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Adverse effects on environment by the Iron Ore Industries – some measures to reduce them

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Abstract : Important iron ore deposits occur in India in the eastern, central and southern parts in the states of Jharkhand, Orissa, Karnataka, Chhattisgarh, Goa etc. Geologically, the Eastern Indian iron ores belong to Archean Iron Ore Group (IOG). Singhbhum-Orissa iron ore belt in the eastern India has abundant reserves of iron ore in the form of horse shoe belt. The soft laminated ore, goethitic-lateritic ores, friable ore and blue dust abundantly occur in this region and are very soft and friable in nature. Large amount of fines and slimes are generated during mining, washing, crushing and screening processes of these ores. These fines and slimes are relatively lower grade and are not suitable for use in blast furnace. Hence these fines and slimes are either dumped as stocks at the mine or permanently lost due to lack of proper beneficiation facilities.

During the rainy seasons, these fines get carried by water and spread to the surrounding areas and agricultural land. Thereby it leads to deforestation and reduces the fertility of the soil. Ultimately the silt and suspended matter are transported and deposited to the nearby tanks and reserves. The dissolved constituents from mining process pollute the surface and ground water of the region by increasing the percentage of ambient/ suspended particles. These fines and slimes also affect production of lumps. Unless fines find outlet, no further mining of lump ore can take place. If the fines are not sold, the entire cost of production will be loaded on lumps which will make steel more costly and mines unviable.

There is no systematic plan in preserving and/or utilization of these fines and slimes. The utilization of fines and slimes can be done only after size enlargement (Agglomeration). However, these fines and slimes are low grade and require proper beneficiation prior to utilization. Thus, beneficiation of these low grade iron ore fines and slimes to remove the gangue minerals and enhancement of its grade is a prospective proposition today. In the present study, the utilization of iron ore fines and slimes have been dealt with. Various environmental impacts on land, air, water, ecological disturbances and impact on socio economic fabric have been discussed. In order to mitigate the environmental problem due to dumping of fines and slimes as waste, optimum utilization of these fines and slimes by beneficiation process and several environmental control measures have been suggested.

1 INTRODUCTION

Important iron ore deposits occur in India in the eastern, central and southern parts in the states of Jharkhand, Orissa, Karnataka, Chhattisgarh, and Goa. The Eastern Indian iron ores belong to Archean Iron Ore Group (IOG). The iron ores of eastern India are relatively higher in quality and quantity containing hematite magnetite and goethite. Broadly the iron ore types are hard laminated, soft laminated, flaky/friable, lateritic and blue dust

or powdery varieties. Indian iron ore is relatively rich in Fe. However, the soft laminated ore, flaky friable ore and powder ores contain higher amounts of alumina, silica and phosphorous compared to the other major deposits of the world.

Generation of fines are undesirable and unavoidable at the same time due to mechanized mining, processing and handling of bulk material (Fig 1). Iron ore is no exception especially the soft laminated and lateritic ores of India that are quite soft and friable in nature. Slime accumulation in most of the iron ore bodies are due to weathering and decomposition of ore and certain rock bodies associated with it. Apart from the primary slime formation, subsequent secondary slimes are produced during mining processing, handling and comminution of iron ore to its liberation size. Attempts are possible to minimise the formation of secondary slime formation. However, formation of secondary slime is unavoidable.

These fines in the form of slimes are relatively low grade and cannot be utilized directly in blast furnace. They are generally dumped into the tailing ponds due to lack of proper processing technology (Fig 2a). However, such dumping may cause serious environmental hazards over a prolonged period and hence there is an increasing need for mineralogical characterization for beneficiating of iron ore fines and slimes. Most of the iron ore slimes are very fine in nature (<150 m). Higher percentage of alumina is usually associated with iron ore slimes. Beneficiation and/or utilization of slimes are till not practiced on an industrial scale in India. The fines and slimes generated by the soft, laminated, friable and lateritic ores of India contain large amounts of Al and it has now been established both by laboratory and plant trials that alumina has an adverse effect on sinter and pellet properties. The reduction degradation behavior of the sinter can be improved considerably by lowering its alumina and silica contents and increasing the iron content. The reducibility index of the pellets would also increase with lowering of alumina content. Thus, beneficiating the slimes to remove the gangue minerals and enhance its grade is a prospective proposition today.

In the present study, the utilization of iron ore fines and slimes have been dealt with. Various environmental impacts on land, air, water, ecological disturbances and impact on socio economic fabric have been discussed. In order to mitigate the environmental problem due to dumping of fines and slimes as waste, optimum utilization of these fines and slimes by beneficiation process and several environmental control measures have been suggested.

2 ENVIRONMENTAL IMPACT OF FINES AND SLIMES

About 70-75% of the total production of iron ore is fines either at the time of mining or become fines during subsequent handling or conversion of lumps into calibrated lump ore (CLO). Unless fines find an outlet directly or through conversion into sinters/pellets, these will go on accumulating at mine sites. These fines will affect on mining operations because fines will occupy space, In addition, it affects agricultural fields or other areas or water bodies during rainy season when fines wash out by water and spill over all around and increase the percentage of ambient/suspended particles. It also affects production of lumps. Unless fines find outlet, no further production of lumps can take place. Most of these iron ore fines and slimes are very fine in nature containing particles below 150 microns. Treatment of such material is a difficult problem. The process of extraction of mineral resources and its use in various ways generate a wide range of environmental changes.

Though many national policies have been formulated for proper conservation and effective utilization of mineral wealth, little have been achieved to ensure rehabitation of the land effected by mining activities. Our aim should not only be to extract the economic benefits of the mining operation but also to ensure reinvestment of a part of it to extend the life of the deposit and to protect the natural environment likely to be spoiled by mining activity.

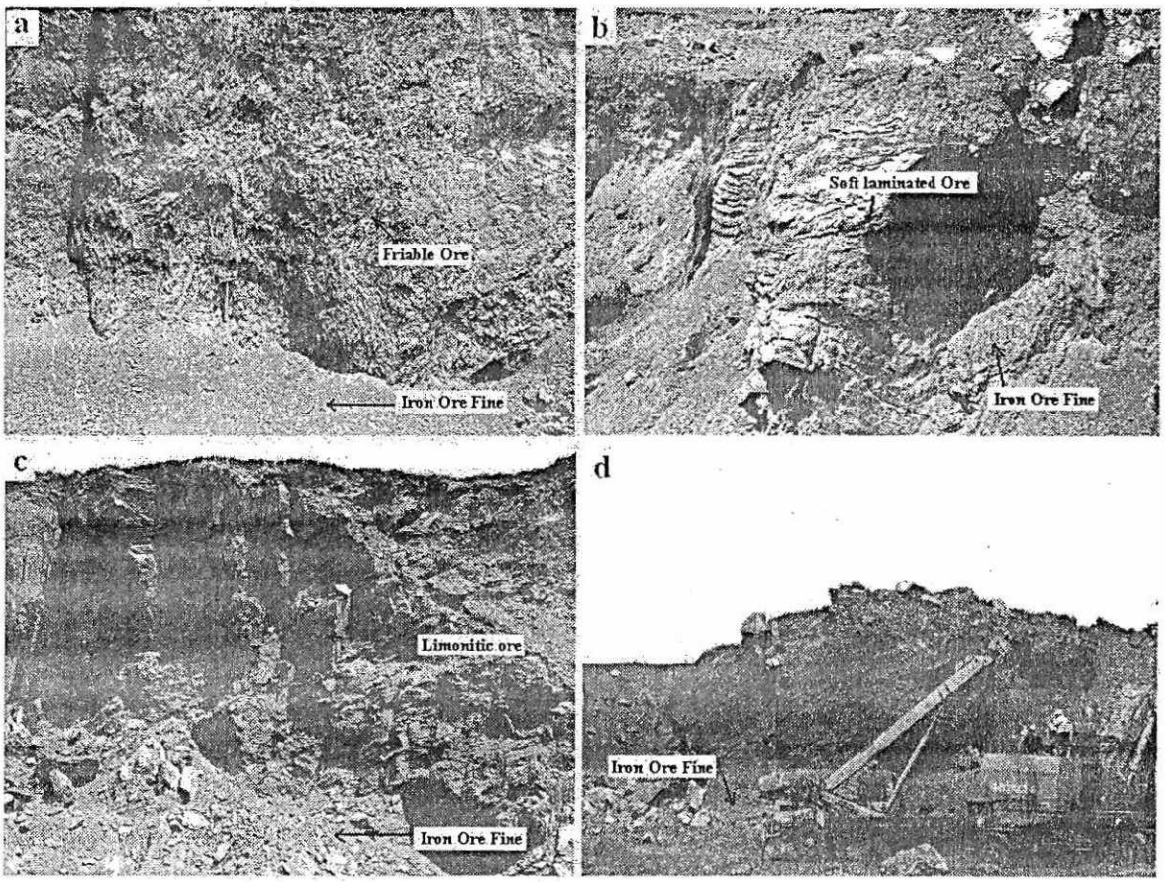

Fig 1: Fines and slimes generated during mining and processing

The fines and slime generated during mining has to be manage properly, otherwise it would damage the environment and ecology considerably. Fine particles are easily inhaled deep into the lungs where they can remain embedded for long periods of time. In people with heart disease, very short-term exposures of one hour to elevated fine particle concentrations has been linked to irregular heart beats and heart attacks. Long-term epidemiological studies have repeatedly demonstrated that people living in areas with high fine particle concentrations have an increased risk of premature death compared to those in cleaner cities. The risk of dying early from cardio-respiratory diseases and lung cancer is higher in such areas. Average life span might be shortened by one to two years.

Fine particle pollution is especially harmful to people with lung diseases such as asthma and chronic obstructive pulmonary disease (COPD), which includes chronic bronchitis and emphysema, because particles can aggravate these diseases. Exposure to air pollution due to fine particles can trigger asthma flareups and cause wheezing, coughing and respiratory irritation in individuals with sensitive airways. People with heart disease such as coronary artery disease and congestive heart failure and people with diabetes are at greater risk of serious cardiac disorders.

Infants and children may be especially susceptible to the health effects of fine particle, because their lungs are still developing. Children have greater exposure to air pollution because of their faster breathing rates and the increased amount of time spent outdoors (Fig 3). In addition to aggravated wheezing and coughing and reduction in lung function, over the long term, particle air pollution could stunt lung function growth in children.

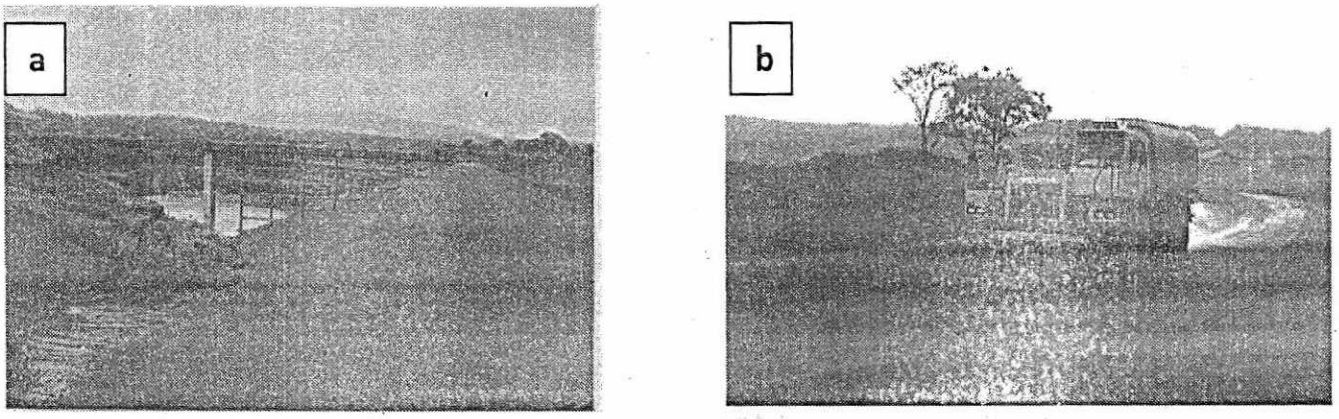

Fig 2: (a) Slime in the eastern Indian iron ore mine, (b) 28KL Water Sprinkler on Haul Road..

Some studies suggest that pregnant women may be another sensitive group. A limited number of studies report that high particle concentrations are associated with low birth weight in infants, pre-term delivery, and increased risk of infant mortality.

It is the need of the hour to plan and control the various impacts of mining on environment. In some of the mining areas it has been observed that fines have been dumped haphazardly. During the rainy seasons the dumped ore is washed down hill destroying the agricultural land. The impact of this results in progressive degradation of soil cover, disfiguring of landscape, deterioration of vegetation, check in the ground water potentialities, pollution of surface and ground water, siltation of water reservoirs and impact of socio economic fabrics etc.

Many of the mines owners of the area have selected hill portions as spots for waste disposal and dumping of fines. During the rainly season most of the fines and dumps are wasted down by rain water lead to deforestation

in large areas. The total vegetation all along the hill slopes is ruined. In some cases this had resulted in encroachment on to agricultural land also.

The mining areas in this region have no proper planning. Preparation of landscape plan before starting operation helps in minimizing this visual impact in this region. Fine ore dumps can be avoided by making stock piles in proper places. This is one of the most important controls not only from environmental aspect but also for future utilization of fines. Stock piles are advisable as land losses and contamination are very less. Green belt development has to be planned which helps in afforestation of the mined area, prevention of soil erosion, silting and pollution of stream water.

Air pollution creates lot of problems in mining areas. The source of air pollution is mainly from drilling blasting and plant operations. In addition to this blowing of dust from the working areas, dumps and stock piles and transportation also creates air pollution. Transportation of ore is also one of the main sources of dust.

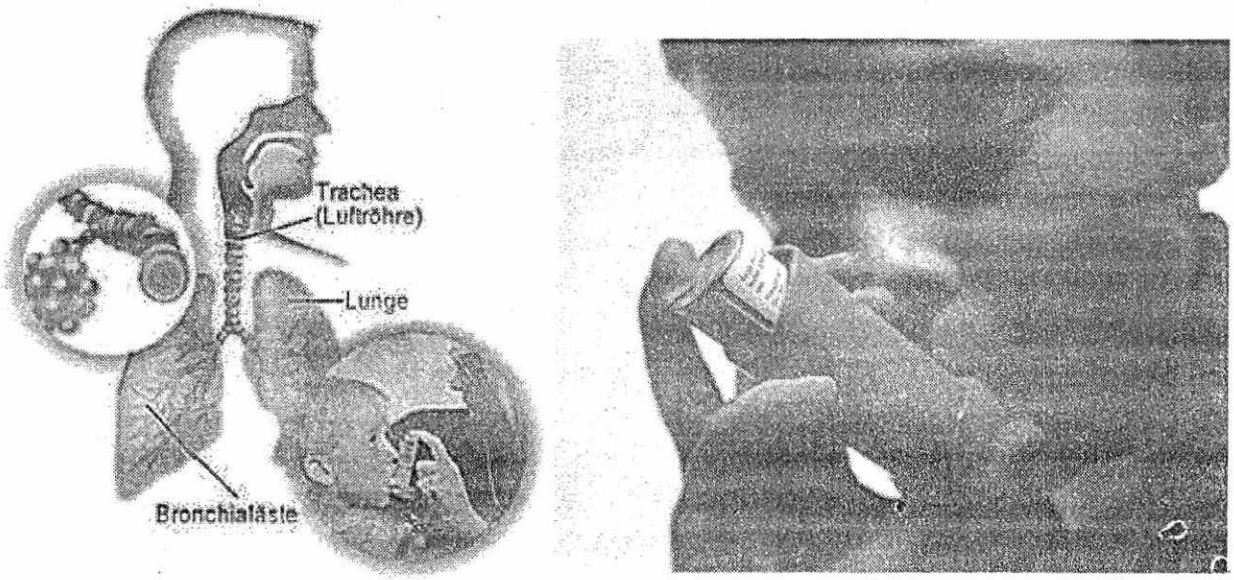

Fig 3: Pulmonary disease due to inhalation of fine iron particles.

The source of water pollution is mainly from spent water from handling plants, pumping of mine water, effluents from beneficiation plants, during dust suppressing, wash off from waste and tailing dumps. The fines dump in the hill portions during rainy seasons wash off from mining area and the run off water is loaded with silt and suspended particles transported and deposited all along the stream sources, tanks and reservoirs. The dissolved constituents in them pollute the surface and ground water of the region. Due to disposal of mine dumps the surface drainages are blocked and this results in decreasing the storage capacity of the adjoining area. Blocking of fines in the drainage areas reduce the yield from the wells and also ground water quality.

Mining in these areas results in change in life style of the people. The health condition of the people engaged in mining and inhabitants in the surrounding area are affected by health hazards. The socio economic environment is undoubtedly improved as mining provide employment and upliftment of economic profile of the region. However, the environmental issues need to address properly.

3 CONTROL MEASURES

The critical factors in good environmental performance in mining are adequate planning and effective management and implementation. Responsibilities for the implementation and monitoring of environmental measures should be specifically assigned. Before mining begins, a mining plan and a mine closure and reclamation plan must be prepared and approved. These plans should be updated regularly as mining progresses.

Mines should take possible measures to suppress the dust by spraying water (Fig 2b). Closed conveyer system or slurry system is advisable to reduced the air pollution as done in Joda and Barsua. To avoid this, trucks and dumpers should be leak proof to prevent dust blowing up to air. Planting of trees on waste dumps has to be done to control dust. Use of covers or control devices for crushing and milling to avoid the generation of dust minimization of freshwater intake; recycling of tailings decant water and wastewater from the concentration process to minimize contaminated discharges to the extent feasible. Collection of leach waters from tailings ponds and treatment before discharge, with sufficient residence time in the tailings pond to ensure thiosalt oxidation. Provision of buffer capacity for the rainy season. Use of ditches to divert surface runoff from tailing ponds. Use of dust suppression measures such as wetting work areas, roads, and storage piles; installing equipment covers; minimizing drop distances by using adjustable height conveyors; and using dust hoods and shields.

Tailings must be managed to optimize human safety and environmental protection. On-land tailings impoundment systems must be designed and constructed in accordance with internationally recognized engineering practices, local seismic conditions, and precipitation conditions. The designs should address the structural integrity of the tailings dams or deposits even post-closure. On-land disposal systems should be designed to isolate acid leachate-generating material from oxidation and percolating water.

It is advisable to take all possible steps to prevent the discharge of toxic effluent in to surface water body and ground water aquifers, and to reuse the water. Waste water treatment method like lime treatment followed by oxidation process to convert ferrous to ferric ion, neutralization with soda ash, caustic soda and anhydrous ammonia, ion exchange, desulfating should be incorporated for neutralization and removal of solids.

Technology should be developed for utilization of iron ore fines and slime to extract the valuables. Slime processing may open up a great opportunity for utilization of slimes that are primarily waste material at present.

4 BENEFICIATION OF IRON ORE FINES AND SLIMES

Indian iron ore slime is characteristically different from iron ores abroad. The volume of generated slimes is large and their grade sometimes is reasonably high hence there are opportunities for utilization of these slimes in order to safeguard the environment and for waste utilization and value addition. Moreover, sinter and pellet feed in blast furnaces around the world have increased manifold over the years. The slimes are ideal for generating the material for pelletization. They can also be used for preparation of sinter feed after microballing. Sintering can be done near steel plant site since sinters, if subjected to handling and long haulage, again degenerate into fines. Since most of the integrated steel plants have captive mines, they utilize their fines by converting them into sinters to the extent possible. In the case of few steel plants like Tatas, Jindals and SAIL, surplus fines (after meeting the requirement of sintering) are being exported. Shore-based sponge iron plants namely, Essar and Ispat are also exporting fines generated out of sizing of lumps procured from NMDC and Eastern and Bellary-Hospet sectors. Pelletisation is the process to convert fines into pellets. The economic size of a pellet plant with 3 million tonnes capacity per annum will cost about five hundred crores rupees, which is beyond the means of an average mineowner. Moreover, the scale of operation of most of the mineowners is low and individually they will not be able to feed this level of pellet plant. Further, consumption of pellets in the country is limited and its export markets highly cyclical. Slime processing therefore, may open up a great opportunity for utilization of these slimes that are primarily a waste material at present. Treatment of such material is not an easy problem. Attempts have been made and techniques to some extent have been developed for concentration of such fines and slimes by Roy et al., 2007; Roy and Das, 2008; Srivastava et. al., 2001.

8 CONCLUSION

The soft laminated ore, goethitic-lateritic ores, friable ore and blue dust abundantly occur in the eastern India and are very soft and friable in nature producing large amount of fines and slimes are generated during mining, washing, crushing and screening processes of these ores. These fines and slimes are low grade and require proper beneficiation prior to utilization During the rainy seasons, these fines get carried by water and spread to the surrounding areas and agricultural land and it leads to deforestation and reduces the fertility of the soil. The dissolved constituents from mining process pollute the surface and ground water of the region by increasing the percentage of ambient/suspended particles. However, the utilization of fines and slimes can be done using proper beneficiation techniques and size enlargement process. These slimes and fines are ideal for generating the material for pelletization. They can also be used for preparation of sinter feed after microballing. Apart from the utilization of these slimes and fines special environmental control measure should be taken to prevent from the adverse effect generated by these huge amount of fines and slimes.

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