International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-3, Special Issue-1, April-2015
Fifth National Conference on Innovative Practice in Construction Waste Management (IPCWM'15) On 8th & 9th April, 2015
Organized by Department of CIVIL Engineering, Sri Ramakrishna Institute of Technology, Coimbatore, India

Retrieval of Ecological Damage with Zero Liquid Discharge System in Ground Water

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ABSTRACT
Groundwater makes up to 20% of the world's fresh water supply which is about 0.61% of entire world's water. The demand for fresh water is increased by 64 million cubic meter cube per year. Some of the industries release their effluents either on the open land or in surrounding surface water bodies contaminating the soil, surface water and ultimately groundwater. Hence, the nature of the surface and subsurface water is highly polluted. This paper focuses on the retrieval of ecosystem in tannery clustered areas at Vellore after the implementation of Zero Liquid discharge system. Zero liquid discharge system is a newly developed concept which aims to lower the effect of contaminants in the ground. The main aim of the work is to give a comparative report on the groundwater quality on the tannery area before and after implementing the zero liquid discharge units.

Key words
Contaminants, Zero liquid discharge, groundwater, tannery, ecology.

1. INTRODUCTION
Vellore District has a tropical climate. The temperatures ranged between 20°C to 35°C. The district receives rainfall from both, the Southwest and Northeast monsoons. The average annual rainfall is about 971 mm. Geologically, the district is covered by crystalline rocks of Archaean age comprising of charnokites, granites, genesis, quartersites etc. Alluvium occurring in the district is of fluviatile origin and restricted to the course of rivers and major streams. The alluvium consists of gravel, fine, coarse sand clay. Groundwater occurs under water table conditions in the weathered and jointed rocks of the crystalline basement. Water levels range between 2 to 29 m in crystalline rocks and 2 to 8 m cartulary deposits depending on topography. The groundwater extraction points are mostly in the form of open dug-wells of diameters ranging between 6m to 10m, these wells vary in yields. There are several groundwater extraction points in the river Palar bed in the form of infiltration wells and galleries and water from these structures is supplied to the major regions located along the river course including a few industries too. In some of the areas bore wells supply water for drinking and industrial use. The Palar river and tributaries are seasonal rivers. Water flows only during the rainy seasons while throughout the year there is barely any flow, the district, therefore, relies mostly on rain water and groundwater.

2. STUDY AREA
The District has a total geographical area of 5887 sq. km. It lies between latitudes 12o 15' North and 13 o 15' north and longitudes 78o 200 East and 79 o 55' East. The Western part of the district has a hilly terrain with undulating topography comprising of a few hill ranges. It is one of the biggest exporting centers of tanned leather in India and discharging their effluents on the open land and surrounding water bodies (Govil *et al.* 2004). While eastern part is a gently undulating with isolated hillocks of which the highest elevation was 1339 m above sea level. Fourteen groundwater-monitoring stations were selected in Vellore District. The monitoring stations were selected in the industrial estate, residential area, (domestic), Agriculture Area (agriculture use). The details of the network are shown in the Table 32. The monitoring stations were selected in Ranipet, and areas around it. Ranipet (Ranipettai in Tamil) is a locality and part of Vellore city. It is a medium-sized community located about 26 kilometers from the Vellore city centre and 100 kilometers from Chennai, the fourth largest urban area in India. It is a main junction in the Chennai-Bangalore highway. However, the city has been a victim of serious groundwater pollution by heavy metals and is considered as one among the most toxic places on earth. The locality is situated on the eastern end of Vellore city, on the northern bank of the Palar river.

3. ZERO LIQUID DISCHARGE SYSTEM
The principle of **"zero discharge"** is recycling of all industrial wastewater. A ZLD system involves a range of advanced wastewater treatment technologies to recycle, recover and reuse of the treated 'wastewater and there by ensuring there is no discharge of wastewater to the environment. This means that wastewater will be treated and used again in the process. Because of the water reuse wastewater will not be released on the sewer system or surface water. The ZLD system combines a number of waste water treatment technologies, including sanitary collection, biological water treatment, microfiltration membrane softening, RO water recycling and evaporation ponds. The unique feature of ZLD treatment process is to concentrate the liquid as much as possible via membrane technology before evaporation. Hence higher recovery before evaporation and lower operation cost of evaporation. Hence

specially designed structure of vibrating membrane module which amplifies shearing force on membrane surfaces and increases fluid passage, thus achieving super high concentration before liquid is discharged to evaporation pond. The systems available of treating industrial effluent are based on Physico-chemical and biological principles. The operation of effluent treatment plants requires technical skill and regular attention so to achieve compliance to standards for 24 hrs x 365 days. Zero Liquid discharge refers to installation of facilities and system which will enable industrial effluent for absolute recycling of permeate and converting solute (dissolved organic and in-organic compounds/salts) into residue in the solid form by adopting method of concentration and thermal evaporation.

ZLD will be recognized and certified based on two broad parameters that is, water consumption versus waste water re-used or recycled (permeate) and corresponding solids recovered (percent total dissolved / suspended solids in effluents).

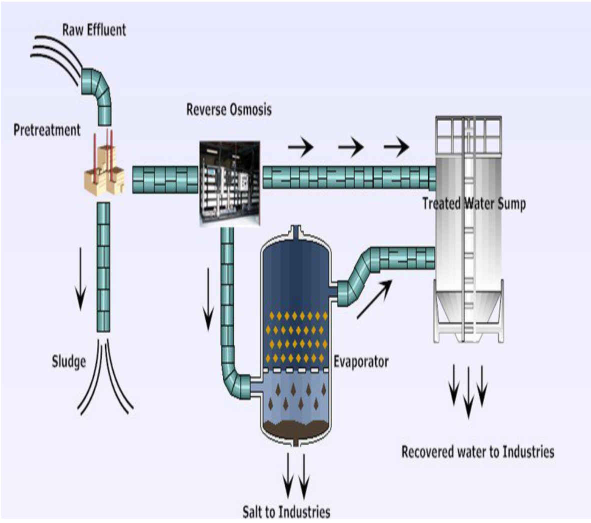

Fig 1: ZLD system

ZLD can be achieved by adopting conventional primary, secondary and tertiary effluent treatment and polishing by filtration and using clean water back into process / or domestic use. In some case, Reverse Osmosis, Micro/Nano Filtration and concentrating with Multiple Effect Evaporators (MEE) can be employed. It has been quite often debated that employing ZLD route is energy intensive and having exorbitant cost / financial burden. But, it cannot be denied that in the present circumstances when ground water table is getting depleted and there is diminishing flow in rivers, permitting industries to discharge even treated effluents, does not seems to be environmentally acceptable proposition. However, industries will be at their technical wisdom and expertise to search for better ZLD achieving practice but with a caution that there will stern actions if, on the name of ZLD, un-acceptable practices are adopted.

In some cases, if any industry feels that a given process needs modification, stopped or substituted, they can do so but, in longer run, treated effluents cannot be disposed. It is also to be understood that in absence of ZLD, industry has to meet compliance with standards and the results through on-line effluent monitoring devices will be available with regulatory authorities and also in public domain. Zero Liquid Discharge is a process that is beneficial to industrial and municipal organizations as well as the environment because it saves money and no effluent, or discharge, is left over. ZLD systems employ the most advanced wastewater treatment technologies to purify and recycle virtually all of the wastewater produced. Also Zero liquid discharge technologies help plants meet discharge and water reuse requirements. The system provides an economical solution to all industries which have to compete with local water availability, water costs and wastewater discharge criteria.

4. ZERO LIQUID DISCHARGE (ZLD) SYSTEMS FOR TANNERIES

Leather is an intermediate industrial product, with numerous applications in down-stream consumer products industry. The tanning of hides and skins also generates other by-products that find outlets in several industrial sectors. Tanning is one of the oldest industries in India and ranks amongst the five top-most export oriented industries of the country. Water plays a vital role in tannery operations. Approximately 30-40 litre (L) of water is used for processing and converting one kilogram (kg) of raw hide/skin into finished leather. Most of the Indian tanneries which are located near the river banks or natural water bodies draw surface water. Ground water from their own open wells/tubewells existing within their premises is also used by some tanneries.

Common Effluent Treatment Plant (CETP) effluent standards for discharge into surface waters and on land have norms for Total Dissolved Solids (TDS) also having a maximum permissible limit of 2100 mg/L. Tannery effluent contains TDS in concentration several times higher than this prescribed limit which is contributed by the common salt used for preservation of hides and skins as well as by the inorganic salts and chemicals used in the tanning process. The conventional treatment methods used for effluent treatment are largely aimed to treat organic matter and do not help in reduction of inorganic TDS due to inorganic constituents. Therefore, tanneries clusters are required to adopt extra measures to meet the CETP effluent standard for TDS. The tanneries clusters in Tamil Nadu have adopted ZLD systems in order to comply with TDS norms. ZLD systems have been implemented for all 12 tanneries CETPs in Tamil Nadu and some of them are already operating successfully for quite some time while others are under stabilization.

It is generally recognized that the pollution mitigation approaches in any industrial activity must follow the principle of prevention or reduction of pollution at source through in-process control measures. This assumes a greater significance now in leather industry primarily due to possible recycle/reuse of water and salt and reduced operation/treatment cost as well as recovery of chemicals. The strategy for in-process control measures for pollution reduction attempts to integrate cleaner process options with the waste management practices because the volume of effluent as well as concentration of pollutants have a direct influence on cost of treatment.

5. RESULTS AND DISCUSSIONS

Groundwater quality of the study area was evaluated for drinking purposes by collecting samples during pre-monsoon season by adopting standard analytical techniques of APHA (2005). The samples were collected in multiple sites where ZLD is in operation and also from traditional treatment process. The water samples collected in the stations were analyzed for electrical conductivity (EC), pH, Total Dissolved Solids (TDS), Total Hardness (TH), BOD, COD, Sulphides, Total chromium. The results of this analysis were compared with the water quality standards of WHO and CPHEEO. In this analysis the various physicochemical parameters such as pH, electrical conductivity, turbidity, total dissolved solids, Alkalinity, Na, Fe, Cr, calcium and magnesium etc., were determined using standard procedures.

Table 1. Groundwater Quality

	Sampling location		**Site 1 (before ZLD)**	**Site 1 (After ZLD)**
Sl No	**Parameter (all except pH are in mg/l)**	**Permissible limit**	**Samples**	**Sample**
1	pH	6.5 - 8.5	6.97	6.82
2	TSS@105°C	NIL	136	28
3	TDS	2000	8940	2054
4	Cl	1000	3549	800
5	SO_4	400	554	144
6	BOD	NIL	24	3
7	COD	NIL	120	32
8	Oil and Grease	NIL	4	-
9	Sulphides	0.05	<1.0	-
10	% Na	NIL	7	-
11	Total Cr	0.05	<0.5	-
12	Cr(VI)	NIL	<0.5	-
13	Ammonical N	NIL	-	-
14	Total Fe	1	2	0.09
15	Alkalinity	600	950	325
16	Total Hardness	600	3210	1220
17	Fl	1.5	1	<0.2

Acknowledgement

The author wishes to thank Dr.P.Shanmugam for his guidance and help in this work. The author is also thankful to the Chairman, Director, Principal and Head of department of civil engineering of Pandian Saraswathi Yadav Engineeering College for their continous support and timely help.

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