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WASTE WATER TREATMENT AND MANAGEMENT TECHNIQUES IN MINES

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ABSTRACT

Mining industries enhance comfort of human life on one hand but this also cause pollution to air and water which are essential for survival of life. Therefore, mining and industrial activity adversely affects the ecosystem including wild life population due to deforestation, fragmentation, to habitat, air and water pollution. Eliminating the mining activities is not the solution to this problem. Hence, it is important to find the most suitable and applicable methods to reduce the pollution caused by mining to the maximum extent. This paper presents the brief review of the various methods which can be implemented to treat and manage the waste water given out from the mines.

KEYWORDS:Skimming, Turbidity, pH, Trickling Filters, Reverse Osmosis, Electro-Dilesis.

INTRODUCTION

We have been exploiting natural resources for making life more comfortable, the natural resources are part of eco-system wherein a mutually balanced relationship exists between living creatures and natural forces. Any exploitation of natural resources means changes within the ecosystem which spreads its influence to all organisms. Mining and its activity have wide influence on earth's natural environment. Mining and other activities may have impact on ecological functions (either directly or indirectly) of both the agricultural and forest lands. In case of open cast mining, land surface is completely disturbed, whereas underground mining have limited losses on surface except subsidence. Land use pattern is also disturbed due to cutting of forest and shifting of agricultural activities. As mine water accumulates when the water level overflows the depth of an open pit surface mine or an underground mine, the water must be pumped or drained out of the mine to ensure safety and stability. Depending on the water accessibility and feature, it may be re-used for development applications on site such as framework water, filth containment or refined operations, grinding, leaching, and steam production .Since more than 70% of all pollutants from the mining industry are emitted into water, the removal of these contaminants prior to discharge is receiving significant attention. It is critical to avoid a discharge of toxic components into the environment and subsequently back to the food-chain. For the reason that local emancipation necessities are becoming more stringent, while nonconformity is being penalized more commonly and more closely. Water and waste water curing is thus becoming a most important focus of mine operations, which is varying the landscape of site water management and treatment.

IMPORTANCE OF MINING

Mining has the potential shape and affect economies directly and indirectly. Mining brings service, administration and government revenues, responsibilities and opportunities for economic growth, cost effective and financially viable growth, and diversification. However, market fluctuations, and resource revenues can present challenges in converting natural resources wealth into sustainable economic growth and development.

CAUSES OF WATER POLLUTION DUE TO MINING

- Discharge of mine water containing toxic substances into nearby water body.
- Abundant mill tailings, coal heaps, spoil heaps and other waste overburden dumps in mining areas contains significant amount of minerals which gets dissolved in rain water and becomes a major source of water pollution.
- Groundwater gets contaminated mainly due to leaching and percolation.

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- Overburden dumps spread over the banks of streams and river causes blockages of free flow and contamination of water.
- Carry-off of the fine solid particles from the surface mine sites and coal preparation plants especially during rainy season.
- Mixing of oil, grease and chemicals in water from workshops and HEMM.
- Discharge of water from residential colony.
- Discharge of water effluent from coal washeries. Truck loading, conveyor transfer point and railway wagons loading areas are common sources contributing fine particles from surface run-off.

CHARACTERISTICS OF WASTE WATER

In any waste management application, the first step is the identification of sources of waste water and characterization of the same. The main sources of waste water from a mine site can be broadly classified into;

- Mine water
- Process waste water
- Domestic waste water
- Surface run-off

The most probable contaminants in the waste water produced by a typical mining industry can be broadly classified into 5 categories and are listed in below given table. Out of these 5 categories, biological pollutants essentially from domestic and sanitation facilities within the amenity building and usually they should be connected to urban sewer or a properly designed one site waste disposal system, radiological pollutants are very specific to uranium and related open cut mines. Important to realize that “effective prevention of contamination at sources” is the only solution available for managing radioactive waste water.

Physio-Chemical Properties of Polluted Water:

- pH – pH is a numeric scale used to specify the acidity or alkalinity of water.
- Colour – the colour of the waste water typically depends upon the matter dissolve.
- TDS – Total Dissolved Solid is a measure of the combined content of all inorganic & organic substances contained in a liquid in molecular, ionized or micro-granular.
- TSS – Total Suspended Solid is a water quality parameter use for example to access the quality of waste water after treatment in waste water treatment plant.
- BOD – Biological Oxygen Demand is a standard measure of the amount of O2 needed by micro-organisms to cause bio degradation of organic and in organic pollutants.
- DO – Dissolved Oxygen (DO) analysis measures the amount of gaseous oxygen dissolves in an aqueous solution.
- COD – The amount of O2 needed for oxidizing inorganic pollutants by chemical oxidation. Is known as Chemical Oxygen Demand (COD).

Table 1: Typical contaminants in mine waste water

Main Categories	Sub Categories
Physical	Suspended solids (SS), Turbidity, Color, Temperature, Taste and odor
Chemical	Coal, Oils and grease, Soaps and detergents, Rubber Dyes and phenolic compounds
Chemical (inorganic)	Heavy metals (Cr, Hg, Cu, Cd, Pb, Zn, Ni etc.) Acids Alkalis Cyanide Dissolved salt - Cations: Mg, Ca, K,Na, Fe, Mn etc. - Anions: Cl, SO4, NO3, HCO3, Pb4 etc.
Biological	Bacteria, viruses, and small organisms
Adiological	Uranium, Tritium and other radioactive substances from mine tailings.

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STAGES OF WATER TREATMENT

1. Preliminary treatment
   a. Screening
   b. Skimming
2. Primary treatment
   a. Sedimentation
   b. Neutralisation
   c. Equalisation
3. Secondary treatment
   a. Oxidation Pond
   b. Activated Sludge Process
   c. Trickling Filters
4. Tertiary treatment
   a. Chlorination
   b. Reverse Osmosis
   c. Electro-Dilesis

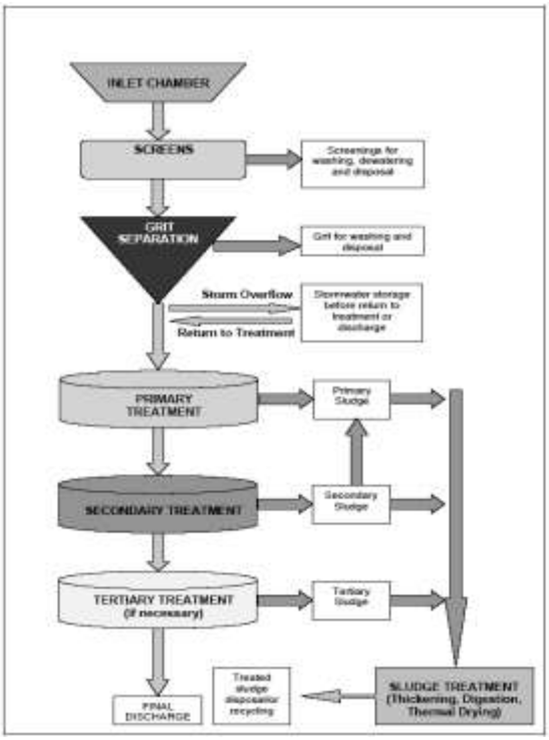

Fig 1: Stages of water treatment

PRELIMINARY TREATMENT

a. Screening

Main objective of this treatment is to remove floating objects such as cloth, wood, plastics bags and other larger objects which includes suspended matter. For this screening is carried out where waste water is allow to pass through screen made of iron bars with spacing of 1 to 2 inches. Spacing is narrow enough to hold back the floating objects in the water.

b. Skimming

Oil, grease and other impurities which are lighter than water rises to the surface and can be removed by mechanical skimming. Skimming tanks (oil & grease trap) is so design that the lighter material like oil and grease remains on top of liquid. For effective removal sometimes compressed air is send through diffuser plate located at the bottom of tank. Fig 2 shows the main treatment steps for oil wastes and waste oil below.

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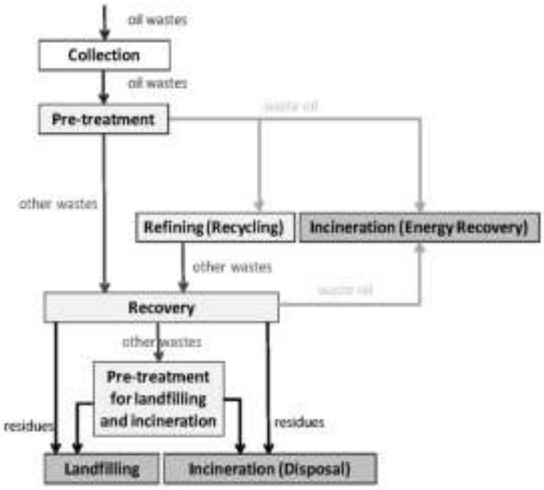

Fig 2: Overview on the main treatment steps for oil wastes and waste oil

PRIMARY TREATMENT

It involves settling of colloidal and suspended matter as sludge. The solid matter which settles down during the primary and secondary stages of water treatment is called sludge. Common method used for settling out of impurities is sedimentation. This is removal of large objects from influent sewage.

Sedimentation

Most of the solids suspended in polluted water are too fine to screen out and too heavy to skim off. However, it can be removed by allowing them to settle down under the influence of gravity. This technique is called as sedimentation. Sedimentation tank is generally shallow and radial shape polluted water is retained in the tank for period of 3 to 4 hours. During this period impurity settles down. Generally depth of sedimentation tank is 3 to 5m & diameter is 30m. The tanks are equipped with mechanical arrangement like scrapper to remove sludge at periodic interval. Primary sedimentation tank removes 60-70% of suspended solids and 20-30% of BOD.

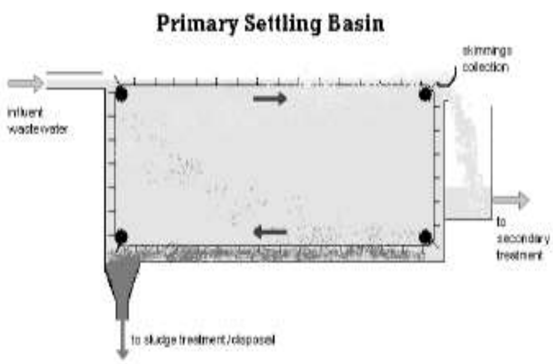

Fig 3: Primary settling basin

Finely divided suspended solids colloidal particles cannot be removed efficiently by simple sedimentation. In such cases sedimentation process is accelerated by mechanical flocculation and chemical coagulation.

Mechanical flocculation:

Here the waste water is passed through a tank with the retention time of 30m.The tank is fitted with paddles rotating at a speed of 0.5m/s. Under this gentle stirring the finely divided suspended solids comes together to form larger particles and settles down easily

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Fig 4: Mechanical Floculator

Chemical Coagulation:

In this process waste water is treated with certain chemicals which are absorbed by suspended & colloidal particles present in water. The chemical coagulants commonly used in industry are hydrated lime, alum, ferric chloride & mixture of ferric sulphide & chloride. Alum is the most popular chemical coagulant use for waste water treatment and coagulation is most effective and economical means for removing impurities.

Neutralization

Highly acidic or alkaline water should be properly neutralized before it is discharge. Acidic water is neutralized by treatment with limestone or caustic soda depending on the type and quantity of waste present in the water. Alkaline water is neutralized by treatment with H_2SO_4.When acidic and alkaline waste water is produced in the same plant then by mixing them in the appropriate proportion neutralization is carried out economically.

Equalization

Mining industries produce different types of waste having different characteristics at different interval of time. Due to this uniform treatment is not possible. In order to solve such type of problems waste water coming from different units are retained in a big holding tank for a specified period of time. In this tank waste water coming from next unit is mixed thoroughly a homogeneous mixture is formed, this mixture is then treated by normal sedimentation process.

SECONDATRY TREATMENT

In this treatment dissolved organic matter present in waste water is removed by biological processes. The biological process involves bacteria & other micro-organism. The secondary treatment removes 70-80% of BOD. This method utilizes biological treatment processes. It removes dissolved colloidal and organic matter from waste water. Microorganisms convert non-settleable solids to settleable solids. Bacteria and protozoa is used in this method frequently. Three approaches are there to accomplish this. Following techniques are adopted for secondary treatment.

Oxidation Pond

It is also called as stabilization pond. It is the simplest biological system available for treatment of waste water. When high quality effluent is not required & large space is available then this technique can be used for domestic and industrial waste water. Ponds are generally constructed of brickwork with relatively small depth embankment are build all around to prevent entry of rain water into the pond.

Normally waste water to be treated is discharge directly into the plant after removing floating material.

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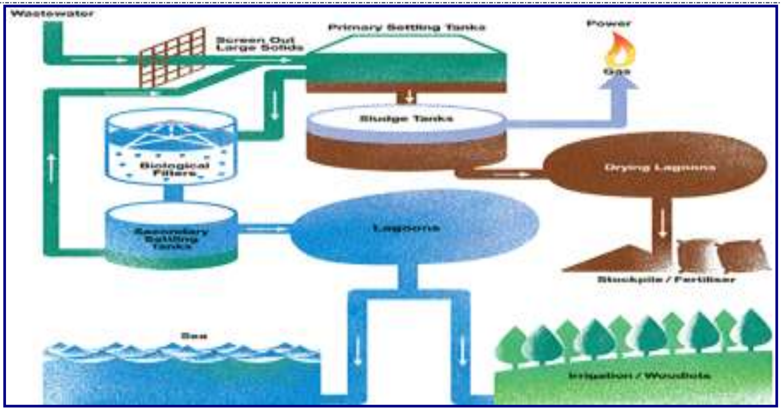

Fig 5: Flow diagram for treatment of waste water, its discharge and sludge utilization

Oxygen is required for decomposition of organic matter present in waste water which is supplied by algae present in the system. This system has low construction & operating cost. It requires minimum operating skills & do not use any mechanical equipment.

Activated Sludge Process

Polluted water from sedimentation tank enters into aeration tank here 20-30% of active sludge is mixed in the water. The mixture is aerated and mixed in the tank for 4-8 hours. The waste water is then taken to secondary sedimentation tank where the degradation & decomposition of all organic matter is carried out by micro-organism & bacteria. Some portion of the active sludge form during the process is circulated into the aeration tank for next cycle of treatment.

Trickling filters (sprinkling filter)

Organic material present in the wastewater is metabolized by the biomass. Organic substance grows in depth as the macrobiotic matter pre-occupied from the flowing waste water is synthesized into new cellular material. The liquid then washes the slime off the medium and a new slime layer starts to grow sloughing. The composed fluid is conceded to a settling tank used for solid- liquid partition.

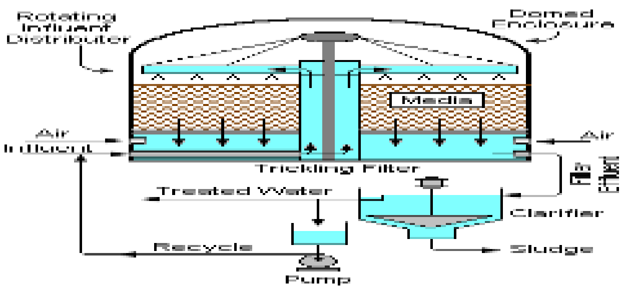

Fig 6: Trickling Filter

It consists of a circular rectangular bed 3-5cm at the top & 10-15cm at the base with a depth of 1-3m.This are provided with brick or concrete walls. The beds are packed with clinker, stone, coal gravels etc. The waste water coming from primary sedimentation tank top when polluted water is passes over the bed, gradually biotic community is established (algae) as a gelatinous layer over the surface of the bed. This layer contains bacteria and other micro-organism. When water trickles down through the layer water comes in contact with micro-organism which breaks the organic impurities into CO_2, nitrate and phosphate. Figure of Trickling Filter is shown in above diagram. This technique is efficient & widely used but it requires adequate time periodfor establishment of biological field (film).

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Rotating Biological Contractor

This consists of a series of closely spaced plastic circular disks. Disks are submerged in wastewater and rotated slowly through it. Organic growths become close to the surfaces of the disks and form a slime layer over the whole wetted surface. The rotation of the disks contacts the biomass in the wastewater, then with the atmosphere for adsorption of oxygen. Biomass utilizes the oxygen & macrobiotic substance for survival thus decreasing the BOD in the wastewater.

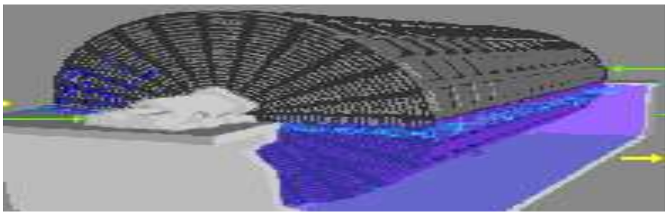

Fig 7: Rotating Biological Contractor

TERTIARY TREATMENT

This treatment is used for removal of inorganic impurities at molecular level. Depend upon the nature of pollution on or more technique may be used. Following techniques are used for removal of impurities that remains even after 3 stages of purification.

a. Chlorination

Gaseous chlorine or compound containing active chlorine such as bleaching powder or sodium hypochlorite (NaOCl) is added to water. This compound generates hypo-chlorous acid which acts as a purifying agent. Chlorination purifies water in 2 ways:-It disinfects water from pathogenic bacteria. It or controls the growth of undesirable algae in water.

b. Coagulation sedimentation

Chemical coagulation sedimentation is used to increase the removal of solids from effluent after primary and secondary treatment. Solids heavier than water settle out of wastewater by gravity. With the accumulation of definite chemicals, solid masses can happen to be heavier than water and will straighten out. Alum, lime, or iron salts are chemicals added to the wastewater to remove phosphorus. With the chemicals, the smaller particles clump or 'floc' together into large masses. The larger masses of particles will settle out in the sedimentation tank reducing the concentration of phosphorus by more than 95%.

c. Adsorption

A physical process that is typically applied as tertiary treatment to remove low concentrations of contaminants from water that is difficult to remove by other means. Activated carbon has been processed to make it extremely porous; thereby creating a very large surface area available for adsorption of contaminants Activated carbon may have a surface area as great as 1500 m^2/g (7.3 million ft^2/lb).

d. Reverse Osmosis

Osmosis refers to a process where pure water flows into a concentrated solution through a semi-permeable membrane. In this technique impure water containing dissolved salt is placed above a semi-permeable membrane & subjected to high pressure. If the pressure is increased beyond value of osmotic pressure, water starts flowing in the reverse direction. Hence this process is called Reverse Osmosis. The pure water flows down through the membrane and molecules in salt is retained by the membrane.

e. Electro-dialysis

This technique is used to purify water containing concentration of ionic impurities. Electro dialysis cell used for this process is divided into 3 compartments using 2 semi-permeable membranes. It is situated near the cathode is coated with negatively charged ions. Therefore, this membrane repeals the ions present in impure water but allows anions present in impure water to pass through it. When current is passed cations get deposited in cathode & anions on anode and central compartment carries water which is free from ionic impurities. A brief detail of step taken for treatment of waste water is shown in below fig.8.

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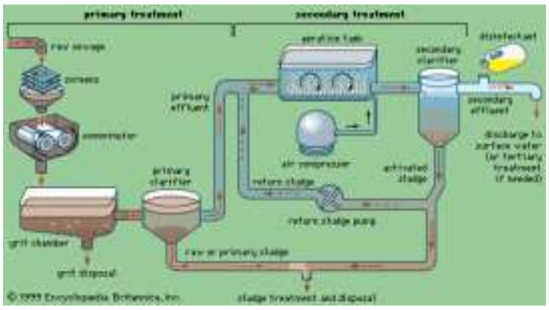

Fig 8: Steps of treatment of waste water

TREATMENT TECHNUQUE IN MINES

Water gets polluted due to mining activity hence for controlling water pollution following treatment techniques are adopted at mine which includes:

a) Treatment plant for mine discharge water
b) Treatment plant effluent for workshop
c) Treatment plant for discharge of domestic sewage

The pollutant water coming from mine is categorized into three classes.

1. *Mine Effluent*

Mining activity are carried out below ground and subside water encounter is to be pumped out for facility this activity. This is the major effluent involved in the mining operation. Therefore to arrest suspended solids sedimentation tank are constructed and sediments are allow to settle before being discharge.

2. *Workshop Effluent*

In big opencast mine workshop are constructed maintenance. Example HEMM, major activity in workshop is washing and maintaining of vehicles. The effluent generated in workshop is treated in effluent treatment plant. Which consist of pre-sedimentation tank, oil and grease trap, flash mixture, Clarifloculator, clear water tank, etc.

3. *Domestic Effluent*

The life of coal mines is limited in the range of 10 years to 30-40 years. Duly constructed residential colonies have been provided in major mines. Most of these mines have Domestic Effluent Treatment Plants, which ensures effluent quality within norms.

Monitoring of effluent water is continuously done as per CPCB guidelines and stipulations. In coal projects it is very rare that any parameter exceeds the permissible limit. In fact, most parameters are below detectable limits. TSS in rainy season poses some difficulty and sometimes goes beyond limits.

WETP (WORKSHOP EFFLUENT TREATMENT PLANT)

In big, Opencast mines, workshops are constructed for maintenance of heavy earth moving machineries. A major activity in the workshop is washing of the vehicles. Figure 9 gives the camera image of the WETP of Durgapur OCM (Chandrapur,(Mah.),WCL). The effluent generated in the workshop are treated in Effluent Treatment Plant which comprise of Pre-sedimentation tanks, Oils & Grease traps, flash mixer, Clarifloculator, clear water tank etc.

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Fig 9: Front View of W.E.T.P (Durgapur OC, Chandrapur Area)

Figure 10 shows the flow diagram of WETP. Western Coalfield Ltd. has achieved great success in curtailing the waste water from workshop to treat it and re-use it for various purposes. Industrial water demand is by 100% re-circulation of effluent water. There is no effluent discharge in such plant. The capacities of these plants are from 150 to 200 KLD.

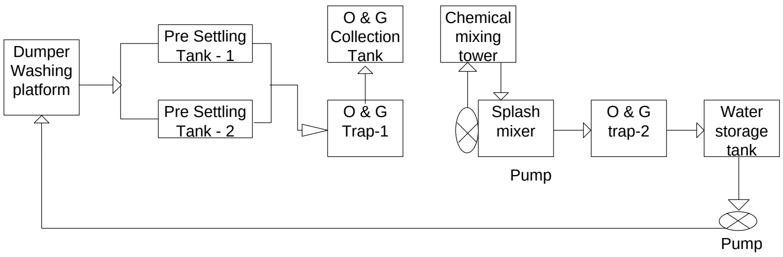

Fig 10: Flow diagram of Workshop Effluent Treatment Plant

The following table 2 from WETP of Durgapur OCM (Chandrapur Area, WCL) gives the data of the total oil and grease recovered in liters and the sludge recovered in cubic meters for every month of the year 2015.This recovered material is then sent for further processing in the third party recovery plants. Table 3 gives the list of almost all WETP's in open cast mines of WCL.

Table 2: Details of work done in W.E.T.P of Durgapur OCM, Chandrapur Area (WCL)

MONTHLY RECOVERY OF USED OIL, GREASE & SLUDGE AT E.T.P. OF DOC SA
(AN ISO-9001-2008 & 14001 2004 Certified Unit)

SN	MONTH		USED OIL GREASE RECOVERED IN LITRES	SLUDGE RECOVERED CUM
1	APRIL	2015	14	3·46
2	MAY	—"—	13	3·45
3	JUN	—"—	14	3·43
4	JULY	—"—	14	3·50
5	AUG	—"—	13	3·56
6	SEP	—"—	14	3·52
7	OCT	—"—	13	3.68
8	NOV	—"—		
9	DEC	—"—		
10	JAN	2015	14	3·32
11	FEB	2015	13	3·35
12	MAR	—"—	16	3·38

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Table 3: List of Work Shop Effluent Treatment Plant

Sr. No.	Location of WETP in WCL Subsidiary
1.	Central workshop
2.	Sasti OC
3.	Gouri I OC
4.	Gouri II OC
5.	Hindustan Lalpeth OC
6.	Durgapur OC
7.	Padmapur OC
8.	Bhattadi OC
9.	Niljai II OC
10.	Ukni OC
11.	Kolar pimpri OC
12.	Pimpalgaon OC
13.	Junad OC
14.	New majri OC
15.	Chargaon OC
16.	Goundegan OC
17.	Padmapur OC

DETP (DOMESTIC EFFLUENT TREATMENT PLANT)

The untreated discharge led to the serious environmental water pollution both to surface water and underground water table. The treatment is made through continuous aeration process on the principle of stabilizing decomposable organic matter in the sewage so as to produce effluent and sludge. The plant is designed for 0.5 million litre per day capacity of sewage input having biochemical oxygen demand (BOD) of 225 mg/litre and total suspended solids (TSS) of 300 mg/litre which after processing is reduced to 20 mg/litre & 30 mg/litre respectively. Figure 11 shows the basic flow diagram of Domestic Effluent treatment Plant. Figure 12 shows the camera image of Domestic Effluent Treatment Plant of Durgapur Opencast Mine, Chandrapur Area (WCL).

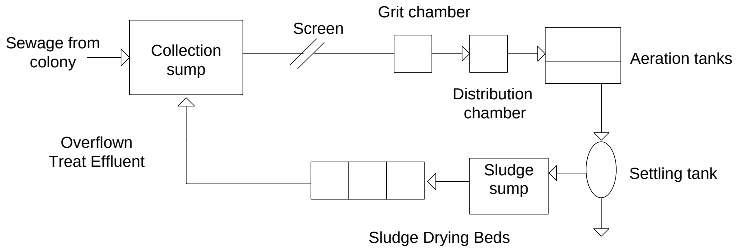

Fig 11: Flow Diagram of Domestic Effluent Treatment Plant

Fig 12: Photo Image of Domestic Effluent Treatment Plant of Durgapur Opencast Mine, Chandrapur Area

WATER MANAGEMENT IN MINING PROCESSES

In the majority of cases, mining processes affect water and, consequently, cause high impacts and influences on the environment. Not only hydro-geological impacts on ground and surface water in mining areas and river catchments or geotechnical and morphological disturbances such as Tailings Storage Facilities TSF) are to be reflected on here, but also Waste Rock and Rock and Waste Dumps, with all their known consequences, such as geo-stability, erosion, dust on environmental compartments and a wide range of socio-economic questions.

In order to cope with all potential impacts and influences, it is necessary to know as much as possible about them and their dependencies. In this context, the Integrated Water Management in mining is concerned with the interplay between politics, economy and society, regarding the various aspects of water use, influenced by mining processes. Figure 13 gives the idea for management of water in mines. Optimal strategies are always site-specific and must take aspects, such as geology, topography, hydrology, mining method and cost effectiveness.

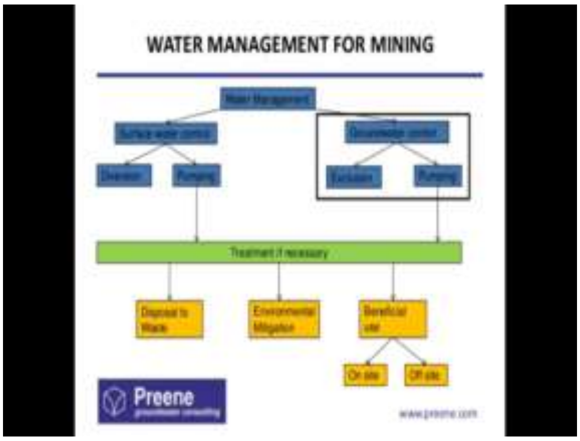

Fig 13: Water Management for Mining

Amongst others, the objectives of water management comprise:
• Prediction of short- and long-term effects
• Better understanding of geologic and hydro-geologic conditions
• Determination of an optimal design for water draw-down
• Control of on-going water drainage (esp. regarding AMD)
• Treatment of process water and other waste water
• Achievement of a specified water quality at every time
• Reduction of the impacts on ground water
• Minimization of long-term impacts on the environment surrounding the site.

For the optimization of water management and as a foundation for decision support analysis, numerical site models are appropriate. Modeling often plays a primary role in the investigations required to predict potential long-term impacts on the environment. A model could be the fundamental basis for any further qualitative assessments and decisions, both in functional-scientific and political fields. During the implementation of the investigations, several complex scientific- technological, social and economical tasks had to be taken into consideration. These include activities, such as:
• Identification and assessment of pollution sources (mining, agriculture, sewage discharges)
• Evaluation of appropriate models for optimal management of water resources
• Identification of water flows and flood plains
• Set-up of one or more hydrological and mass transport models
• Simulation and prognosis of future developments of water quantities and water chemistry
• Selection and testing of appropriate models for optimized management of water resources
• Definition and assignment of responsibilities
• Development of laws and regulations.

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INTEGRATED WATER MANAGEMENT TECHNIQUE

The concept of Integrated Water Management comprises the practice of making decisions and taking actions while considering multiple viewpoints of how water should be managed. These decisions and actions relate to situations, such as river basin planning, organization of task forces, planning of new capital facilities, controlling reservoir releases, regulating floodplains and developing new laws and regulations. The need for multiple viewpoints is caused by the competition for water and by complex institutional constraints. Mining activities cause high impacts on the environment and, in this context, on the water in the mining area.

Morphological (e.g. tailings, waste and rock dumps) and hydro geological impacts on ground and surface water are of particular importance and must be managed to meet water quality standards and water quantity needs. In order to consider all viewpoints from water management agencies, government and non-government stakeholder groups in different geographic regions, as well as with regard to the different knowledge disciplines they represent, all stakeholder groups need to be involved in the Integrated Water Management planning process.

Fig 14: Integrated Water Management for Mines

There are three main aspects to be investigated:
• Quality and quantity of ground and surface water
• Interactions of water with land and environment
• Inter-relationships between water and social and economic development.
Water, which is discharged from the mine, is collected in a small pond as shown in figure 15. Adopting the Integrated Water Management approach requires a constant discussion of all aspects mentioned above, with all stakeholders concerned and at each step in the mine cycle.


Fig 15: Mine Water Discharge Collected in the Small Pond

Water management

Amec Foster Wheeler has comprehensive expertise in mine water management. This consist the study of groundwater, surface water, mine water and acid rock drainage (ARD) formed by mine wastes. We collect key site-specific data from mines, and integrate and analyze those data using state-of-the-art modeling techniques such as Gold SimTM and the depth of experience of our world-class experts to develop cost-effective mine water management and treatment solutions. Lucrative solutions frequently entail smart mine waste handling and water management techniques, such as isolation of mine wastes, separation of contact water from non-contact water, water recycling, seasonal storage, and conjunctive use of surface water and groundwater provisions. Amec Foster Wheeler's strength is to integrate these disciplines to develop optimal water management strategies.

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Groundwater

Understanding the hydro geological conditions at mines sites is essential to minimizing the impact on groundwater and to developing practical and cost-effective management and mittigate solutions. Our hydro geologists and hydro geochemists are very experienced in conducting groundwater investigations at mine sites in support of developing water and waste management plans. We have expertise in the study of groundwater-surface water interactions, groundwater movement, contaminant hydrology, and vadose zone hydrology. When required we employ a variety of groundwater modeling techniques, from simple lumped parameter spreadsheet models to advanced 3D flow and transport models. These models are applied to address key water issues.

Surface water

Effective surface water management is critical for the successful operation of a mine. Amec Foster Wheeler has decades of practice in surface water investigation and administration for mining projects. Our expertise is wide and varied, from baseline studies and basin scale modeling for Environmental Impact Assessment (EIAs), to the development of complex site-wide water balances for operating mines, storm water management plans, to the design and construction supervision of drainage, diversion and storage facilities.

Mine waste geochemistry

Estimating the possible outcomes of future water quality at mine sites is a critical component of mine water management. Our experts use a variety of geochemical techniques (e.g. mineralogy, acid-base accounting, total and leachable metals analysis, laboratory and field kinetic testing), an in-depth understanding of the geology and environmental conditions at a site coupled with advanced software applications and predictive methodologies to estimate the future behavior of mine wastes and what impacts these materials will have on site water quality.

Integrated water resources simulation

To support mine water management, as well as our plant designs, we use dynamic simulation tools (such as GoldSimTM) and other leading edge software to build water balances and water quality models. Our use of advanced modeling and our knowledge of treatment technologies result in cost-effective solutions that meet challenging regulatory requirements. Figure 16 shows the flow diagram for Integrated Water Management Simulation.

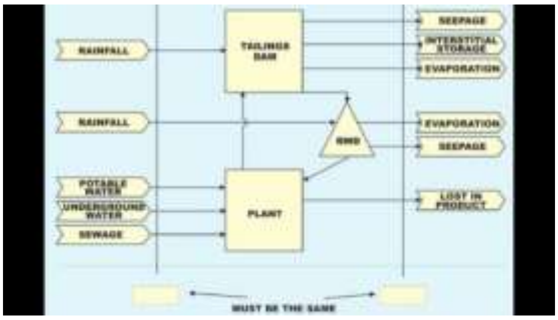

Fig 16: Flow Diagram for Integrated Water Management Simulation

CONCLUSION

Water is no more a cheap commodity. Mining for coal has disturbed the general water regime leading to water scarcity. While the industry is discharging social obligation by providing economical flooring stone for everyone, poor or rich, yet it cannot turn its face from adopting various techniques for effective restoration of water regime. Soil conservation, dense afforestation in the mining area, better mining techniques, differed pumping from open pit has helped in reducing the water scarcity.

The basic objective is to arouse the interest of mining society to verify the claim of waste water treatment and management, tried in the industrial area where water treatment plants have been installed but they hardly function properly due to lack of regular maintenance.

The coal mines of Chandrapur Area and Majri Area (WCL), Maharashtra were visited to study the water treatment techniques for the mine water discharge of their respective mines to use it for drinking and domestic purposes.

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On the basis of field and laboratory observations it is concluded that due consideration should be given to geochemical nature of coal associated rocks with water bearing strata, while preparing the acid mine drainage management action plan .

It would be desirable to have reassessment of the impact of different pollutants in the water body of the coal field.

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