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The Physico –Chemical Analysis of Paper Industry Effluent and its Impact of Ground Water Quality at Madathukulam, Udumalpet City

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Abstract: The paper and pulp raw materials are wood pulp bleacher and dyes Fibers such as Chalk, Clay, Titanium oxide, guns and starch, sodium hydroxide and sodium sulphide are used during the manufacturing of paper. The waste water in the high volume is not treated properly. During rainy season the effluent is carried by rain water and reaches nearby ponds, rivers and wells. The flow of effluent rate in to canals during rain reason travels a long distance and percolates into ground and causes ground water pollution. The residential area of water resources are polluted with very high TDS from ground water. The TDS range in the effluent contains 1329 mg/liter which is 3 times higher than the permissible limit. The ground water contains high TDS, Conductivity, and hardness. The ground water sample also reveals that it is 4 times higher TDS value. The hardness also indicate a high value which make it unfit for drinking purpose.
Keyword: Raw paper effluents, treated effluents, total dissolved solids, paper industry, physico chemical analysis.

Introduction

The chief sources of liquid waste in an integral paper manufacturing unit are from the raw material processing, pulp producing, paper machine sections and caustic soda-chlorine plants. The raw-material preparation results in effluents during washing, cleaning, debarking and chipping of wood[1]. Considerable amounts of suspended solids get included in the liquid water which increases the total solid load. The effluent from digestion consists of spent liquor brown stock washing, bleaching chemical recovery process, water spills and leakages wash water from chemical-preparation plants[2]. In the paper-machine section liquid water from stock preparations and the paper-making machine contains fine fibers along with dyes, alum and talc. In a majority of paper-making machines, the fibers are recovered and reused in the process along with the recovered water. Sledges are obtained in caustic-chlorine units where different liquid and gas streams should be processed to recover chemicals[3].

In the digestion process, while handling spills and leakages of black liquor contribute to the pollution load of the wastewater. Chemicals from black liquor are recovered from the digester contents by vacuum filtration ~where the separated pulp is continuously washed by a spray of water[4]. The wash water contains the liquor adhering to the cake and contributes to the pollution load. The liquid is alkaline in character. The

condensate from the multiple-effect evaporator contains soluble organic materials such as sulphides, mercaptans also contribute to pollution load in waste water[6]. Detergents are used in paper in cleaning applications such as washing. A large variety of other surface-active agents, floatation additives -and chemicals are used for reducing deposits in process equipment. Detergents are potentially toxic substances that can cause foaming in treatment plants[7].

Micro biocides such as chlorine, chlorinated phenols, organo sulphur compounds, etc., are used in paper and pulp industries to keep the microbial population in check in order to avoid the formation of slimes. Oils and greases can result from fuel-oil spills and discharge of used lubrication oils and greases. Some volatile and nonvolatile toxic compounds are produced during debarking, mechanical and chemical pulping and bleaching operations[8]. Non-volatiles include resin acids and unsaturated fatty acids during pulping, and their chlorinated derivatives during bleaching and caustic extraction. Volatiles include hydrogen sulphide, dimethyl sulphide and methyl mercaptans which, apart from being toxic, impart a bad taste and odour to the receiving waters.The spent cooking liquors in chemical-pulping operations during which lignin and its derivatives are solubilized from raw materials, contain high-coloured chemical compounds[9]. They repeatedly washed from the pulp, resulting in the wash water containing fairly large amounts of colour-bearing materials which can exert a long term BOD. Besides, colour in waste retards photosynthesis and is not aesthetic when discharged m receiving waters[10]. Inorganic compounds present in waste water from pulping operations include acids, alkalis and heavy metals. Water is alkaline in the Kraft process and acidic in the sulphite process[11]. Heavy metals in the liquid waste are the result of additives used in paper making and pulping as well as corrosion products (Mahajan, 1985). To reduce the pollutants in waste-water and to meet the regulatory standards of various pollution regulation authorities, various treatment methods are being adopted by various industries including Pulp and Paper industry[12].

Scope and Objective of the Study

Mitigation of Groundwater Pollution

Once it is known that a groundwater aquifer has become polluted, it is very important - and very urgent - to institute remedial measures. The following facts justify this assertion.

1. Groundwater is inaccessible and, therefore, its clean-up is tedious and time-consuming.
2. The tangible effects of groundwater pollution usually come to light long after the contamination has occurred.
3. Once contaminated the groundwater remains tainted for many decades.
4. It is difficult to identify the source of contamination of groundwater.
5. Contaminants in groundwater can enter into other water resources like rivers, lakes and streams.
6. A large chunk of human population use groundwater as their main source of drinking water and irrigation. In the event of aquifers becoming polluted, generally no immediate fresh water substitutes are available to these people.
7. Many aquifers arc close to large population centers and the impact of ground water pollution can be serious.

Therefore, when it is discovered that a groundwater resource has become polluted, it must immediately be decided as to what remedial action ought to be taken. In investigate phase, the nature and extent of pollution is detern1ined. In risk assessment phase, it is evaluated as to what extent the pollutants are harmful to human health and the environment[13].

Need for the Study

The Paper and Pulp industry located at Madathukulam causes water pollution problems due to the discharge of Paper and Pulp industry effluent. The industry is functioning for past twenty years and discharging untreated effluents into the cannels and percolates into the wells and bore wells. It affects the ground water quality at an alarming rate. Hence the study is undertaken to find the pollution effect of paper industry effluent[14].

Objectives

1. To investigate the characteristics of the paper industry effluent.

2. To evaluate the water quality parameters of the well and bore well water in and around the paper industry.
3. To suggest the suitable methods for the treatment of polluted water in that area.

Materials and Methods

Location of the Study Area

Udumalpet is one of taluk of tirupur district of Tamil Nadu state lies between 10.3^0 and 10.48^0 of North latitude and 77.15^0 and 78.20^0 of East longitude. The district has extensive hilly and rocky area with undulating plains covered mostly by red soil. North East Monsoon benefits udumalpet with a mean annual rainfall of 42.66%. The mean sea level lies at 280.11.

Choice of Study Area

Madathukulam is located on palani road 15 Km away from udumalpet in east side, where most of the ponds and river are presently polluted by the stagnation of Industrial effluents, and sewage waste water from the inhabitants. The sewage water and industrial wastes from the east of Madathukulam reach the pond and river. The inhabitants living on the western side of Madathukulam discharge through drains in the Madathukulam pond and river without any treatment. The Madathukulam was situated at one end eastern side of udumalpet town. The study area was selected in and around the Madathukulam. The area was in the rural limit. The pond and river are source for domestic purpose and agricultural purpose. People residing around the pond have to depend on ground water, well water available in the Madathukulam.

A close view of effluents discharging to the river

Environmental Pollution Problems in Madathukulam Area

The number of Chemical based industries increasing in madathukulam day by day. There is no proper treatment for waste water from the isolated industries. Hence the environment is badly affected.

Water Resources

Madathukulam is situated in palani road at a distance of 10 KM From the udumalpet town. During rainy season water flows along with the effluent. Also people used to take bath and wash their clothes in the river water and it reaches the Ground water. Due to discharging of Paper Industry effluent the pond water ,the ground water and river water are highly polluted.

Results and Discussion

The Results of the various physico-chemical analysis of the Paper Industry effluent, river water and the ground water samples were collected, analysed, presented and discussed.

Sample collection	**BIS Desirable Limit**	**Sample-1 Effluent**	**Sample-2 Effluent**	**Sample-3 Borewell**	**Sample-4 Borewell**	**Sample-5 Openwell**	**Sample-6 River**	**Sample-7 River**
Appearance		Slightly Whitish	Whitish	Clear	Clear	Clear	Clear	Clear
colour(Pt.Co -Scale)	5	Slightly Whitish	Whitish	Colourles	Colourles	Colourles	Colourles	Colourles
Odour	Unobjectionable	Highly Bad Smell	Algae Smell	None	None	Bad Smell	None	None
Turbidity	5	85	60	6	5	16	8	12
Total dissolved solids mg/L	500	1329	1238	1329	2214	5738	3468	3493
Electrical conductivity		1955	1821	1955	3255	8438	5096	5136
CHEMICAL PARAMETERS								
Ph	7.0-8.5	6.48	6.71	7.41	7.36	7.57	6.99	7.2
Alkalinity	200	368	392	360	212	120	440	408
Total hardness	300	630	456	630	824	2200	1430	1430

Calcium mg/L	75	132	117	132	168	560	300	300
Magnesium	30	72	39	72	97	288	163	163
Sodium as Na	–	156	164	148	328	710	510	510
Potassium as K	–	38	14	38	102	90	55	55
Iron as Fe mg/L	0.3	1.39	1.34	0.61	0.57	1.01	0.53	1.14
Ammonia	–	10.86	10.52	3.01	2.05	37.24	11.58	15.02
Nitrite as NO_2 m	–	0.05	0.1	1.32	0.11	0.15	0.02	0.69
Nitrate as NO_3	45	11	7	11	8	20	11	11
Chloride as Cl	250	380	268	350	880	2500	860	890
Fluoride as F	1	0.8	0.4	0.4	1.8	0.8	0.6	1.2
Sulphate as SO_4	200	82	49	161	239	189	933	942
Phosphate	–	1.38	0.58	1.22	4.41	0.51	1.29	2.82

Discussion

Sample-1 [Paper Effluents]

The value of Total Dissolved Solids is 1329 Mg / Ltr. but the standard acceptable limit is 500mg / lit. The amount of Alkalinity as $CaCO_3$ is 368 mg / lit. Which lies above in the acceptable limit 200 mg / lit. The amount of Hardness as $CaCO_3$ is 630 mg / lit. Which lies above in the acceptable limit 300 mg / lit. The permissible limit for Iron as Fe 0.3 mg/lit. But the observed value of the sample of water is 1.39 mg/lit. The permissible limit for Chloride 250 mg/lit. But the observed value of the sample of water is 380 mg/lit.

Sample-2 [Paper Effluents]

The value of Total Dissolved Solids is 1238 Mg / Ltr. but the standard acceptable limit is 500mg / lit. The amount of Alkalinity as $CaCO_3$ is 392mg / lit. Which lies above in the acceptable limit 200 mg / lit. The amount of Hardness as $CaCO_3$ is 456 mg / lit. Which lies above in the acceptable limit 300 mg / lit. The amount of Magnesium is 39 mg / lit. Which lies above in the acceptable limit 30 mg / lit. The permissible limit for Iron as Fe 0.3 mg/lit. But the observed value of the sample of water is 1.34 mg/lit. The permissible limit for Chloride 250 mg/lit. But the observed value of the sample of water is 268 mg/lit. Also both Ammonia and Phosphate are Present in the Sample.

Sample-3 [Bore Well water]

The value of Total Dissolved Solids is 1329 Mg / Ltr. but the standard acceptable limit is 500mg / lit. Hence the water sample is chemically not potable. The amount of Alkalinity as $CaCO_3$ is 360 mg / lit. Which lies above in the acceptable limit 200 mg / lit. The amount of Hardness as $CaCO_3$ is 630mg / lit. Which lies above in the acceptable limit 300 mg / lit. The amount of Magnesium is 72mg / lit. Which lies above in the acceptable limit 30 mg / lit. The permissible limit for Iron as Fe 0.3 mg/lit. But the observed value of the sample of water is 0.61 mg/lit. So, this water is unfit for drinking. The permissible limit for Chloride 250 mg/lit. But the observed value of the sample of water is 350mg/lit. So, this water is unfit for drinking.

Sample-4 [Bore Well water]

The value of Total Dissolved Solids is 2214 Mg / Ltr. but the standard acceptable limit is 500mg / lit. Hence the water sample is chemically not potable. The amount of Alkalinity as $CaCO_3$ is 212 mg / lit. Which lies above in the acceptable limit 200 mg / lit. The amount of Hardness as $CaCO_3$ is 824mg / lit. Which lies above in the acceptable limit 300 mg / lit. The amount of Magnesium is 97mg / lit. Which lies above in the

acceptable limit 30 mg / lit. The permissible limit for Iron as Fe 0.3 mg/lit. But the observed value of the sample of water is 0.57 mg/lit. So, this water is unfit for drinking.

Samlple-5 [Open Well Water]

The value of Total Dissolved Solids is 5738 Mg / Ltr. but the standard acceptable limit is 500mg / lit. Hence the water sample is chemically not potable. The amount of Hardness as $CaCO_3$ is 2200mg / lit. Which lies above in the acceptable limit 300 mg / lit. The amount of Magnesium is 288mg / lit. Which lies above in the acceptable limit 30 mg / lit. The permissible limit for Iron as Fe 0.3 mg/lit. But the observed value of the sample of water is 1.01 mg/lit. So, this water is unfit for drinking. The permissible limit for Chloride 250 mg/lit. But the observed value of the sample of water is 2500mg/lit. So, this water is unfit for drinking.

Sample-6 [River Water]

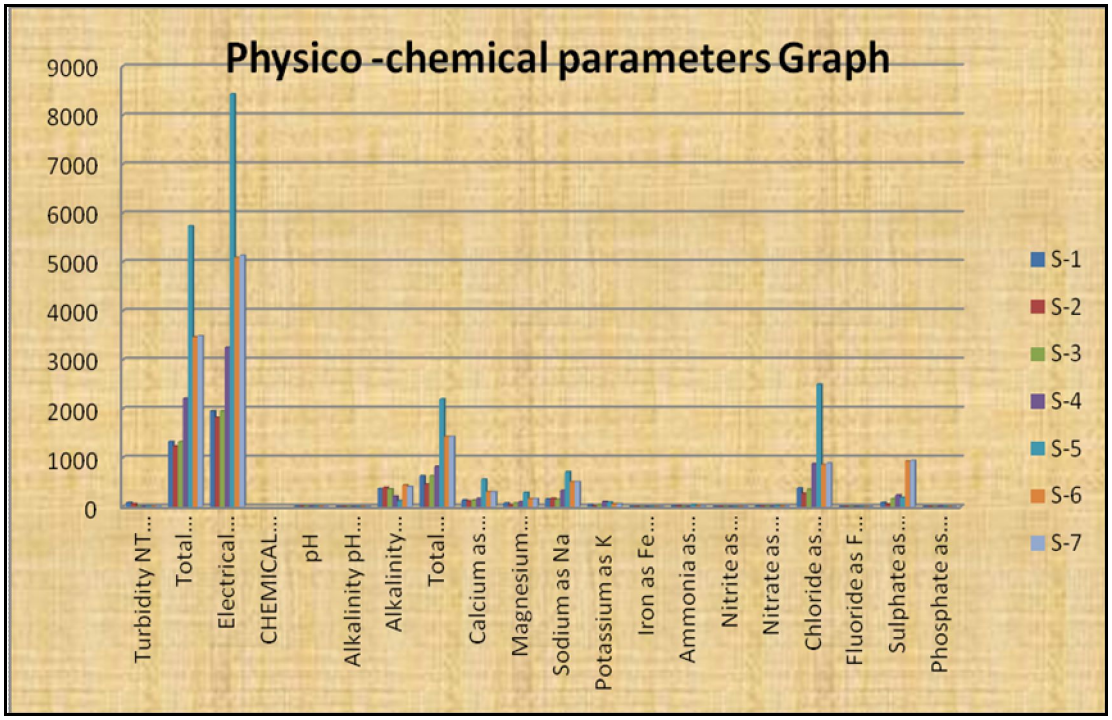
The value of Total Dissolved Solids is 3468 Mg / Ltr. but the standard acceptable limit is 500mg / lit. Hence the water sample is chemically not potable. The amount of Alkalinity as $CaCO_3$ is 440 mg / lit. Which lies above in the acceptable limit 200 mg / lit. The amount of Hardness as $CaCO_3$ is 1430mg / lit. Which lies above in the acceptable limit 300 mg / lit. The amount of Magnesium is 163mg / lit. Which lies above in the acceptable limit 30 mg / lit. The permissible limit for Iron as Fe 0.3 mg/lit. But the observed value of the sample of water is 0.53 mg/lit. So, this water is unfit for drinking. The amount of sulphate is 933mg / lit. Which lies above in the acceptable limit 200 mg / lit. The permissible limit for Chloride 250 mg/lit. But the observed value of the sample of water is 860mg/lit. So, this water is unfit for drinking.

Sample-7 [River Water]

The value of Total Dissolved Solids is 3493 Mg / Ltr. but the standard acceptable limit is 500mg / lit. Hence the water sample is chemically not potable. The amount of Alkalinity as $CaCO_3$ is 408 mg / lit. Which lies above in the acceptable limit 200 mg / lit. The amount of Hardness as $CaCO_3$ is 1430mg / lit. Which lies above in the acceptable limit 300 mg / lit. The amount of Magnesium is 300mg / lit. Which lies above in the acceptable limit 30 mg / lit. The permissible limit for Iron as Fe 0.3 mg/lit. But the observed value of the sample of water is 1.14 mg/lit. So, this water is unfit for drinking. The amount of sulphate is 942mg / lit. Which lies above in the acceptable limit 200 mg / lit. The permissible limit for Chloride 250 mg/lit. But the observed value of the sample of water is 890mg/lit. So, this water is unfit for drinking. Also both Ammonia and Phosphate are Present in the Considerable amount in the sample.

Diagram

Physical and Chemical Parameters of various samples graph



Conclusion

An attempt has been taken to study the pollution of ground water in and around madathukulam area due to the discharge of untreated paper and pulp industry effluent in to the open land through canals. The effluent finally reaches nearby water resources like amaravathi river to shanmukha river. Due to the perculation of the highly polluted effluent into the ground, the ground water quality changes at an alarming rate. During survey the people living in and around Madathukulam, it is found the bore well water in the ground is badly polluted and become unfit for drinking purpose. The various samples collected in Madathukulam area are unfit for both drinking and domestic purposes due to higher limits of water quality parameters.

It was also observed in many cases that heavy contaminants of waste water leads to the pollution of well water and bore well water. Hence the people living in that area depend only on panchayat water for drinking purpose. It is concluded that due to high degree of river water pollution and ground water pollution the effluent from paper and pulp industry present in at madathukulam area are highly affecting the people"s health. In order to purify the surface and ground water pollution, suitable treatment system should be introduced.The modern R.O water treatment system is suitable and is recommended.

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