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**ADVANCEMENTS IN GREEN MINING TECHNOLOGY:
PAVING THE WAY FOR SUSTAINABLE RESOURCE EXTRACTION**

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Introduction

The extraction of valuable ores from the Earth's depths has fueled human progress for centuries, yet it has come at a tremendous cost to our environment. Mining practices, often driven by the insatiable demand for minerals and metals, have left a trail of unsustainability and environmental degradation in their wake. While these problems remain formidable, a ray of hope emerges on the horizon with the advent of "green mining" technologies and practices.

What is actually green mining?

Green Mining Defines a mixture of technological advances and best practices to achieve the extraction of minerals and metals while mitigating the Environmental Impacts of the Process.

TRANSFORMING MINING: SUSTAINABLE PRACTICES SHAPING THE FUTURE OF RESOURCE EXTRACTION

Green mining technologies and practices have been gaining attention in India as the country seeks to address environmental concerns and promote sustainable mining operations. Here are some examples of green mining technologies and practices adopted in India ;

Solar Power Integration:

Incorporating solar integration in green mining is the practice of using solar energy to power mining operations while minimizing the industry's environmental impact. By deploying solar panels or power plants on-site, mining companies can reduce their reliance on fossil fuels, lower greenhouse gas emissions, and lower operating costs.

Efficient Water Management:

Water scarcity looms as a pressing concern in numerous regions across India. In response to this challenge, mining companies are turning to innovative water management solutions to mitigate their environmental impact. Hindustan Zinc's Dariba Smelting Complex, nestled in the arid landscapes of Rajasthan, has set an inspiring example. By implementing water recycling and treatment systems, the complex recovers a significant portion of its process water, thereby minimizing water consumption and conserving this precious resource. In addition to these initiatives, mining operations utilize Effluent Treatment Plants (ETPs) to purify water used for vehicle washing. These ETPs effectively remove contaminants and pollutants from the water, showcasing mining companies' dedication to environmental responsibility and eco-conscious practices.

Biogas Plants

Biogas plants are being used to convert organic waste from mining operations into biogas, a renewable energy source primarily composed of methane. This sustainable approach reduces the need for traditional fossil fuels and helps lower the environmental impact, showcasing the mining industry's commitment to eco-friendly practices.

Green Transportation:

Indian mining companies are commencing on a transformative journey by incorporating electric vehicles (EVs) into their fleets. Mining companies now a days has enthusiastically adopted battery-powered EVs, revolutionizing the mineral transportation process within its mines. These electric vehicles not only promise a significant reduction in emissions but also provide a quieter and cleaner alternative to their diesel-powered counterparts.

Revolutionizing Mining with Sonic Drilling

Sonic drilling is a new era of eco-friendly mining, with its innovative mechanical oscillation drills that drills more quickly than conventional methods. This technology is particularly notable for its

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application in mining precious resources like diamonds, gold, and lithium. By reducing the use of drilling fluids and enhancing drilling efficiency, sonic drilling is not only streamlining resource extraction but also significantly lowering the environmental impact of mining operations.

● **Solid Waste Management :**

● In the mining industry, organic waste from canteen doesn't go to waste. Instead, it is transformed into vermicompost, a nutrient-rich soil produced with the help of earthworms. This "black gold" is used in improving soil quality for reclamation projects, boosting plant growth, and reducing the need for chemical fertilizers.

Turning Waste Materials into Road-Building Resources

Mining companies are finding a new way to deal with waste. These materials are now being used as minor minerals. This approach is getting popular, especially for road repairs. Instead of discarding waste materials, mining companies are reusing them to create road-building materials contributing to sustainable and cost-effective road infrastructure development. By this the problem of space for storing waste material is solved and alternate use of waste material is accomplished.

Bioremediation:

Indian mining companies, like KIOCL in Karnataka, are using bioremediation techniques to reduce the environmental impact of mining. They're employing specially selected plants that can absorb and neutralize pollutants, helping to restore mined land and reduce soil contamination. This nature-inspired approach is a step toward making mining more eco-friendly. The Iron Mountain Mine in California is employing bioremediation techniques. Microorganisms are used to clean up the acidic and metal-laden waters that have polluted the region for decades, showcasing the potential of bioremediation in restoring ecosystems. Biosurfactants can be produced by bacteria like *Bacillus subtilis* to remove heavy metals from contamination by precipitation-dissolution, ion exchange, counter ion binding. Sophorolipids play a vital role in removing Iron, Arsenic and Copper from mine tailing.

Liquid emulsion technology

Acid mine drainage stands as a formidable environmental challenge, with far-reaching impacts on ecosystems. While several methods like biosorption, ion exchange, and chemical precipitation have been employed to combat this issue, they often come with their own set of disadvantages. In central Chile, they use liquid emulsion tech to clean copper from acid mine water. It's a more effective method, reducing mining's environmental impact.

M-Sand Technology

Mining companies have been actively exploring innovative solutions in the realm of green mining as part of its commitment to sustainable and environmentally responsible mining practices. One notable addition to their green mining initiatives is the incorporation of M-sand technology. Manufactured Sand (M-sand) is an eco-friendly alternative to natural river sand that is used in construction and infrastructure development. By adopting M-sand technology, CIL aims to reduce the environmental impact of mining operations while contributing to the conservation of river ecosystems. This sustainable approach not only ensures the availability of quality construction material but also aligns with the global effort to reduce the depletion of natural resources and safeguard the environment.

Belt Conveyors & Pipelines: Sustainable Mined Material Transport

Belt conveyors play a pivotal role in green mining practices, offering a sustainable and efficient way to transport mined materials. By reducing the need for truck transportation, these conveyors help lower particulate matter emissions and energy consumption. Additionally, they contribute to a safer work environment by minimizing vehicular traffic congestion in mining areas. This eco-friendly approach aligns with the mining industry's focus on reducing its environmental footprint while improving operational efficiency. In addition to belt conveyor, pipelines are also used to transport mined material over long distance with reduced energy and with a smaller environmental footprint. This innovative approach minimizes the traditional transportation methods, such as trucks etc.

Reduced Blasting Frequency:

Blasting may be reduced to three times in a month by increasing the quantity of explosives per blast by adopting optimizing techniques. By doing so, the detrimental effects associated with blasting, such as ground vibrations, noise, and air pollution, are significantly mitigated. In other way it will be beneficial as the loss of working hours due to blasting is reduced.

Sustainable dust control measure

The implementation of a sprinkling system in mines road and the installation of Dry fog system in mines signify step towards sustainable practices. These are reducing dust emission and conserving water resources. The DFS efficiently suppress the dust without using excess of water. The sprinkling system at mines road control the dust emitted and hence improving the air quality.

Continuous Ambient Air Quality Monitoring Systems (CAAQMS)

Continuous Ambient Air Quality Monitoring Systems (CAAQMS) have become an integral part of green mining initiatives. These advanced systems are strategically installed to monitor real-time air quality in and around mining sites continuously. Monitoring the levels of diverse air pollutants, including particulate matter such as PM10 and PM2.5 as well as gases like nitrogen dioxide (NO_x), sulfur dioxide (SO₂), carbon monoxide (CO), and others, aids mining companies in effectively overseeing and reducing potential environmental impacts.

Conclusion

Green mining technologies and practices in India are gradually gaining momentum, driven by a growing awareness of environmental and sustainability issues. These initiatives aim to strike a balance between mineral resource extraction and environmental preservation, contributing to a more responsible and eco-conscious mining sector. It may be noted that Green mining go hand in hand with health and profitability of the mining industry.

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