Environmental life cycle assessment of Barytes mineral pulverising industry: Case study from YSR Kadapa district, Andhra Pradesh

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doi:10.6088/ijes.2012030131071

ABSTRACT

Mining based industries play an important role in improving country’s economic growth and in generating employment. On the other hand mining activities and its auxiliary industries have the potential to cause environmental degradation. Life cycle assessment is one of the effective practices to achieve environmentally better management in mine based industries. Baryte mineral is richly available in YSR Kadapa district and is widely used in several industries. Thus Barytes mineral based industries are also plenty in this region. In these industries by using pulverisers, Barytes rock are grinded to prescribed mesh size end products and are transported to different parts of the country. A Baryte mineral pulversing factory was taken as a case study to study the product process by Life Cycle Approach method. The environmental assessment revealed the presence of air pollution especially due to less particles size, local noise pollution and open dumping of raw materials in the industry compound. The life cycle assessment indicates that, maintenance of equipment, time schedule for the effective procuring of raw materials and export of end products, safety measures to workers at the work place are few helpful measures to be taken. It also indicated that steps have not been taken to strategically improve the value addition to Baryte mineral by starting new industries that can use the Baryte mineral in this region itself.

Key words: Barytes, Environmental impact, inventory, life cycle assessment, pulverize.

1. Introduction

Mining Industry is an important sector in the growth of the country’s economy. It provides most of the raw materials for industrial processes and products. Mining is being carried out in around 0.5 million hectares which forms 0.15% of the total land mass of the country. The mining of minerals, from the time of independence - mainly involved in coal, iron, oil and gold with a worth of 58 crores has increased tremendously to a level of producing around 89 minerals of worth around 1,27,900 crores in 2009-10. Mining sector contributes around 4% to the Gross Domestic Product (GDP) and is one of the largest employer of our country, providing employment to around 1million (4%) of the India’s workforce. (Mining in India and Foreign Investment-: www.indiajuris.com) . But these activities have also resulted in severe environmental degradation in mining areas. The mining activities has the potential to - pollute the air with heavy metals, Sulphur dioxide etc., to degrade the surface and ground water quality and the activities like blasting, movement of rocks and removal of overburden can cause land degradation. The sustainable development frame work for Indian mining sector which highlights the issues like Sustainable mining, Environmental Safety, local area development for better environmental friendly mining practices and economic development...
has produced mixed results (mines.nic.in - Final Report SDF 2029 Nov11.pdf). In this situation, a system perspective and a comprehensive view are necessary. There are different tools that can be used to achieve environmental improvements, one of which is LCA –

1.1 Process of Life Cycle Assessment

LCA is called a "cradle-to-grave" assessment which involves an assessment of the environmental impacts of products, processes or services from raw materials to waste (Georgakellos, 1999). The essence of LCA is the evaluation of the relevant environmental, economic and technological implications of a material, process or product across its life span from creation to waste (Suppen et al., 2006). The life-cycle assessment is an objective process to evaluate the environmental burdens associated with a product, process or activity by identifying and quantifying energy and raw material usage and environmental releases, to assess the impact of those energy and raw material usage and releases on the environment, and to evaluate and implement opportunities to effect environmental improvements (Duracan et al., 2006). The assessment includes the entire life cycle of the product, process or activity, encompassing extraction and processing raw materials; manufacturing, transportation and distribution; use, re-use and maintenance; recycling; and final disposal (Kwame-Awuah-offei.Akim.Adekpedjou, 2011). LCA is used to identify “hot spots”, in the life cycle that are critical to the total environmental impact and is also often used to compare products with the same function (Andersson et al., 1998).

Barytes is a naturally occurring barium sulfate mineral. Barytes is widely used in many industries, e.g. oil, glass, paint and chemical industries. In the oil industry, barytes is chiefly used as drilling mud. Barytes crushed to pass through 2.00 to 0.840 mm sieve mesh is employed in the production of homogenized glass as a flux and to add brilliance and clarity to the product. Bleached ground barytes is used as a pigment in several ways: as the natural white sulfate and as blanc fixed in lithophone as an indicator in medical X-ray photography. It is also used as filler in oil cloth, linoleum, rubber, X-ray proof plaster, and brake linings, clutch facings, rope finishes (Raghu, 1998). These utilities and demand for Barytes mineral are increasing year by year.

The State of Andhra Pradesh is endowed with rich mineral resources and occupies 2nd place in mineral value production in the country. Within the state, YSR Kadapa district, contains one of the largest Baryte deposits of the world and is considered to have formed through precipitation from volcanic vapours under submarine conditions and sub aerial showering of ash and molten Baryte lapilli. The famous Mangampeta Barytes are of the highest grade and often occur as pure barium sulphate. It has a reserve of over 74 million tonnes that constitutes about 98% and 28% of the total known reserve of India and the world respectively. Another important Barytes deposits are situated in the belt between Velpula and Vempalli in the Pulivendula region. In about 30m depth from surface the mineralized belt extends for about 100km from Vedidandla in the West to Mittemiddipalle in the East (GSI http://www.portal.gsi.gov.in/portal/page, Dey et al., 1971, Reddy and Sriramdas, 1973). Thus many Barytes mineral based industries thrive in this region. The mineral being mined in these mine rich areas is transported by trucks to the factories where the mineral will be grinded to fine grained size for its varied utilization in oil drilling mud, medicines, plastic fillers, paint, foam, crackers, glass and urea manufacture. One such factory was taken as a case study to study the product process and as well effects on local Environment by Life Cycle Approach method.

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2. Materials and method

The essence of LCA is the evaluation of the relevant environmental, economic and technological implications of a material, process or product across its life span from creation to waste. The methodology of LCA generally consists of three steps: Goal, System Boundaries and Inventory analysis and Impact assessment (Suppen et al., 2006). A case study approach was undertaken to study the above mentioned mineral based industry. The supply data for processes were collected and collated directly by visiting the factory for around 15 times. Open interview method was undertaken with factory management officials to know the input data for the processes to be included inside the system boundaries. Majority of the industries of this kind are using more or less the same infrastructure and processes and thus comparison among different processes was not undertaken. The Baryte minerals which were mined and transported to the factory, sorted then grinded to fine grained size and exported to other regions for its varied utilization in various industries like oil drilling mud, medicines, plastic fillers, paint, foam, crackers, glass and urea manufacture, floor coverings and textiles was undertaken. The electrical energy utilized by motors of capacity 5hp to 25hp mainly for running roller machines was considered. Water utilized for cleaning the rock material was considered. Handling of raw and waste material and precautions taken by the work was considered Secondary data were used to describe the environmental impact of energy use and transport. Mining hazards at mine places were not included. The study was confined to impacts on natural environment. It does not include the risks of accidents or parameters for which the environmental impact has not yet been thoroughly examined like radiation etc.

3. Results and discussion

The case study undertaken is M/S. Lakshmi Minerals in the Kadapa industrial zone, located at Andhra Pradesh Infrastructure and Industrial Centre (APIIC) Industrial Park. Lakshmi Minerals industry was started in the year of 1965 in about 1 acre area. There are around 16 such units of Barytes based mineral industries within this APIIC Industrial Park and 80 Barytes mineral based industries are present in 25 km radii of the Kadapa town region. Lakshmi minerals industry use crude Barytes rocks and produces the end product of Barytes powder of 2.50 – 0.850 mm mesh size. The Barytes rocks are procured from mining areas in Vemula, in and around Pulivendula town. The equipments used for the production are millers, vibrator, Jagresser machine, Impax Pulveriser etc. The final product of required mesh size will be packed in 50 kgs of packets for export. The generated waste is being used in road laying projects. It has the capacity to produce 25 tonnes of Barytes powder per day. The industry is run with a man power of 15-20 workers. On average a total of 7083-8500 KWH/month electricity is used.

A flow chart (Figure 1) was drawn for the mineral product and then data on environmental load was gathered for processes present in the life cycle. The flow chart constitutes procurement and sorting of raw materials areas, transport mechanism, product making infrastructure, utilization of water and electricity, end product and reuse opportunities. The mined rocks from the mining areas are transported to the factory by means of lorries and mini trucks. Mined rocks are usually of size 6-12 cm and of weight 0.5 to 5 Kg. The waste rocks are differentiated from the Barytes mineral rocks by sorting out with hands as they are conspicuously in shades of white color. The big boulder Barytes mineral rock are further crushed into smaller fragments by hands to a size of 2-5 cm and stored in heaps. Here work conditions are harsh and there is a high probability of occurrence of accidents. These rock fragments are cleaned up with water in a miller machine run by both diesel and electricity.
The miller machine will be handled by 2-3 workmen. Then the fresh rock material is led into vibrator (separator) containing of three different mesh sizes by means of a conveyor belt. This machine is run by means of electricity. The vibratory noise is being reduced by means of springs.

![Diagram of Barytes mineral process system](image.png)

**Figure 1:** Life Cycle Phases of the Barytes mineral process System Boundaries and Inventory analysis

The main part in the whole product process is to reduce the rock fragment size to appropriate one. In this, the first step occurs in Jagresser machine which contains diamond chips to cut and roller machines to grind. This machine is run by electricity with the help of five 10 hp motors. The resulted fine grained rock of size of 1-2 cm was led into Impax Pulverizer machine which contains three grinding rollers revolving at a speed of 300rpm/minute run by three motors separately. The resulting product is fine grained powdery rock of sizes 240-500 mesh size and 2.00 to 0.840 mm sieve size. This powdery product is led into the blower machine which rotates at a speed of 1500rpm/minute. There are two outlets one for the product and the other for the waste which will be gathered in a filtered bag (Tubular dust collector). Overall 15-20 workers will be employed in the overall running of the factory.

### 3.1 Inventory Assessment

This step includes data collection for inputs and outputs of the product system and the details are provided in Table 1.
Table 1: The inventory assessment of input and output results

<table>
<thead>
<tr>
<th>Input</th>
<th>Capacity</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barytes mineral rock</td>
<td>25 tonnes per day</td>
<td>400kgs to 5 tonnes per month</td>
</tr>
<tr>
<td></td>
<td>400-500 tonnes per month</td>
<td></td>
</tr>
<tr>
<td>Energy (Electricity)</td>
<td>7083 KWH – 8500 KWH per month</td>
<td>Rs 40,000 per month</td>
</tr>
<tr>
<td>Water</td>
<td>500 litres per day</td>
<td>Ground water depletion</td>
</tr>
<tr>
<td></td>
<td>1,80,000 litres per year</td>
<td></td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Grinding Motors, Equipment etc.</td>
<td>Wear and tear out, to be replaced at an average of 5-10 years</td>
</tr>
</tbody>
</table>

The input of basic raw material (Barytes rocks) is approximately 25 to 30 tonnes and the output, in the form of 50 Kgs bags of Barytes powder of appropriate mesh size is around 400kg to 5 tonnes per month. Electricity consumption of Barytes mining industry is around 7083 – 8500KWH/month and the cost incurred is approximately Rs 40,000 per month. The consumption of electricity can be decreased by taking measures like lubricating the machines, over hauling the old equipment. It was learnt that the infrastructure get worn away for every 5 years and they usually replace or service them. They are of opinion that this forms the major components of costs on the factory. Wear and tear of equipment is the most important component in the product process that has to be managed so as to meet the demand and to achieve reasonable profits. Thus a time schedule with information about the monthly fluctuations of product demand across the years has to be prepared. This will help in knowing the lean period in which overhauling the equipment can be carried out to undertake intensive work in demand periods.

3.2 Impact assessment

Impact Assessment characterizes and assesses the effects of the environmental pollution like air, water, noise and land use pollution and one of the challenging aspects of LCA and the details are provided in table 2. The results indicate that a better environmental life cycle assessment process needs detailed background information about the environmental conditions in the mining areas and as well mining based industries so that it can achieve better results as also observed in the study on Mexican mine based industries (suppen et al., 2006).

The air pollution in the form of air borne suspended particles which affects the respiratory system is the noticeable problem for the factory workers. The precautionary measure like wearing of masks is not being taken up. For which, waste reduction efforts must be taken at the mining site and as well at sorting of Barytes rocks stage. Wearing of hand gloves while sorting as well breaking of boulders into small sized rocks is not being carried out and this must be taken care off.
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Table 2: Details of the resulting environmental pollution from the Barytes mineral factory

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Severe</th>
<th>Average</th>
<th>No impact</th>
<th>Precautionary Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air pollution (Respiratory suspended particulate matter &lt;2mm)</td>
<td>✔</td>
<td></td>
<td></td>
<td>Impact is severe but precautionary measures not taken</td>
</tr>
<tr>
<td>Water pollution</td>
<td></td>
<td>✔</td>
<td></td>
<td>Extraction of ground water is present. Sludge formation is also observed.</td>
</tr>
<tr>
<td>Noise pollution</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land use pollution</td>
<td>Open dumping Note: Due to high demand the product will be exported. Usually the work will be taken when orders were received.</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Though bag filters are being used they should be replaced quite often and its number have to be increased as the air borne dust matter has the potential to cause respiratory problems to the workers. The effectiveness of Electrostatic Precipitators is not well known as they have not being used at all. Better storage facilities should be constructed as some times final products are also being left open in the open space. Water pollution impact is average because of the absence of water bodies at the industry site, but extraction of ground water and formation of sludge is seen. The generated waste rock material is fully utilized in road laying projects and they claim it is in high demand. Noise pollution is present, but it is local to the industry site and they claim that the utilization of springs in roller machines have reduced the noise levels.

4. Conclusion by SWOT analysis for the Barytes mineral industry

Table 3: SWOT analysis for the Barytes mineral industry

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weakness</th>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of Barytes ore</td>
<td>Unsustainable, unscientific and environmentally risk mining</td>
<td>New resource ore mineral have been identified. New type of minerals like Fullerene have been found</td>
<td>Raw materials are grinded and being exported Externalities are not included</td>
</tr>
</tbody>
</table>

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The results indicate that for Kadapa region, the mining activity and the associated Barytes mineral industry can form an ideal platform for the economic growth of this region. But usually mining leads to serious health and environmental problems also. The product process is that Barytes rocks raw materials are crushed into particulate size and the products are transported to other industries. For which LCA indicates to prepare a month wise work plan schedule for better utilization of manufacturing equipment to meet the demand needs and to achieve decent profits. From environment side, workers exposure to dust has to be reduced and masks should be made compulsory at the work place. Open storage of raw material and products should be reduced by better planning of demand and supply cycle. It is notable that the waste material is being extensively used in road laying projects. The observations prove that this particular industry has not changed significantly in the past 20-25 years. It must be seen from the entrepreneur skill as well from government planning that any specific effort were not carried out to establish and auxiliary industries that can use the raw materials here itself. In addition, any kind of value addition to the resource was also not undertaken. Thus over all life cycle assessment calls for stringent environment friendly mining rules, time schedule for better management of equipment and work orders and the establishment of few ancillary industries in this area itself to reduce the transportation and as well to improve the economic status of the local people.

Acknowledgement

Authors acknowledges the sources from which the data used in the study were obtained, they also acknowledges Mr.,Madusudhan Reddy, Managing director, Lakshmi Minerals, APIIC IInd Phase Extension, Kadapa industrial zone, Andhra Pradesh for the permission given to conduct the study in their premises and also to publish the output of the work.

5. References


