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Water Quality Concerns at Mines for Environmental Impact Assessment

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ABSTRACT: The usefulness of water in mining has the ability to affect the quality of surface water and groundwater. In respect to environmental concerns and regulations of government agencies, the mining industry worldwide keep vigil on water discharged from mine sites, and has implemented various strategies for the prevention of water pollution. Water issues and management differ from site to site and it should be dealt locally, but in general the mining industry seeks to minimize its impact on water quality and availability.

KEYWORDS: Environment, Water, Mining, Groundwater, Regulation, contamination, pollution

I. INTRODUCTION

Mining operations use water for mineral processing and recovery of metal, controlling, dust, and fulfill the needs of workers on mine site. The quantity of water required by a mine varies depending on the mine size, extraction of minerals, beneficiation, and the extraction process applied. Metal mines which chemically process ore to concentrate metals like copper and gold use more water compare to non-metal mines like coal, salt, or gravel.

Big mining operation may use a considerable quantity of water; the minerals industry consumes small quantity of water at national and international levels. The water reuse and recycling rate in mineral processing is very high at mine sites, especially in areas with arid environment. Various practices were developed and applied to reduce water use.

II. CLASSIFICATION OF MINE WATER

Numerous classifications of mine water exist, which vary in quality and potential for contamination:

- **Mine water:** Surface or groundwater present at mine site.
- **Mining water:** water which come into contact with any mine workings
- **Mill water:** water used for crushing and grinding ore, may contain dissolved minerals and metals
- **Process water:** water used for chemically extracting metals, contains process chemicals.
- **Leachate:** water which has trickled through solid mine wastes and may contain dissolved minerals, process chemicals, and metals
- **Effluent:** Mining, mill, or process water which is discharged into surface water, often after treatment.
- **Mine drainage water:** Surface or groundwater which flows or has the ability to flow off the mine site

All the mine water at metal mines is collected and stored in tailings ponds before treated and released to surface water(9).

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Water contamination



Water pollution from mines is a major cause of concern. Previously mines operated without the strategies and control technologies that are standard practice among big mining companies, they are contributing to environmental concerns over proposed mines and doing the Environmental Impact assessment.

Regulated mines fourfold improved their environmental performance, the use of liquid mercury in informal or artisanal mining (ASM) continues to show a serious threat to water quality in some areas of world. ASM produces approximately 20-30% of the world's gold (500-800 tonnes per year). At least 650 to 1000 tonnes of mercury are released into the environment every year by ASM as a result of poor management tactics, which accounts for about a one third of all human-released mercury. Other environmental problems associated with ASM include the direct dumping of tailings and effluents into rivers, improperly constructed tailings damage acid rock drainage from mining areas. Monitoring environmental violations and enforcing the rules that combat those violations has been difficult due to a lack of resources and the widely scattered and inaccessible nature of ASM.

III. WATER QUALITY STANDARD AND REGULATIONS IN INDIA

Water Quality Standards in India (Source IS 2296:1992)

| Characteristics | Designated best use | | | | |
|--|---------------------|---------|---------|---------|---------|
| | A | B | C | D | E |
| Dissolved Oxygen (DO)mg/l, min | 6 | 5 | 4 | 4 | - |
| Biochemical Oxygen demand (BOD)mg/l, max | 2 | 3 | 3 | - | - |
| Total coliform organisms MPN/100ml, max | 50 | 500 | 5,000 | - | - |
| pH value | 6.5-8.5 | 6.5-8.5 | 6.0-9.0 | 6.5-8.5 | 6.0-8.5 |
| Colour, Hazen units, max. | 10 | 300 | 300 | - | - |
| Odour | Un-objectionable | | | - | - |
| Taste | Tasteless | - | - | - | - |
| Total dissolved solids, mg/l, max. | 500 | - | 1,500 | - | 2,100 |
| Total hardness (as CaCO ₃), mg/l, max. | 200 | - | - | - | - |
| Calcium hardness (as CaCO ₃), mg/l, max. | 200 | - | - | - | - |
| Magnesium hardness (as CaCO ₃), mg/l, max. | 200 | - | - | - | - |
| Copper (as Cu), mg/l, max. | 1.5 | - | 1.5 | - | - |
| Iron (as Fe), mg/l, max. | 0.3 | - | 0.5 | - | - |

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| | | | | | |
|--|-------|-------|-------|-----|-------|
| Manganese (as Mn), mg/l, max. | 0.5 | - | - | - | - |
| Cholorides (as Cu), mg/l, max. | 250 | - | 600 | - | 600 |
| Sulphates (as SO ₄), mg/l, max. | 400 | - | 400 | - | 1,000 |
| Nitrates (as NO ₃), mg/l, max. | 20 | - | 50 | - | - |
| Fluorides (as F), mg/l, max. | 1.5 | 1.5 | 1.5 | - | - |
| Phenolic compounds (as C ₂ H ₅ OH), mg/l, max. | 0.002 | 0.005 | 0.005 | - | - |
| Mercury (as Hg), mg/l, max. | 0.001 | - | - | - | - |
| Cadmium (as Cd), mg/l, max. | 0.01 | - | 0.01 | - | - |
| Salenium (as Se), mg/l, max. | 0.01 | - | 0.05 | - | - |
| Arsenic (as As), mg/l, max. | 0.05 | 0.2 | 0.2 | - | - |
| Cyanide (as Pb), mg/l, max. | 0.05 | 0.05 | 0.05 | - | - |
| Lead (as Pb), mg/l, max. | 0.1 | - | 0.1 | - | - |
| Zinc (as Zn), mg/l, max. | 15 | - | 15 | - | - |
| Chromium (as Cr ⁶⁺), mg/l, max. | 0.05 | - | 0.05 | - | - |
| Anionic detergents (as MBAS), mg/l, max. | 0.2 | 1 | 1 | - | - |
| Barium (as Ba), mg/l, max. | 1 | - | - | - | - |
| Free Ammonia (as N), mg/l, max | - | - | - | 1.2 | - |
| Electrical conductivity, micromhos/cm, max | - | - | - | - | 2,250 |
| Sodium absorption ratio, max | - | - | - | - | 26 |
| Boron, mg/l, max | - | - | - | - | 2 |

The Water (Prevention and Control of Pollution) Act was enacted in 1974 to provide for the prevention and control of water pollution, and for the maintaining or restoring of wholesomeness of water in the country. The Act was amended in 1988. The Water (Prevention and Control of Pollution) Cess Act was enacted in 1977, to provide for the levy and collection of accession water consumed by persons operating and carrying on certain types of industrial activities. This cess is collected with a view to augment the resources of the Central Board and the State Boards for the prevention and control of water pollution constituted under the Water (Prevention and Control of Pollution) Act, 1974. The Act was last amended in 2003.

Acts

- No.36 of 1977, [7/12/1977] - The Water (Prevention and Control of Pollution) Cess Act, 1977, amended 1992 ,
- No. 19 of 2003, [17/3/2003] - The Water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003.
- No.6 of 1974, [23/3/1974] - The Water (Prevention and Control of Pollution) Act, 1974, amended 1988

Rules

- G.S.R.860(E), [30/11/2012] - The Central Pollution Control Board (Qualifications and other Terms and Conditions of Service of Chairman) (Amendment) Rules, 2012.
- G.S.R.840(E), [22/11/2012] - The Central Pollution Control Board (Member-Secretary, Terms and Conditions of Service and Recruitment) Rules, 2012.
- G.S.R.830(E), [24/11/2011] - The Water (Prevention and Control of Pollution) Amendment Rules, 2011.
- G.S.R.378(E), [24/7/1978] - The Water (Prevention and Control of Pollution) Cess Rules, 1978
- G.S.R.58(E), [27/2/1975] - The Water (Prevention and Control of Pollution) Rules, 1975
- Central Board for the Prevention and Control of Water Pollution (Procedure for Transaction of Business) Rules, 1975 amended 1976.

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IV. POTENTIAL FOR WATER CONTAMINATION

The potential for water contamination at a mine site depends on a number of factors:

- **Type of ore being mined:** Some ores, such as sulphide ores, are more chemically reactive than others, and have a greater tendency to dissolve and contaminate water. Common contaminants that are present naturally in metal ores include metals, metalloids, and salts.
- **Chemicals used:** Chemicals used to process metal ores include cyanide, sulphuric acid, and organic chemicals. A single mine may use a combination of physical and chemical processes to separate metals from ore.
- **Climate:** The amount of water available and potential for contamination at a mine site can vary depending on the climate
- **Life stage of mine:** Whether a mine is under construction, operating, or closed can affect its potential to contaminate water. For example, the potential for water contamination from process chemicals is minimal following the closure of a mine, but if the mine workings were to be subjected to natural flooding, minerals could dissolve and mix with the surrounding groundwater.
- **Environmental management practices:** Modern water management practices and mine designs greatly reduce the potential for water contamination at mine sites.. Knowledge of water management and impact reduction has greatly increased over time, and the prevention of water contamination is now an important component of mine operation and closure plans (11).

Environmental impact assessments (EIAs), required in more than 100 countries including India, identify potential sources of water contamination at proposed mine sites, and the environmental management strategies that the mining companies intend to use to limit or prevent water contamination. While some form of EIA exists in many developing countries, their implementation tends to fall short of international standards. However, there have been international efforts by the United Nations, the U.S. Environmental Protection Agency, and the World Bank to encourage the adoption of EIAs in developing countries like India by providing training and capacity-building programs.

Tailings ponds

Tailings are finely ground rock and mineral waste products from mineral processing operations. Tailings are usually deposited in the form of water-based slurry into tailings ponds, which sedimentation lagoons enclosed by dams are built to capture and store the tailings.

Negative impacts of water contamination

Water contaminated with high concentrations of metals, sulphide minerals, dissolved solids, or salts can negatively affect surface water quality, aquatic ecosystems, and groundwater quality. Impacts on aquatic life can include increased mortality, health or reproductive problems, and a reduction in the number of species present. Impacts on human health can occur where the quality of water supplies used for irrigation, drinking, and/or industrial applications is affected. Water contamination can result in a need for treatment of water or the adoption of a different water source

V. CONCLUSION

Modern water management practices and mine designs greatly reduce the potential for water contamination at mine sites.. Knowledge of water management & EIA has greatly increased over time, and the prevention of water contamination is now an important component of mine operation and closure plans.

As many chemicals were used to process the ore which is poisonous in nature and it mingled with water and hazardous to human being and animals too. Continuous monitoring of environmental violations and enforcement of rule minimize the contamination of water at the mine site and provide great help to the people around the mine site.

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