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Review Article

Technological Overviews in Water/Waste Water System

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ABSTRACT

The paper deals with the energy efficient technologies along with simple case studies for the treatment of wastewater. The wastewater management Practices in mining industries across the world using cost-effective technologies are dealt with a simplistic approach. The significant efforts of the government to reduce the surface water pollution can be compiled with the technologies. Some of these have a wide range of climatic tolerance like the microbial mat reactors, anoxic limestone drains and so on. ALDs or the Anoxic Limestone Drains are passive treatment systems that can be an effective technology in treating acidity of Mine Influenced Water (MIW) under specific geochemical conditions.

Keywords: Water pollution; Anoxic limestone drains; Phytotechnologies

INTRODUCTION

With the rising demand for land due to an increasing population, the need for food and water for survival are the challenges that need to be addressed. The proper treatment of the water/waste water to make it eligible for consumption is the need of the hour. The technologies like Anoxic Limestone Drains (ALDs), Microbial mat reactors, Phytotechnologies, Passivation technology, Pressure-Driven Membrane System (PDMS) are some of the few cost-effective technologies considering the environmental concerns. The steps towards establishing water supply 24/7 for all would require the use of some of the technologies that are accessible to both urban and rural areas. The application of these technologies are found in different mining industries across the world. The mine-impacted water if discharged without treatment can create havocs because the water, both surface and ground waters are essential components of our existence. The dissolved metals like arsenic, fluorides in water if consumed in excess can introduce dental fluorosis, crippling, discolouration and so on. It is important to identify the sources of water pollution. The technologies discussed below have certain advantages and limitations too. It is necessary to understand their implications. Some of them being driven by solar power prove to be environment friendly [1].

LITERATURE REVIEW

Anoxic limestone drainage

It consists of a trench containing limestone surrounded by a plastic membrane. It is capped by a layer of clay or compacted soil to maintain anoxic conditions. It is further overlain by a vegetation to prevent erosion of the soil. It is essential to maintain the anoxic conditions to avoid the clogging of pore spaces of limestone. ALDs can be used to treat the metals in mine-influenced water by precipitating in the ALDs. It can be used to keep a check on the MIW flow rates alone or by other treatment systems. The presence of limestone leads to release of carbon dioxide (CO_2) which is to be retained and it helps in increasing the Ph. The discharge should remain in an anoxic state prior to its entry into the ALDs and this condition is achieved by constructing it directly on top of the discharge, allowing the acidic water to flow through the limestone, adding calcium carbonate to the water and increasing the alkalinity and pH while maintaining anoxic conditions. Field tests indicate that the highest rates of limestone dissolution occur during the first 15 hours of contact with the MIW. Therefore, ALDs systems are commonly sized to allow for a minimum 15-hour detention time throughout the life of the system [2].

It can be implemented in remote areas because of its passive nature. It is cost-effective, has got a limited visual impact and has a wide range of climatic tolerance.

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Longevity of treatment is a concern. This is because if the influent water has enormous Fe^{3+}, Al^{3+}, it would lead to clogging of the limestone thereby, reducing the effectiveness of the treatment. Watzlaf, Schroeder, and Kairies suggest the ideal influent water quality for an ALDs is net acidic water with a pH above 5.0. At this pH level, ferrous iron, manganese, and low levels of ferric iron and aluminum remain soluble, preventing precipitation of metals into the voids of the limestone and ensuring effectiveness and permeability of the ALDs. If there are elevated levels of ferric iron and aluminum in the AMD, other treatment technologies should be considered. Local availability of limestone and mobilization costs might be looked upon [3].

Phytotechnology

It is completely solar-driven and therefore, environment friendly. This technology revolves around phytostabilzation, phytoextraction, phytovolatilization and phytodegradation. In Phytostabilization, a vegetation cover is provided over the heavily contaminated portion to prevent it from being eroded by wind or any other agents. The plants used for this have extensive root system and possess tolerance to contaminants. In phytoextraction, the contaminants are extracted from the soil which is stored in their tissues and at the end of the complete growth, the plants are segregated and sometimes they are dried and incinerated or even dumped. The heat from the incineration is used to generate energy. In hytovolatilization, the soluble contaminants stored are transported to ground tissues where they are volatilized in the presence of atmosphere. In phytodegradation, the aquatic or soil microorganisms play an important role as they carry out the degradation by breakdown the organic pollutants [4].

It is useful for treatment of domestic wastewater where sewage treatment plant is not readily available. It is used in treating the industrial wastewater containing biodegradable organics. It is a cost-effective technology as it is powered by the solar radiation. It lowers labour and reduces operational costs. The table below gives an idea about the associated expenses of the technology.

The availability of land is a requirement. This technology is affected by phytotoxicity as plants have particular tolerance levels to the contaminants. Pollutant removal is time-consuming as it depends on the growth of plants. Plants involved in this technology need to be maintained and harvested at regular intervals (Figure 1) [5].

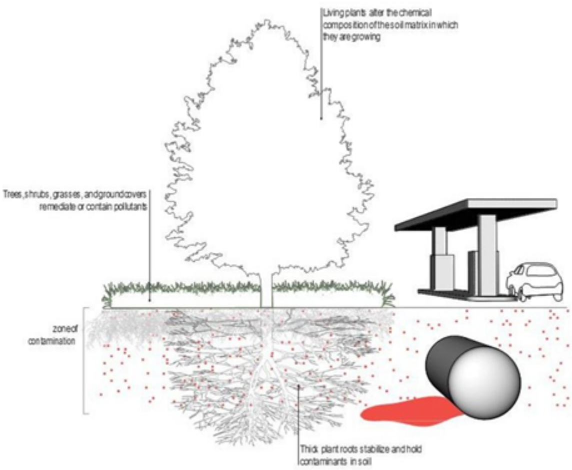

Figure 1: Schematic image for the functions involv ed in the process of phytotechnology.

Microbial mat reactor

It has been developed at Fort Hood in Texas as a type of bioreactor and field-tested for the removal of organic contaminants and metals. It consists of a 2 m × 1 m × 1 m box with five removable shelves and was built for approximately $3,000. The microbial mat bioreactor is operated at a rate of 2 gpm. The cyanobacteria are grown on fiber mats that fit onto each of the shelves. A pump is used to transfer the contaminated water into the top of the reactor. The water flows by gravity through each of the layers of microbial mat, the contaminants are removed, and clean water flows through an outlet at the base. This type of system can run for many years with minimal weekly maintenance [6].

Since this technology involves the use of microbial mat, it is an environment friendly technology.

It is usually effective for low ph (<2) and not effective for high concentrations of Fe, Mn, Al and may require pre-treatment to remove Fe. Suspended solids in the wastewater need to be removed prior to treatment. Suspended solids in the wastewater need to be removed prior to treatment.

Passivation technologies

Surface passivation of a surface is analogous to that of galvanising a nail. The mine waste containing sulphides need to be treated so that it can be isolated from oxidising agents like Fe^{3+}, O_2 etc. For this, the sulphidic layer needs to be passivated and it is usually done by various chemicals like silica, phosphate, permanganate that act as a protective layer or coating. When a sulphidic layer comes in contact with the oxidising agents, Fe^{3+} is released and in the presence of the coating of phosphate, Fe^{3+} ions are scavenged and ferric phosphate layer is precipitated. The presences of passivated surfaces block the transport of oxidants to the sulfidic surface and consumes Fe^{3+} so that it does not behave as an oxidant (Figure 2) [7].

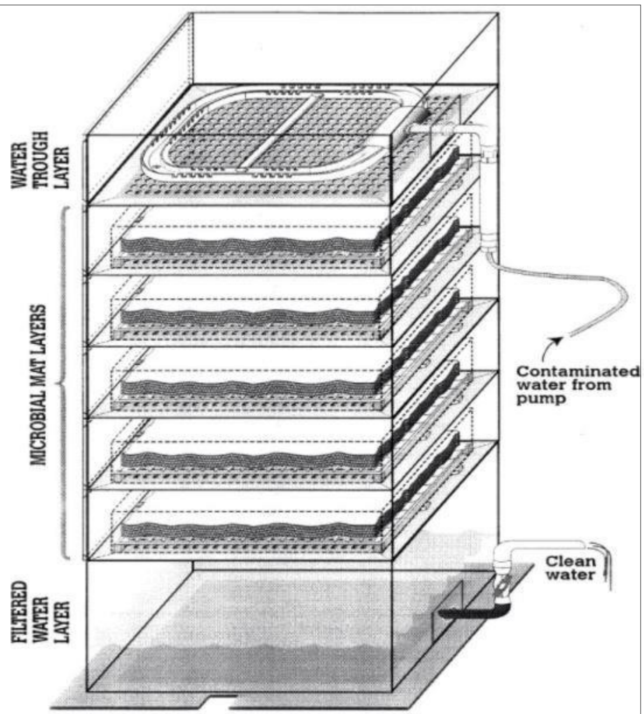

Figure 2: The Schematic view of flow -thr ough microbiamat plate and shelf bioreactor.

Since the chemicals are used as a solution or slurry, it can be applied to treat the solid mine waste and also at inaccessible places such as pit walls. The reaction can be stopped at the source and are potential enough to provide long-term source control.

It cannot be applied on all materials as the technique is restricted to the application of chemicals with water, the reactions and subsequent effectiveness is limited to the surfaces that can be contacted. This makes treatment difficult at depth and for large stock-piles as the flow paths of the mine waste would be tortuous. Treatment lifeline is not known.

Pressure-driven membrane separation technologies

A membrane is essentially a thin barrier that permits selective mass transport of solutes and solvents across the barrier. Different membrane compositions, configurations, and characteristics are available, enabling these processes to be used at various sites. The rate of transfer of solutes or solvents across a membrane is controlled by a "driving force," and the rate of solute rejection is controlled by the size and shape of the solute molecules. There are different PDMS processes like Reverse Osmosis (RO), Nano Filtration (NF), Ultra Filtration (UF) and Micro Filtration (MF) viable for the treatment of mine-influenced water. The primary selection criteria for determining which process to implement should center on the treatment goal [8].

"RO membranes are tightest membranes in liquid separation". This process is used to remove ionic solutes, metals, and macromolecules from feed solution and is best known from the desalination industry but has other applications such as the treatment of industrial waste water, mine water, and mill effluents. With the development of a new generation of membranes, such as thin-film composite membranes, which are capable of tolerating wide Ph ranges, higher temperatures, and harsh chemicals such as oxidisers, the application of RO has become more widespread. Water is effectively the only material that passes through RO membranes. All dissolved and suspended solutes, organic and inorganic, are rejected. Rejection of the solutes is affected by the size and shape of the solutes, the ionic charge of the solutes, and the membrane composition and characteristics. In combination with an NF process, RO can cause selective solute separation based on charge, molecular weight, and size characteristics. Combined with other separation technologies such as UF, evaporation, and distillation, treatment hybrids can result in highly effective and selective separation process.

As noted by Williams and as included in the Kennecott Bingham Canyon case study, ideal properties of RO membranes include resistance to chemical and microbial agents, provides structural stability over long operating periods and appropriate separation selectivity for the feed solution.

PDMS processes may involve higher capital and costs than to other water treatment technologies, depending on the size of the treatment unit, the volume of feed solution to be addressed and the clean-up goals. PDMS processes have been demonstrated as a viable option for treating MIW, but economic limitations have slowed their widespread use in the mining industry [9].

CONCLUSION

The RO has widespread applications. One of them has been discussed in the form of a case study was conducted by World Vision water.

Reverse osmosis for water purification In badghis province, afghanistan

According to the 2017 WV AIP survey, Badghis Province ranks 31st out of 32 provinces for child wellbeing. Only 19% of households in Ab Kamari district are using an improved drinking water source. The diarrhea rate of children under 5 in Ab Kamari district is 66% (2017 WV AIP Baseline Survey). Groundwater TDS level is 2422 mg/L (almost 2.5 times the WHO maximum threshold of <=1000 mg/L). Groundwater fluoride level is 3.5 mg/L (more than double the WHO maximum threshold of 1.5 mg/L). On average, it took families 2.4 hours to collect water every day. The fluoride level is particularly concerning due to the negative health impacts of prolonged fluoride consumption as it can lead to tooth discolouration if fluoride levels in excess of 2mg/L. Consumption of drinking water with fluoride levels in excess of 4mg/L can lead to crippling fluorosis. The groundwater in Ab Kamari is not fit for human consumption according to WHO and Afghanistan National Drinking Water standards.

Installation of RO system

The RO system is powered by solar energy which is an environment friendly approach. World Vision (WV) sited the RO system where there is a known abundance of groundwater, regular aquifer recharge, and where demand for water is unlikely to outstrip supply. WV also plans to conduct Farmer Managed Natural Regeneration (FMNR) to support groundwater recharge. The private sector access has opened new opportunities for the locals because of the relationship that WV has set up between Kaihan Sanaat and the communities in Ab Kamari.

Learnings

RO system can be installed in remote places. The environment friendly approach is the need of the hour and solar driven methodology in RO system is cost-effective. The groundwater aquifers should be handled with caution and care must be taken to avoid any contamination. Areas with abundance of groundwater can be used to site the RO system. Collaboration with companies willing to invest for the installation of RO units should be encouraged as it would prove to be mutually beneficial for the local communities and the company.

Golden sunlight mine

According to the sources as cited by ITRC, Golden Sunlight Mine is an open-pit gold mine located near Whitehall in Jefferson County, Montana. It is a currently active mine with sulphide-bearing minerals in the pit and waste rock resulting in mining-impacted water. The surface water, groundwater and soils were affected. Primary contaminants include acid mine water, Al, As, Cd, Co, Cu, Fe, Pb, Mn, Ni, sulfate, and Zn.

Technology adopted

The Golden Sunlight Mine, owned by Placer Dome Corporation, contracted with UNR to test the technology on pit wall surfaces. This mine contains rock that is very acid-generating. Passivation using potassium permanganate was used on freshly mined surfaces and it proved to be helpful for over a period of 8 months but it could not be continued because of safety issues.

REFERENCES

1. Bender J, Duff MC, Phillips P, Hill M. Bioremediation and Bioreduction of Dissolved U(VI) by Microbial Mat Consortium Supported on Silica Gel Particles. Environ Sci Technol. 2000.
2. Fresenius W, Schneider W, Böhnke B, Poeppinghaus K. Waste water technology. Origin, collection, treatment and analysis of waste water. Springer Verlag. 1989.
3. Vliet BJV. Sustainable innovation in network-bound systems: Implications for the consumption of water, waste water and electricity services. J Environ Pol Plann. 2012; 14(3):1-16.
4. Rump HH. Laboratory manual for the examination of water, waste water and soil. J Chem Educ. 1993.
5. Panguluri S, Nelson TD. Wyman RP. Creating a cyber-security culture for your water/waste water utility. Cyber-Physical Security. 2017;133-159.
6. Siregar B, Menen K, Efendi S, Andayani U, Fahmi F. Monitoring quality standard of waste water using wireless sensor network technology for smart environment. Int Conference ICT Smart Soc (ICISS). 2017.
7. Bhargava A. Physico-chemical waste water treatment technologies: An overview. Int J Sci Res Educ. 2016.
8. Jabna KK, Meera V. Nanosilver As Antimicrobial Agent in Treatment of Water/Waste Water. Int J Conference Innovative Res Sci Technol Manag. 2017.
9. Mostafa M. Waste water treatment in textile Industries-the concept and current removal technologies. J Biodiversity Environ Sci. 2015;7(1):501-25.