country. Now environment clearance is mandatory for mining of minor minerals irrespective of the area of mining lease. Sand is classified as a "minor mineral". Under the MMDR Act, the legal and administrative control over minor minerals vests with the State Governments, who have the powers to make rules to govern minor minerals. As per a rough estimate, the demand of sand in the country by 2021 will be 1.4 billion tons and it is increasing at the rate of 6-7% annually. Issues of illegal mining, environmental damage, high sand prices and quality of sand that are interlinked with each other are prevalent across many States [7]. The following three alternatives are proposed.

Table 1: Major producers of sand (As per reference [4]).

Country	Production in 2019
(in 1000 Metric Ton)	
China	190.000
United States	110.000
Netherlands	54.000
Spain	36.000
Turkey	14.000
India	12.000
Malaysia	10.000
Germany	7.500

Manufactured Sand (M-sand)

It is the most common alternative to river sand, which has already gained prominence in some of the southern States. It is produced by crushing rocks and quarry stones to a stipulate size of 150 microns. To arrive at the required grain size, existing coarser hard rock deposits are crushed in a series of crushers and the crushed material is segregated in different fractions as suited to various construction activities. The sand obtained through this process is further refined by removing fine particles and impurities through sieving and washing. As per IS-383, the chemical characteristics and strength are similar to the river sand and the same type of applications can be served using M-sand. The total M-sand production in the country is estimated at 32 million cubic meters [7].

Sand from Overburden of Coal Mines

The overburden spread over in situ coal seam needs to be removed for extraction of coal to an external dump till sufficient space is created for internal back filling by acquisition of land nearby coal bearing area. Further, this overburden dump needs to be re-handled at the time of closure of mine for land reclamation. As per the mine closure plan, 80% of the extracted overburden is used for backfilling the excavated area and the remaining 20% overburden can be used for producing sand. Feasibility Studies conducted by the Central Institute of Mine and Fuel Research show that processing of overburden yields 60 to 65% sand, 30 to 35% clay and 5% pebbles [7].

Import of Sand for Coastal Cities

Another way to meet the demand could be to import sand. Some of the south-east Asian countries e.g., Malaysia/ Indonesia has ample sand available in their country, which if not removed could lead to floods. The sand could be sourced from these countries and imported to Indian ports to meet the deficit. However, it needs to be considered that while importing sand from other countries, sand should qualify for IS 383 quality standards as well as be free from any phytosanitary issues. Southern Indian States have already started importing sand and are framing rules for sale of imported sand. Imported sand, however, tends to be costly and is therefore suitable only for high deficit areas [7].

Case Study of Western Coalfields Limited

Western Coalfields Limited (WCL) is one of the eight subsidiary companies of Coal India Limited (CIL) which is the largest coal production company of the world. WCL has 82 operating mines clubbed under ten areas and is designed to achieve 61 million tons coal target in 2021. Electricity Boards are major consumers of its coal along with cement, steel, chemical, fertilizer, paper and brick Industries. As a responsible corporate citizen WCL has taken many steps including supply of treated mine water and production of sand from overburden of coal mines to nearby industries and villages.

Sand Processing

Coal seams occur below the surface. To extract coal, the overlying rock is required to be removed and stacked outside the coal bearing zone till sufficient space is created for internal back filling. As per mine closure laws the all the cavities created due to extraction of the mineral are to be back filled. Due to swell factor inspite of back filling at least 20% rock remains in the form of dumps. Sandstone is the key overlying rock in Indian coal deposits. Sandstone contained in these Overburdens (OB) dumps is being used by WCL to produce processed sand. Overburden dumps pollute the nearby water regime, silting the base of natural water channels and polluting flora and fauna. Thus, processed sand manufacturing is not only eco-friendly but also helps to release land locked under dumps (Figure 1). The OB is loaded by excavator, from a designated OB dump in the tipper, which carries it to the grizzly of the plant located @0.9Km away. The OB below -600mm size passes through the hopper below the grizzly to belt conveyor through a vibrating feeder. The belt conveyor discharges the OB to Jaw crusher wherein the material is further crushed to the size -150mm. The output has to pass through a dual screening arrangement of aperture (-150mm) and (-5mm), the oversized material over the screen is again subjected to secondary crushing and below 5mm is sent directly to surge bunker for washing. The material (-150mm) size is then fed to secondary crusher (Cone crusher) which produces material of (-20mm). This output is made to pass VSI crusher, thus

crushing the material to below 10mm size. The oversized output is again subjected to pass through secondary crusher and VSI crusher till the desired output of below 5mm is achieved. The output from the surge bunker (-5mm) is sent to a sand washer plant where through double stage hydro cyclone washes sand below 5mm size. Sand being heavy settles down and the clay with water is pumped to a pond at a distance of 2km, where flocculent is added so that the clay settles down and the clear water is available for reuse in the system. The washed sand is stacked in a sand stack yard @ 0.215km away. Sand to the customers is given from this yard.

Figure 1: Sand processing plant on site.

The plant is being worked by a private operator to produce 2000M^3/day of sand and WCL is providing water @ of 1 kilo liter per cubic meter of sand output. WCL has provided electric power at 3.3KV/550V/440V at the plant site and the operator is provided electricity free of cost @ Rs 2.5 units per cubic meter of sand output. Processing charges/ Cu. M provided by WCL to plant operator are Rs 163.73. After adding the manpower cost of supervision and electricity, expected cost will be Rs 200/M^3 ($2.66/$M^3$). WCL has been permitted by the State Government to sell sand to government organizations organization @ Rs 797/M^3 and to private customer through E auctioning [8]. If all the seven subsidiaries of Coal India Limited are instructed by the Government to process and segregate sand from the overburden, around 150 million cubic meters (283 million tons) of sand can be processed, which is around 35% of the total sand consumed in the country at present.

Mine Water Utilization a Successful Way to Reduce the Water Footprint of Mining

India is also facing acute water stress. Per capita availability of water has been falling continuously at an alarming rate. It has fallen down from ~5000 cum in 1950 to around 1500 cum in 2020. If it declines further to around 1,000-1,100 cum, then India could be declared as water-stressed country. In the process of coal mining, a huge volume of mine water gets collected in mine sumps and subsequently pumped out to surface. Previously mine water was used for industrial purposes and domestic use in mine colonies. Excess water was pumped into the local water regimes. Later on, by application of appropriate treatment methods, the available mine water is now being used for drinking/irrigation purposes. In total 738 villages spread in 9 States are getting benefitted by the aforesaid community water supply by coal companies [9].

Mine Water Utilization Status of Coal Mining Companies in India as on 31.3.2020 [8]

a. Total Mine water pumped out – 8538L cum

b. Own use by Coal companies – 3668L cum (43%)

c. Community Use (Domestic) – 735L cum – with 12.16 lakh beneficiaries

d. Community Use (Irrigation) – 1858L cum – Irrigation potential creation – 1.92L Acres

e. Ground water recharge and other usage – 2277L cum

WCL Supplying Water to Mahagenco

WCL has entered into an MoU with MAHAGENCO for providing excess mine water of quantum 107.6 Lakh Cum/year from Bhanegaon OCM to meet the industrial water demand of Kaparkheda Thermal Power Station. Earlier, this water demand of TPS was being drawn from Pench irrigation Reservoir (Figure 2). Now, the saved water from Pench reservoir is being utilized to meet the increasing water demand in Nagpur city [10].

Bottled Water Supply by WCL – Coal Neer

RO Plant (10,000 litres/hour) has been installed at Patansaoungi UG mine. The treatment plant includes the stepwise process of sedimentation, filtration through slow sand filter & processing through RO plant, followed by UV treatment. In addition to it, packaged drinking water "COAL NEER" is introduced with installation of RFC Bottling Plant (capacity: 15000 Bottles per day). WCL in collaboration with local Self-Help Groups (SHGs) started distributing water to the doorsteps of villagers. The SHGs are earning revenue from the distribution of the purified water and villagers are getting access to purified potable water at their doorstep. Two more plants have been commissioned at Majari area also [11].

Figure 2: Operating RO plant at WCL.

Conclusion

Sustainable development technologies in the core areas like construction & infrastructure industries for supply of various construction materials is needed urgently in vastly populated country like India for protection of environment. The efforts taken by the government in policy framing and their implementation by government organizations are commendable [12-16]. Private sector, professionals, academicians all involved with construction industry need to focus on generating technology for utilization of waste materials. The processing of sand from dumped material and mine water utilization are real life examples of creating wealth from waste material.

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