INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 5, Issue 4)
Available online at: www.ijariit.com

Water quality assessment of the Unnao Tannery region

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ABSTRACT

The leather industry has gained immense socio-economic importance in India. Indian leather division has contributed significant economic growth by providing job opportunities. The main reason for the development and growth of the leather industry in the country is its large animal population. India holds nearly 10% of the total global availability of raw hides and skins which are the basic raw material for the leather industry. The impact of tanning and associated activities on air, surface and groundwater and soil pollution arise from the chemicals applied, the raw materials used and the effluents, waste and off-gas releases generated in the process. The tanning industry is known to be very polluting especially through effluents high in organic and inorganic dissolved and suspended solids content followed by propensities for high oxygen demand and containing potentially toxic metal salt residues.

Keywords— *CETP, Chromium, Wastewater, Tanning, Pollution*

1. INTRODUCTION

Unnao is one of the major industrial towns adjacent to Kanpur having most of the cotton, leather, pharmaceutical, steel, and other industries. The Unnao industrial area and surrounding villages of Unnao district lie between 260 26' and 260 41' North latitudes and 800 15' and 800 33' East longitudes, falling in the survey of India Toposheet No. 63B. It is bounded on the north by Safipur block, in the east by the Bichhia block, in the south Sikandarpur Karon block, whereas the Ganga River in the west separates it from the district of Kanpur. The total area is about 220 km^2. Unnao industrial area is situated near Kanpur in the northern side of Ganga River has more than 50 industrial units mainly tannery, catering the need of the nation. The effluents discharged by the industries, after passing through a common effluent treatment plant having approx. 70% treating capacity, is finally discharged in the Ganga River. The quality of groundwater in the industrial areas is under constant threat of contamination directly or indirectly. A remarkable high concentration of chromium in some parts of groundwater of Unnao and Kanpur districts is a common feature in the region.To limit pollution of the natural environment, biological treatment, using Activated sludge process has been the common treatment process for sewage. [1]

Cr is one of the most important pollutants released from the tanning industries and the biggest problem is its disposal and recovery. Compared to the recommended permissible limit of 2 mg/L prescribed by BIS, India alone released about 2000-3000 tons of chromium into the environment annually from tanneries with chromium concentrations ranging between 40- 5000mg/L. Chromium is a potential pollutant and well known for its mutagenicity [2] and carcinogenic effects in humans, animals, and plants. Soil profile, surface water bodies such as ponds and rivers, human health, fishes and other aquatic biodiversities are at risk of serious threat due to the extensive use of chromium in tanning industries and discharge of wastewater [3].

1.1 Impact on surface water by tanneries

Surface water is not uniformly distributed over the earth's surface. According to the U.S. landmass, only about 4% is covered by rivers, lakes, and streams. The amounts of these freshwater sources depend on geographic, landscape and temporal variations and one the impact of human activities. Since surface water supplies are always in a state of transition, hydrologic models become valuable tools for estimating future water supply scenarios based on assumed sequences of hydrologic variables, such as precipitations, temperature, and evaporation and for projects physical manipulations of the surface water containment system. Thus tannery wastewater discharge pollutes surface water like drains, lake, and ponds [4].

Water bodies receiving the tannery effluent show high Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and chloride levels that are well above the stipulated concentrations prescribed by the Indian Standard Institutes [5].

Water pollution is a major problem related to the industrial growth of the country. Some of the industries like tannery release their effluents in surrounding surface water bodies contaminating the surface water. The amount and toxicity of waste released from industrial activities vary with the different industrial process. Among all the industrial wastes, those released from tanneries have the highest concentration of pollutants [6].

Fig. 1: Chrome tanning process Flowsheet

1.2 Impact on groundwater by tanneries

Groundwater acts as a reservoir by large pore space in earth materials as a conduit which can transport water over long distances and act as a mechanical filter which improves water quality by removing suspended solids and bacterial contamination. It is the source of water for wells and springs that recommended the source of rural domestic use. According to their result of anthropogenic activities, groundwater is contaminated by the constant addition of industrial, domestic and agricultural waters to it. Groundwater contamination is generally irreversible, i.e. once it is contaminated its original quality cannot be restored back. Excessive mineralization of groundwater degradeswater quality producing an objectionable taste, odor and excessive hardness [7]. The tannery industries release their effluents either on open land or surface water bodies contaminating the quality of groundwater.Groundwater is a precious natural resource. Unfortunately, it has been subjected to maximum exploitation and has been severely degraded due to tanning activities (8).

1.3 Location of the study area

Unnao district represents flat topography with a general elevation of 98 m (322 ft.) covering an area of 4558 $km^{2.}$ By virtue of its geographic setting in the great (Ganga) plains, the land is highly fertile. The soil is mostly alluvial. The district is mainly drained by the river Ganga and its tributaries Kalyani, Khar, Loni and Marahai in the western part of the district and by Sai River in the eastern part of the district. All these rivers are perennial in nature. About 87% area of the net sown area (3, 00,000 hectares) is irrigated both by surface water (Sharda Canal network system) and groundwater through shallow and moderately deep tubewells. The share of surface water irrigation is 48% while that of groundwater is 52%.

In Kanpur (& Unnao) region, Ganga River flows along NW-SE trending weak zone (a tectonic lineament) showing a prominent escarpment on the southern side and well-developed flood plain in the northern side [9]. This weak zone has also controlled the subsurface stratigraphy in the alluvium [10].

Soil found in Unnao industrial and surroundings village of Unnao district exhibit wide variance in composition and appearance. The major part of area consists of ordinary soils known locally as Bhur or sand on the ridges, Matiar or clay in the topographic lows and Dumat or loam on the plains. Clay is dominant in the areas where "Reh" or usar prevails. Alluvial soils of river valleys notable the "Kachhar" of the Ganga formed by repeated deposition of silt brought down by the existing river system during floods.

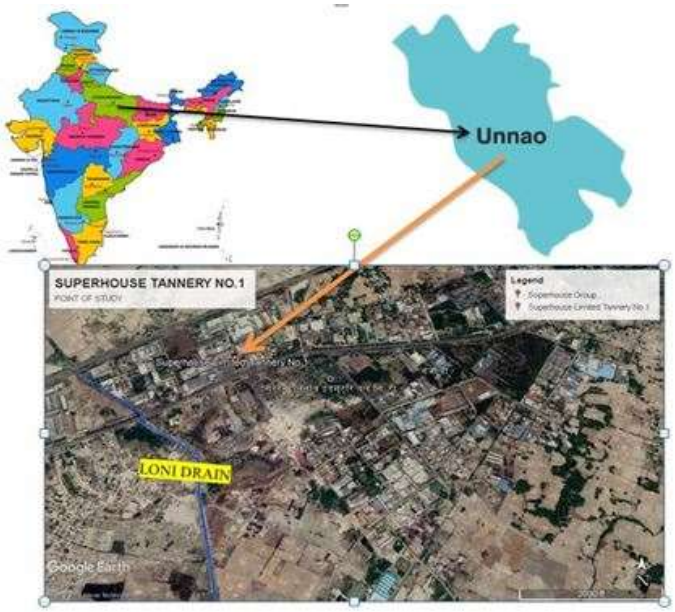

Fig. 2: Satellite imagery Location of Study Area

1.4 Industrial Area Site

1 consists of 5 units (One slaughterhouse, one meat processing unit, two fat processing units, and one metal unit). Approximately 0.75 MLD effluent is generated from all these units and is discharged in Loni Drain after treatment.

Fig. 3: CETP Unnao Outlet into Loni Drain

1.5 Industrial Area Site – 2

It consists of 21 tannery units out of which 14 are operational and 7 are non-operational since long. Out of 14 tannery units, 2 units have their own effluent treatment plant and effluent from 12 tanneries goes to the combined effluent treatment plant (CETP) after undergoing primary treatment which involves chrome recovery and suspended solids removal in general. Apart from tanneries, there is one slaughterhouse and one meat processing unit, both having their own effluent treatment plant. These units produce approximately 4.37 MLD effluent. The CETP was made operational in October 1995 at the cost of Rs. 195 lacs. The designed treatment capacity of plant is 2.15 MLD. CETP consists of bar screen, equalization tank, primary clarifier for suspended solids removal, 2-stage aerobic bioreactor and clarifiers for removal of organics, tertiary clarifier for removal of organics and suspended solids by adsorption on chemical sludge, followed by multigrade filter and activated carbon filter for final polishing. It is operated and maintained by Unnao Tanneries Pollution Control Company.

Fig. 4: Location of CETP near Superhouse Tannery Limited next to Loni Drain Satellite Imagery

Treated effluent from Site – 1 and Site – 2 are discharged in Loni drain. Approximately, 5 MLD untreated sewage from the city is also discharged in the Loni drain. Loni drain meets River Ganga in Raebareli District after traveling approximately 146 km. Water from Loni drain is utilized for irrigation by the farmers.

2. MATERIAL AND METHOD

Water and wastewater (Effluent) samples were collected in polyethylene bottles using dip/grab sampling method during pre-monsoon (May 10-12, 2017) and post-monsoon (August 3-4) season and preserved by using appropriate reagents as per standard methods. All glassware and other containers used for trace element analysis were thoroughly cleaned, soaked in 10% nitric acid for 48 h and finally rinsed with de-ionized water several times prior to use. All the testing procedures were carried out in the laboratory of Indian Institute Technology ISM Dhanbad Jharkhand. The physicochemical analysis was performed as per Standard Methods for the Examination of Water and Wastewater [11]

Table 1: Analytical Methods and Equipment Used in the Analysis

S no.	Parameter	Method	Equipment Used
1.	pH	Electrometric	pH Meter
2.	Suspended Solids	Gravemetrically	-
3.	BOD	5 days incubation at 20^{o}C followed by titration	BOD Incubator
4.	Chromium	Digestion followed by Atomic Spectrophotometer	Atomic Absorption Spectrometer

3. RESULT AND DISCUSSION

Table 2: Characteristics of Effluents of Superhouse Tannery No.1 Ltd

S no.	Parameters	Inlet (S-1)		Outlet (S-2)		Effluent Standards
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
1	pH	8.1	9.2	7.3	7.6	6.5-9.0
2	TSS, mg/L	2150	-	250	-	100
3	Total Chromium, mg/L	5.80	1.62	0.67	0.52	2
4	BOD, mg/L	1237	452	35	254	30

Effluent discharged by. M/S Superhouse Tannery No.1 Ltd is not in conformity with the effluent standards notified vide S.No. 57; G.S.R. 475(E) dated 5.5.1992 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water for TSS and BOD and needs appropriate statutory action by UPPCB/CPCB.

4. CONCLUSION AND RECOMMENDATIONS

The samples of wastewater/ treated water were collected from the inlet and outlet, of the sewage treatment plant and the results discussed are only pertaining those physicochemical parameters which are above the threshold limits to cause harmful effects. The concentration of chromium is reduced because it is being recycled by a chrome recovery plant that is installed within the premises of the superhouse tannery. A proper system of collection and transportation of domestic waste should be developed. A landfill site(s) should be identified and it must be scientifically designed for the disposal of domestic waste. Groundwater quality near landfill sites should be regularly monitored.

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