Explosives efficiency improvement with due regard to safety – step towards sustainable mining process

Introduction

Minerals constitute the back-bone of economic growth of any nation and India has been eminently endowed with this gift of nature. There is much evidence that exploitation of minerals like coal, iron-ore, copper, lead-zinc has been going on in the country from time immemorial. However, the first recorded history of mining in India dates back to 1774 when an English company was granted permission by the East India Company for mining coal in Raniganj.

Thus, India has a mature mining industry built on nearly more than 250 years of experience. The strength of India's mining sector has fuelled much of its economic development and helped underpin social development. This growth has also seen the increased adoption of sustainable mining methodologies. It is time to harness the developed leading practice solutions in practice at global platform and adapt to Indian mining conditions to operate in a sustainable manner.

It is exteremly important to note that Indian mining industry in pursuit of sustainable mining recognizes that environmental accountability; social responsibility and commercial success are now inseparable concepts.

Although, Indian mining industry has developed capabilities in environment and water management, innovative approaches to community engagement and development needs special attention for sustainable mining.

Industry overview

India has vast minerals potential with mining leases granted for longer durations of 50 years. The demand for various metals and minerals will grow substantially over the next 15 years. The power and cement industries also aid growth in the metals and mining sector. India's strategic location enables convenient exports. India's per capita steel consumption is four times lower than the global average. India has the world's 8th largest reserve base of bauxite and 6th largest base of iron ore, accounting for about 5% and 8% respectively of total world production. India is 4th largest iron ore producer in the world and 5th largest bauxite ore producer in the world. India has 302 billion Mt of coal reserves and production is poised to grow from about 638 million Mt to 1.35 billion Mt by 2020.

Growth drivers

- With the Indian economy expected to grow by approximately 7% in the years to come, sectors such as infrastructure and automobiles will receive a renewed thrust, which would further generate demand for power and steel in the country. This is expected to provide a major thrust to the demand of minerals like coal and iron ore.
- Minerals like manganese, lead, copper, alumina are expected to witness double digit growth in the years ahead. There is significant scope for new mining capacities in iron ore, bauxite, and coal.
- India has an advantage in the cost of production and in conversion costs of steel and alumina.
- Sustained growth in India's automotive sector has been driving demand for steel and aluminum.
- The power sector accounts for a large share of the consumption of aluminum and coal in the country.
- Infrastructure projects continue to provide lucrative business opportunities for steel, zinc and aluminum producers.
- Demand for iron and steel is set to continue, given the strong growth expectations for the residential and commercial building industry.
- India has the 301.56 billion tonnes coal reserves as of April 2014. Production of coal stood at 540 million tonnes and 557.7 million tonnes in 2012 and 2013, respectively.
- India ranks fourth globally in terms of iron ore production. In 2013, the country produced 136.02 million tonnes of iron ore.

Sustainability across the mining life cycle

The most widely accepted definition of sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

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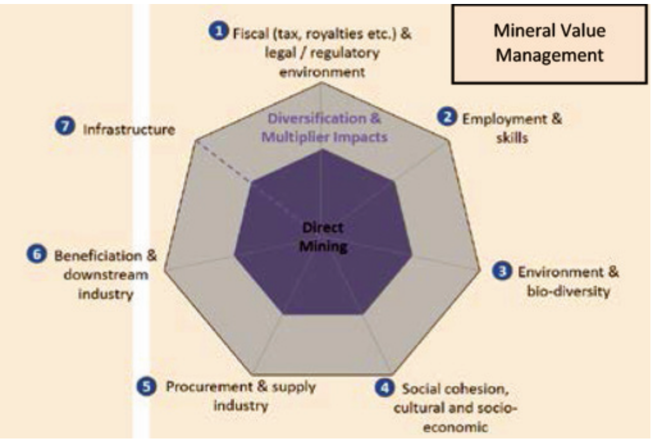
Indian mining industry has considerable experience in bringing together the concepts of environmental accountability, social responsibility and commercial success. Sustainable mining depends on excellence in mine safety and health as well as optimizing the extraction of the mineral resources efficiency.

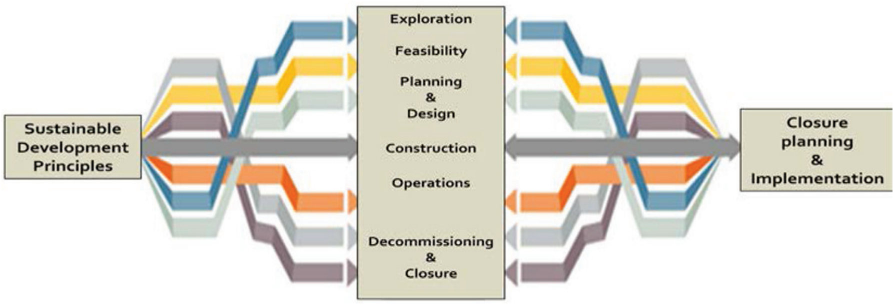


The mining companies should recognize the need to manage their mining projects in an environmentally and socially responsible manner. To do this, a range of initiatives and protocols are to be developed and put in practice covering all stages of the mining process from initial exploration to mine rehabilitation and closure.

A mine needs a 'social licence to operate'. Unless the community is engaged and supportive of a mining operation, opposition and confrontation may ensue. Mining operations run by corporations have been disrupted on many occasions in the recent past particularly from local inhabitants, who were earning their livelihoods before the commencement of the operations.

Dysfunctional community interaction will ultimately distract management from its main focus of efficiently running the mine. Enlightened mining companies, maintain their social licence to operate by undertaking various initiatives, including preferentially employing local people; training and providing skills in businesses or enterprises that will endure after the mine closes and so on.

Phases of a mining project which need to be considered in evaluating mining sustainability.



World's leading practice in sustainable mining

However, need of the hour is to adapt world's leading practice in sustainable mining in a manner which further aligns with community expectations, and which seeks to maximize the long-term benefits to society through the effective management of country's natural resources. To be more conscious of the importance of environmental sustainability, the mining industry has to further invest heavily in personnel, training, scientific research and development to ensure that the highest environmental, safety and community standards are achieved.

Explosives - resource efficiency

A mine has to be efficient in the way the resource is managed and extracted. Mining engineers, geologists and metallurgists collaborate to optimize resource extraction.

Explosive is one of the key inputs for mining sector and with the Indian economy expected to grow by approximately 7% in the years to come, sectors such as infrastructure and automobiles will receive a renewed thrust, which would further generate demand for power and steel in the country. This is expected to provide a major thrust to the demand of minerals like coal and iron ore. Thus, there is immense potential for explosives in years to come and the requirement with growth @ 7% is estimated to be about 14.00 lakh Mt by 2019-20.

The blasting system right from design, explosives, initiating device should be of high accuracy and 100% reliable and safe to yield desired result and maintain adequate rate of production.

Further to unearth the mineral wealth at increased scale of economy, higher capacity equipment i.e. shovels and draglines will be utilized calling for large consumption of explosives in each round as well as more number of blast rounds too.

This will be a big challenge as environment in and around mining areas is likely to be adversely affected due to blast induced ground vibrations

and mine operators will be facing herculean task to address the complaints from the people residing close by. Also, the constraint will gradually become more difficult to handle with increasing population migrating to mining areas in search of jobs in rendering services related to mining industry.

The use of shock tubes has to some extent helped in addressing the environmental issues but the pyrotechnics has the limitation of accuracy because the chemicals may react differently with change in temperature, humidity and shelf life. Thus, most of the time scattering in delay i.e. overlapping of delay period is observed in practice leading to inadequate relief of burden and poor fragmentation, fly rocks and high blast induced ground vibrations.

Also, the pre-assigned delay period limits selection of desired/change in delay period in ms per meter of effective burden which is likely to give better blast quality and least ground vibration.

The existing explosives manufacturers have to upgrade the requisite capabilities in terms of state-of-the-art technology and skilled technical manpower to meet the sharply growing demand of explosives along with initiating systems.

Initially, the explosive manufacturing started in country with due regard to intellectual property but gradually there has been large erosion in this area leading to drop in margins and poor expenditure in R&D area.

Although, the new initiating device like electronic detonators have been introduced by Indian manufacturers the quality is inadequate, impairing the productivity of the mining operation. One must keep in mind that in blasting the process is irreversible, unlike tightening of nut and bolt and thus, a single failure however small it may be, shall impair the productivity of the mines and no corrective action can save the mine operator from attracting loss of revenue.

Thus, performance reliability of each time and every time assumes utmost importance in explosives and initiating system manufacturing as well as its application in mines. This calls for premium quality products and highly skilled and trained manpower to operate and handle the entire system.

Indian Oil has taken lead in delivering high quality bulk explosives using state of the art PLC in pump trucks and introduction of higher capacity pump trucks with longer delivery hose lengths to pump down additional quantity from single stationery position reducing spotting time as well as refilling of emulsion matrix at base support plant.

Also, time has come that total system cost is evaluated instead of simply looking at elemental cost, which may be a difficult proposition, for enhancing productivity of mines by reducing the total cost of operation by monitoring and measuring the key performance indicators cost i.e. explosive, initiating system and excavator (consumables-power/fuel/lubricant, etc).

Typically for a 10 m^3 electric rope shovel consuming electrical power at a level of about 1000 kVA during its operation, the cycle time on an average can be split under swing time for an empty bucket - 24%, filling of bucket - 41%, swing time for the loaded bucket - 25% and dumping time - 10%. It is possible to gain a second here and a few milliseconds there especially during the process of filling of bucket which consumes bulk of the total cycle time through well trained operator and good quality blast.

The explosives cost (including initiating system) is just about 9%-10% of cost of production and say a small increase in explosives and initiating system cost say by 8%-10% is likely to reduce the electrical power cost by Rs0.80 to Rs1.00 per cubic meter of overburden through improved bucket fill factor by about 4%-5%.

The other benefits will add to a significantly large savings on recurring basis.

Safety

For sustainable mining, safety being one of the strong attributes of explosives during manufacturing, transportation, handling and usage in mine needs to be relooked and reassessed and brought at par with global practices.

For both ethical and business reasons, a mining operation should aim to prioritise safety. Characteristics of safe mines include a commitment to risk management; appropriate attitudes and behaviours; reporting systems to be in place; a focus on education and training; and a focus on processes and equipment.

The use of explosives to break rock is an intrinsically hazardous process. These hazards have been studied over the years and modern mining methods have evolved to minimize the inherent risks of blasting under most conditions.

For sustainable mining, it is suggested that training courses should be designed for explosives engineers for ensuring safe practices to be followed while handling, loading, guarding, clearance and blasting of explosives in mines/sites. Presently, the explosive engineers are learning while actual working at site from seniors/colleagues which may not engrain right safe practices and with passage of time people start taking safety for granted. The safe work culture should be inculcated and refreshed from time to time. To support this, code of safe practices will be required to be developed for each mine/site incorporating local operating conditions.

Elevated Temperature and Reactive Ground

Code to assist the safe usage of explosives in conditions where a speciûc additional hazard may exist due to the possible unwanted reaction between an explosive and the rock being blasted. In such situations the unwanted reactions may result in premature detonations with potentially fatal results. The reactions can be caused by rock chemistry, temperature or a combination of both.

Blast Guarding in an Open Cut Mining Environment

Code to manage the blasting procedure to protect mine personnel, contractors and the general public from exposure to foreseeable, if unintended, adverse consequences of a blast. Adverse consequences may include, but not be limited to, one or any combination of the following scenarios:

- Persons inadvertently at risk from flying rock generated by the blast
- Persons at risk from fumes generated by the blast
- Persons at risk from misfired blastholes
- Persons carrying out tasks other than blasting with workplaces inside an area subject to blasting effects
- Electrical storms arriving when a blast is ready to fire
- Unauthorized persons unintentionally driving or walking inside a blasting zone
- Blast effects extending outside the mine boundaries

On-Bench Practices for Open Cut Mines and Quarries

There is need to provide guidance on establishing best practice systems and procedures for managing on-bench procedures for the loading and firing of blasts at open cut mines and quarries, to minimize risks for its members, its clients, their employees and the wider community.

The use of explosives to break rock involves the sudden application of large amounts of energy, and is therefore a process requiring the effective management and control of activities to ensure that hazards are identified and appropriately controlled. On a mine or quarry site the potential hazards are increased by the need to handle sensitive initiating explosives while working in a harsh environment. The blasting process must be managed in a way that minimizes the risk of the unplanned detonation of explosives, and associated undesired outcomes, and uncontrolled blast behaviour at the time of firing.

In considering the safety of mine personnel, contractors and the general public, hazards associated with the blasting process include, but are not be limited to, the following:

- Loss or theft of explosives from the mine/quarry site, representing a security risk;
- Unplanned detonation of explosives due to incorrect handling or application, or during transportation;
- Unplanned detonation during placement due to impacts associated with operating equipment (e.g. as drills and excavators in adjacent areas); impact from passing equipment; or snap-slap-shoot risks from passing equipment;
- Unplanned detonation of explosives after placement, from an external source of initiation such as hot/reactive ground, or lightning;
- Unplanned detonation of explosives due to the application of electrical energy for testing or firing of electronic initiation systems, e.g. following undetected damage by lightning;
- Fly rock risks to persons, equipment and infrastructure, outside the blast exclusion zone, generated by an inadequately confined blast, within a blast exclusion zone that has not been adequately cleared prior to firing, or an exclusion zone inadequately determined based on ground conditions;
- Environmental compliance risks (overpressure and ground vibration) associated with overloaded blastholes, large (reinforcing) blasts, and unfavourable meteorological conditions;
- Persons at risk from dust and fumes generated by the blast, outside the blast exclusion zone or potentially outside the site boundary;

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