EFFECTIVE POLLUTION ABATEMENT STATERGIES IMPLEMENTED AT HUTTI GOLD MINES, RAICHUR, KARNATAKA

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Abstract: The present paper reports the effective pollution abatement strategies carried out at various levels of mining activity to control / minimize/ abate pollutant generation. Based on the characteristic nature of the pollutants generated suitable abating technologies at all possible stages has been incorporated.

Hutti Gold Mine (HGM) as a corporate citizen and environmentally conscious and committed to achieve its business goals through sustainable development / growth. The Corporate Environmental Policy of HGM also emphasizes on "conducting our operations in an environmentally concern manner, complying with applicable regulations and striving to go beyond". HGM recognizes its responsibility to continuously improve its energy efficiency and optimize resource consumption through various measures viz. improvement in process technology in the areas of raw materials, reuse/re-cycle of the by-products generated. HGM has been a pioneer in terms of environment management and in adoption of advanced eco-friendly technologies. The effective pollution abatement strategies are expected to satisfy the environment friendly, safe, technique in processing of gold ore.

HGM has taken adequate measures by adopting suitable control measures along with adaptation of suitable technology to abatement of pollution which are likely to cause at various stages in the mining activities.

Key Words: **Pollution abatement, Gold Mine, Environment Management,**

INTRODUCTION

Gold mining consists of the processes and techniques employed in the extraction/removal of gold from the ground. Apart from the mining process there are several techniques involved in processing /extraction of gold. Some of the common processes involved in the process of gold recovery from a gold ore are crushing, grinding, gravity separation, Cyanidation etc., the various stages of processing may be involved in generation of pollutants which is the major challenge and concern of a gold processing industry.

The regulatory bodies like MoEF, CPCB, IBM, DGMS imposing varies specific and general conditions to regulate, monitor, management of pollution caused in the process of carrying out various Mining activity (air, water, noise etc.,) and it becomes inevitable for an mining industry to find out all possible ways to regulate, monitor and maintain the quality and quantity of the pollution generated below the standard permissible limit.

Location and History:

Hutti Gold Mines Company Limited (HGML), a Government of Karnataka Undertaking (established in 1947 as Hyderabad Gold Mines), has a unique distinction of being the only producer of primary gold in the country. The Hutti gold deposit is located in Hutti- Muski greenstone belt. The auriferous lodes occur within Meta-Basalts. The Gold-Quartz-Sulfide lodes are confined to laterally and depth persistent shear zones. Gold occurs in native form in quartz veins as well as in sulfide minerals viz., Arsenopyrite, Pyrrhotite and pyrite.

Environmental Measurements and Achievement of Environmental Compliance at HGML:

As per the guidelines of the ministry of Environment and Forests (MOEF), HGML is committed to regular monitoring and submitting the reports to Karnataka state pollution control board (KSPCB). All measurements conducted at HGML are summarized below.

d) Monitoring schedules for different environmental components

Sl no	Monitoring of Environmental parameters at mine		
1	Ambient air quality for SPM, RPM, SO_2, NoX.24hrs 2days in aweek/4 weeks in a season.	One location	3 seasons Two days per week for 2 days. 2 samples per day (8 hrs /samples)
2	Drinking water as per IS:10500 (surface and ground water)	One location	3 spot samples per season at the rate of one sample each on 3 different days
3	Noise level measurement	One location	1 season
4	Effluent analysis as per GSR 422(E)	One location	1 season (summer)
5	Personal sampling at work man areas	One location	1 season (summer)
6	Free silica analysis	One location	1 season
7	Ground vibration study		Only once
8	Dust fall measurements	One location	3 seasons

Water quality Management:

The Hutti Gold Mines Co Ltd (HGML) has adopted the cleaner technology along with the best sustainable practices by adopting the "3R"principle-Reduse, Recovery and Recycle**:**

Adopting Cleaner technology is being practiced in the process by complete detoxification of the process waste by adopting recovery system which reduce the chemical consumption and complete recycling of the water to form an zero discharge there by significantly reducing the amount of hazardous substance (Cyanide) escaping to the environment recover utilization by recirculation of the process water, which play a significant role in achieving the Environment standards.

HGML has adopted various eco friendly techniques for reusing and recycling,

- Recycling of the process water completely by ensuring zero discharge to environment.
- Reusing of the treated water from the Oxidation Pond for gardening, Afforestation activities.
- Reclaiming of the cyanide used in the process and reused back in the process, thereby reducing the cyanide consumption.
- Activated carbon in the recovery of gold by the surface adsorption process, the loaded activated carbon is stripped and reused, thereby reducing the raw material consumption.
- The organic waste segregated from the community solid waste is being composed and used as manure for plants.
- Solar heater has been installed to canteen to generate steam, which is used for cooking purpose.
- Solar water heater is incorporated in the Guest house to supply hot water for bathing.
- Solar emergency lighting system & 2 Nos CFL bulbs has provided at free of cost on replacement basis to all the officers houses (150 houses) to encourage the renewable and sustainable use of energy.

Monitoring wells and Bore wells:

Two monitoring wells exist in the upstream and downstream of the tailing dam. Twelve Bore wells exist near the mining area, employee's colony and nearby Hutti village. Regularly water samples from these wells and bore wells are collected for quality analysis as per the Indian Standard IS: 10500 and reported to the KSPCB on monthly basis. It is evident from the analysis report of water samples (refer table) that all quality parameters within the tolerance limit except TDS. The higher concentrations of Total Dissolved Solids (TDS) in the majority of the well and Bore well samples of this area is due to arid climate and high evaporation rates and minimum recharges to ground water and higher dissolution of rock minerals in the moving ground water.

AIR QUALITY MONOTORING:

The dust that emitted due to Mining activities will be made to subside by installing appropriate equipments at various points. Ambient air quality and water quality tests will be carried out regularly and the results will be sent to the Pollution Control Board, Govt. of Karnataka, as per air and water pollution control act.

Controlling Dust Levels

Dust is the major pollutant generated from the mining operations. Dust would be generated during mining, handling and haulage of ore. The work place environmental control measures, which are being taken and proposed to control the fugitive dust released during the ore production are given below:

Mines

- Wet drilling is being practiced.
- Personnel protective Equipments like Dust masks is being provided for the workers.

Haulage

- All haul roads will be maintained regularly by clearing the spilled materials.
- Water is being carried out regularly on the roads by using water tankers.
- Avoiding over filling of tippers and consequent spillage on the roads
- Ore carrying trucks will be effectively covered by tarpaulin to avoid escape of fines to the atmosphere.
- Avenue plantation and peripheral plantation is being carried out all along the roadside and in the vacant areas, which help in arresting the dust carried by the wind.
- Air quality will be regularly monitored both in the core zone and the buffer zone.

Controlling of NO_X Levels

The source of NO_X would be due to vehicular emissions. This has been controlled by regular maintenance and servicing of vehicles.

Controlling of process emission:

The process of smelting and drying generate emission of gases,
The source of emission is identified and before emission the gas is made to passed through Bag filters and Scrubber for removal of harmful gases liberated in the process there by meeting the prescribed emission standards.

Measures for dust suppression:

Mine seepage water is being used to suppress the dust during ore transportation, in the haulage area and also in drilling. Water spraying is done at the loading point. Further avenue plantation and peripheral plantation has been done to arrest the dust carried by the wind.

Control of Noise and Ground Vibrations:

The noise generated by the machineries has been reduced by proper lubrication and regular maintenance. All the workers employed near the noise source have been provided with personnel protective systems such as earmuffs and earplugs. Addition to this development of green barrier reduces the noise level significantly. Controlled blasting methods are being practiced. Blasting is being practiced by optimized spacing, quantity of explosive and charge per delay. Therefore, no much impact is envisaged from the blasting.

A detailed study has been carried out on the ground stability at Hutti gold mines by National Institute of Rock Mechanics (NIRM), KGF and as per its report no instability is expected in the walls of the excavation. Further post filling of the voids is adopted. Stope size is designed based on numerical modeling as suggested by NIRM, KGF. Controlled blasting methods (charge per delay) is being followed.

For measurement of noise level in the mine area, an Integrating Sound Level Meter Lutron SL-4001 is being used, which provides a complete acoustical measurement system with a data logger. To assess the noise level due to plant and mining operations, following monitoring is being practiced.

Noise source monitoring at equipment has been deployed

Work zone noise level monitoring within mine and metallurgical plant area

Ambient noise level monitoring in the colony.

The Ambient Air quality standards in respect of noise as specified under the Noise Pollution (Regulation & control) Rules, 2000 are as follows.

Area category	**Limits in dB (A) in - Leq**	
	Day time	**Night time**
(A) Industrial area	75	70
(B) Commercial area	65	55
(C) Residential area	55	45
(D) Silence Zone	50	40

As per the Directorate General of Mines Safety, the prescribed noise levels, in respect of mining areas, for 8 hrs exposure are the warning limits at 85 dB (A) and the danger limits are 90 dB(A). No worker should be allowed to enter where noise level exceeds 140 dB (A) and ear protection devices must be worn when exposure level is above 115 dB (A). The result shows that ambient noise level is within the permissible limits. However, in the work zone, wherever noise level exceeds 85 dB (A) workers

are provided earplugs and barricade system. Addition to this, regular lubrication of machineries and periodical medical examination of the workers are being carried out.

a. Tailings Detoxification:

A dilute solution of sodium cyanide typically in the range of 0.02% to 0.05% (200ppm to 500ppm) is used for the gold dissolution. It forms stable gold cyanide complexes with native gold in presence of oxygen and dissolves in the gold solution. Only a small fraction of the total cyanide used in the process is utilized for gold dissolution and a major fraction is consumed by other constituents of the ore and some unutilized active cyanides remains in Carbon-in-Pulp (CIP) tailings. The cyanide in the tailing is characterized as active cyanide and non-active cyanide based on the strength of metal cyanide bond. Active cyanide includes free cyanide (HCN & CN^-, the most toxic form of cyanide) and weak acid dissociable cyanide complex (cyanide complexes of cadmium, copper, nickel & zinc). Non-active cyanide refers to strong acid dissociable which includes cyanide complexes of metals such as Cobalt, Iron, Silver, Gold, etc.

Though cyanide is deadly poisonous, its high dose ingestion can put to death to any living being, it is not persistent in nature. It's transformed into less toxic compounds by physical chemical and biological processes in the nature. However, from the environment point of view active cyanide in tailings is the constituent of concern in tailing and requires to be treated before impounding in the tailing dams.

Cyanide treatment is classified as either a destruction-based process or recovery-based process. In destruction process either chemical or biological reactions are utilized to convert cyanide into another less toxic compound, usually cyanate. There are several destruction processes that are well proven to produce treated tailings with low level of cyanide. Recovery processes are a recycling approach in which cyanide is removed from the solution or slurry and then re-used in the leaching circuit. Recovery based processes have not found wide acceptance in the gold processing plants around the world because of complex technology and unfavorable overall economy.

The modified detoxification plant in the Hutti Gold Mines Co. Ltd (HGML) possesses very unique features. It is a hybrid of recovery & destruction processes. In the process more than 50% quantity of solution in tailing is recovered along with active chemicals with the help of tailing thickener, before detoxifying it with calcium hypochlorite (Bleaching Powder) in alkaline condition. The recovered solution is re-used in the process. Thickened pulp from tailing thickener is pumped to detoxification tanks – five number tanks of effective volume of 80 M3 each - operating in series. Bleaching powder solution is added in the first tank @ 5 – 7 times the (CN-) concentration in the tailing and lime to maintain the required pH about 10.5. Detoxified tailing is pumped to the tailing dam. Active cyanide concentration is regularly checked in the impounded tailing which varies between nil & 0.14ppm which is much below the standard 0.20ppm. Supernated solution from dump is recycled – recovery reduced from 30% to 15% after introduction of tailing thickener - for use in the process by these zero discharges is maintained.

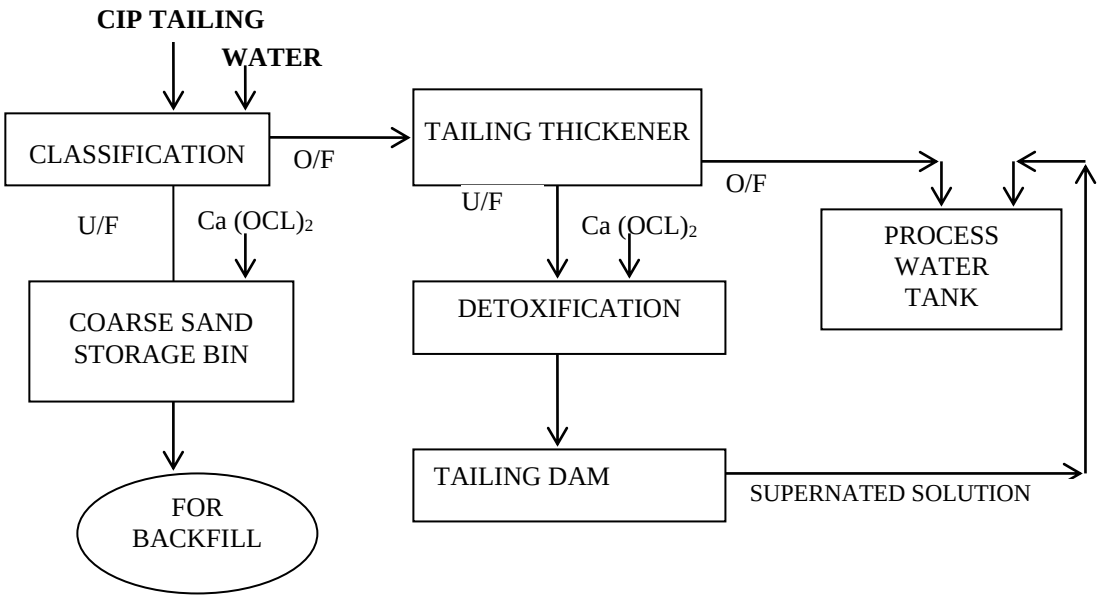

Fig: Flow sheet of Detoxification plant

WASTE MANAGEMENT

During underground mine development for the planned year, the waste rock generated will be used for civil works and as road ballast.

TOPSOIL MANAGEMENT

There will not be any significant effects on the surface area, as the main mining workings will be done underground. Hence, the problem of storage and preservation of topsoil doesn't arise.

Programme of Phase wise Afforestation:

To reduce dust which is carried by wind from the tailing dumps and crushers, plantation is being done in the surrounding plant area, along the boundary of tailing dumps and within company premises, all along the roads and in the company Colony.
A separate fund has been earmarked for Environmental protection measures and maintained in separate account and which will not be diverted for other purpose.
HGML will make all efforts to achieve sustainable development and to emerge as eco friendly mining.

Solid waste management

Process waste Management (Tailing dump Management):

- The process of recovery of metal from ore involves crushing, grinding, and Cyanidation to remove the unwanted solids, which form the tailing (The tailings are the products obtained in the process of beneficiation). Since tailings are generally considered as wastes, their disposal/storage is important at the mining site.
- Formation of tailing dump: The tailings in the form of slurry is pumped to the earmarked site for impounding where it is allowed to dry under sun and consolidate to reduce the impact of leaching and water run-off. The decanted water is made to store in the catchments ponds/storage sump which pumped back to plant and reused in the process.
- As per Ministry of Environment and Forest (MOEF) KSPCB/IBM/DDMS Guidelines, tailing dumps are being managed with all necessary safety and environmental concerned.
- The area of old & new tailing dump 25 ha and built up to 28 M high and 37 Ha and built up to 18.5 Mts in height respectively.
- Catch drains and siltation ponds have been made to arrest silt and sediment flows from dump.
- Garland drains have been made around the dump to detain the runoff during rainfall.
- Retaining wall at the toe of dump and benches to check runoff has been made to arrest the breached silt.
- Waste rock has been placed at toe to prevent erosion and trap solids being washed down the slope.
- Peripheral trench around the tailing dump has been made to divert the agricultural runoff and it avoids mixing of runoff water with seepage water.
- Peripheral Wall has been made by using waste rock around the dump to avoid any breached sand flow to the neighboring lands.
- Regular monitoring of ground water as well as surface water for heavy metals to keep observation on any unforeseen changes.
- Fencing has been made to stop unauthorized entry of people and stray animals.
- Around the dump plantation has been carried out and at the foot wall xerophytes like cactus have been planted at one side. In future it will be covered on other side
- Efforts are being made for vegetation of slope of the dump at one side.

Solid waste management in the colony is being done, which include daily door to door collection of waste, collected waste is then separately segregated & transported in the closed containers using bullock driven bandies. It is then transported to the earmarked Solid waste Disposal Site, suitable care is taken for segregating & handling the waste at site as per the municipal waste Management & Handling Rules 2000 in the specified 2 acre area by maintaining hygienic and in sanitary conditions around it.

Hospital Solid waste Management:

The Bio-Medical Waste generated in the Hospital – 130 beds is to be handled. The solid waste generated is segregated at the source using colour coded bins as per the norms of Bio-Medical Waste Management & Handling Rules, Will be Transported to the handling and disposal site by closed bullock carts, where the solid waste is handled as per the Bio-Medical Waste Management & Handling Rules.

The solid Bio-Medical Waste generated in the Hospital is first segregated and stored in specified color-coded containers, which is then transported to the site in the closed bullock carts, which is then subjected to treatment as per the conditions specified under Bio-Medical Waste (Management & Handling) Rules 1998.

The effluent generated from the hospital is subjected to the process of disinfection by treating it with the hypo chloride solution with suitable residence time.

Deep burial is carried out for the incinerable waste by following the procedure,

1. A pit is dug about 2 meters deep and its half filled with waste, then covered with lime within 50 cm of the surface, before filling the rest of the pit with soil.
2. It is ensured that animals do not have any access to burial sites. Covers of galvanized iron/wire meshes are used.
3. On each occasion, when wastes are added to the pit, a layer of 10 cm of soil is added to cover the wastes.
4. Burial is performed under close and dedicated supervision.
5. The deep burial site is relatively impermeable and no shallow well is there close to the site.
6. The pits are distant from habitation, and sited so as to ensure that no contamination occurs of any surface water or groundwater. The area is not being prone to flooding or erosion.
7. The record of all pits for deep burial is being maintained.

Awareness Programmes:

Awareness programmes are being conducted by the Environment Engineer, for all the Hospital Staff / Doctors / Workers / Nursing students regarding Hospital Solid Waste Management- (Handling, Safety, Collection, Segregation, Storage, Transportation, and Disposal & Treatment) the same is being followed as per the Bio-Medical Waste (Management & Handling) Rules. Installation of Incinerator- 10 kgs/hr is under process, for handling the Solid Bio-Chemical Waste .

Awareness programmes are being conduced by the Environmental Engineer in Schools / College children, regarding the Environment Concepts, Viz., Conservation of natural resources (Water, Energy, Forest, Minerals), Solid waste management, Rain water Harvesting, Afforestation etc.,

Afforestation Programme:

Afforestation is being carried out in the acquired land. The mine seepage water is being pumped regularly and is used for gardening and Afforestation for watering the saplings. The native species has been planted to restore the natural ecosystem. In the core zone, draught resistant plants have been planted. Entire earmarked area will be covered by the phase wise plantation every year.

To protect the dust being carried by wind and get deposited on the nearby areas, to filter this dust, a green belt of 10 m. Width is proposed surrounding the mill/plant area, power house, workshop, assay lab, mine exhaust fans, along the boundary of the tailing dump yards and also along both sides of the public road. This green belt, apart from acting as a dust filter, it as a sound barrier and also act as site screen around the waste dump. For this green belt, four rows of tree species, pits of depths 0.5 m will be dug out, which will initially be filled with a mixture of manures and soils. The space in between the tree saplings will be covered with bush and grass variety of species. Creation of green barrier will be undertaken on priority basis along the northern boundary of the acquired land, adjoining Hutti nallah.

Later, during subsequent years, this green barrier will extend to other areas, along the boundaries of tailing dumps etc. Within the colony areas and near other official buildings, full fledged avenue plantations have already been developed by M/s HGML. Hence, no further major avenue plantations are proposed in this area, except small portion in the south and western portions adjoining the colony area, where vacant land exists. Further, near hospital area, adjoining the public road, a green barrier of 20m width is proposed along the road side, to attenuate the noise level generated by the vehicular traffic.

Conclusions

In pursuit of preventing degradation of environment in and around Hutti, HGM strives to adhere with all the guidelines of relevant statutes for environment protection. Reports of control parameters in comparison with standards reveal the endeavor of the HGML towards bettering the environmental conditions in a very scientific manner. The HGM's journey to better the best environmental practices will continue as a realization of major responsibility towards future.

HGM has initiated and implemented various pollution abatement strategies for conservation of natural resources. The increased emphasis on water recycling has contributed to considerable reduction in fresh water consumption. The Company does not use any ground water source for industrial or domestic use. The potable water supplied by the Company to the city matches all national and international parameters.

The negative impact of mining on health, land, water, air, plants and animals, and other aspects of society are reduced by careful planning and implementation of best pollution abatement practices. The HGM has established lots of profitability besides bringing in cultural, social, and environmental credibility.

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