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POLLUTION LOAD IN INDUSTRIAL EFFLUENT AND GROUND WATER OF GADOON AMAZAI INDUATRIAL ESTATE (GAIE) SWABI, NWFP

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ABSTRACT

A study was conducted for the analysis of pollution load in industrial effluent and ground water of Gadoon Amazai Industrial Estate, Swabi, NWFP, in April 2004. Samples were collected from eight different industrial units including chemical, marble, soap and oil, textile, ghee and steel industries and main drain and were analyzed for various physical and chemical parameters like pH, EC, TSS, TDS and heavy metals content. Samples of ground water were collected from three different tube wells. The pH of the samples of the industrial effluents ranged from 6.47 to 8.48, temperature ranged from 26.9-30.2˚C, EC ranged from 0.258-0.865dSm^{-1}, TSS 140.5-1670.8mgL^{-1}, TDS from 143-1050mg L^{-1} and BOD was in range from 72.9- 463.7mg L^{-1}. The results of the ground water samples showed pH values ranging from 6.82-7.9˚C with EC 0.351-0.511dSm^{-1}, temperature was found from 26.0-26.7^{o}C, TSS was 1.78-2.09mgL^{-1}, TDS ranged from 139-513 mgL^{-1} and BOD of ground water was in range from 0.294-0.802mgL^{-1}. The results obtained from heavy metals determination in Industrial effluents showed that the concentration of Ni ranged from 0.009 to 0.794 mgL^{-1}, Cd concentration was from 0.003 to 0.043 mgL^{-1}, Pb ranged from 0.20 to 2.84 mgL^{-1}, Cr was found 0.004 to 0.28 mgL^{-1}, Cu ranged from 0.381 to 1.136 mgL^{-1}, Zn, Fe, and Mn was in range from 0.003 to 0.097 mgL^{-1}, 0.008 to 4.5611 mgL^{-1} and 0.014 to 0.163 mgL^{-1} respectively. Most of the results were in permissible limits of National Environmental Quality Standards. The results of the heavy metal content in ground water samples showed that the concentration of Ni was 0.030 to 0.066 mgL^{-1}, Cd and Pb was found 0.007 to 0.025 mgL^{-1} and 0.21 to 1.20 mgL^{-1}, respectively, Cr was found from 0.017 to 0.111 mgL^{-1}, Cu and Zn ranged from 0.780 to 0.893 mgL^{-1} and 0.007 to 0.066 mgL^{-1} respectively, Fe ranged from 0.004 to 0.037 mgL^{-1} and Mn from 0.059 to 0.164 mgL^{-1}. All the results of ground water were compared with US-EPA and WHO standards, from the findings it was concluded that all ground water samples were safe for drinking purpose.

Keywords: pollution, water, effluent, assessment, industrial, Gadoon, Swabi.

INTRODUCTION

Industrialization plays a vital role in growth and development of any country. The idea of industrialization originated in Uk where the first industrial estate was established in Manchester in 1886. The “Trafford Park Estate Limited,” the second industrial Estate was established in Chicago USA in 1899, thereafter no concrete steps were taken up for their establishment. Industrial state became popular after 2nd world war. Since such estate have been and are being established in advance as well as under developed/developing countries.

In Pakistan industrial estate establishment was started with the introduction of 1st five years plane 1955-1960, which laid emphasis on the establishment of large estates in the country. Till middle of 1997 there were 39 industrial estates in Punjab, Sindh, N.W.F.P and Baluchistan. The recent privatization has also promoted the industrial estates in Pakistan. On provincial level industrial development is also getting momentum and 14 industrial estates have been established so far in N.W.F.P of which three are major industrial estates including Peshawar, Hattar and Gadoon Amazai industrial estates and eleven small estates located in various areas of the province (IUCN,1996).

This rapid industrialization is also having a direct and indirect adverse effect on our environment. Industrial development manifested due to setting up of new industries or expansion of existing industrial establishments resulted in the generation of industrial effluents, spatially small scale cottage industries which discharge untreated effluents which cause air, water, soil and soil solid waste pollution. The present method of transportation of theses effluents and their ultimate disposal and treatment for making effluents innocuous and safe are inadequate, unplanned and their development at the hands of municipal bodies and corporation suffers through negligence and shortage of funds. With the apathy of industrialist towards the treatment of the effluents from their respective units prior to discharge to sewers or open surface drains, storm water canals, rivers, etc. Untreated water near the point of disposal, create foul smell and bad odor (Kulkarni, 1979). This bad odor is due to decomposition of floating solids present in untreated sewage. The net result is large scale pollution of the water bodies which may act as a source of water supply for domestic use of inhabitants of localities. This loss of water quality is causing health hazards and death of human, livestock and death of aquatic lives, crop failure and loss of aesthetics. In NWFP, no proper wastewater treatment facilities are available and the industries discharge their untreated wastewater into various water bodies causing surface and ground water pollution endangering biodiversity and lowering agriculture production.

It is alarming that most of the cities and industries in Pakistan are without wastewater treatment facilities. Large quantities of untreated municipal sewage and industrial effluents are being discharged directly to surface water resulting in serious pollution. Due to high organic loads and toxic materials, the industrial effluents form a major source of water pollution in Pakistan. It has been reported that total number of registered industries in the country is 6634 of which 1228 are considered highly polluting industries (Ahmed and Waris, 1999). High levels of pollutants mainly organic matter in river water cause an increase in biological oxygen demand (Kulkarni, 1979), chemical oxygen demand, total dissolved solids, total suspended solids and fecal coliform. They make water unsuitable for drinking, irrigation (Hari *et al.*, 1994) or any other use.

Present studies were carried out on Gadoon Amazai Industrial Estate to identify the industries majorly contributing to water pollution in Gadoon Amazai Industrial Estate and to determine the physico-chemical characteristics of the industrial effluents, this planed research will be helpful to asses the impact of the industrial effluent on the ground water of the surrounding area.

MATERIALS AND METHODS

Sampling:

Effluents were collected from Saif Textile Mills, Mir Marble Industry, Sardar Chemicals, Frontier Steel Limited, M.B. Dyes, Amrath Cola Industry and Main Drain for analysis of various physical and chemical parameters like temperature, pH, EC, TSS, TDS, BOD and Heavy metals content from the effluents out flow followed by industries of Gadoon Amazai Industrial Estate along with ground water samples from various tube wells and one sample from main drain. Samples were collected in clean dry bottles of plastic (1500ml) in such a way that no bubbles were formed in the bottles. After collection the samples were analyzed in 5 days for all Parameters. All analytical work was carried out in the Labs of Soil and Environmental Sciences and Agricultural Chemistry Departments, NWFP Agricultural University Peshawar, while temperature was calculated at the site of sampling.

Analytical procedures:

Temperature:

Temperature was noted using thermometric method at the site of sampling using portable calibrated mercury thermometer (EPA, 1998).

pH:

pH of the samples was noted using potentiometric method using pH meter already standardized by using buffer solutions of known value before analysis (Skoog *et al*., 1988).

Electrical conductivity (EC):

EC is the measure of the ability of an aqueous solution to convey an electric current. This ability depends upon the presence of ions, their total concentration, mobility, valence and temperature. EC was determined by conductivity meter following the procedure of Richard (1954).

Total suspended solids (TSS):

Total suspended solids are the portion of solids that usually remains on the filter paper. Suspended solids consist of silt, clay, fine particles of organic and inorganic matter, which is regarded as a type of pollution because water high in concentration of suspended solid may adversely affect growth and reproduction rates of aquatic fauna and flora. For TSS analysis, known amount of sample was filtered through the pre weighed filter paper. Filter paper was then dried at 103-105^{o}C. TSS was determined by using following formula (Anon, 1992).

$$TSS\ mgL^{-1} = \frac{(final\ wt - initial\ wt)}{amount\ of\ sample\ taken}\ X\ \ 1000$$

Total dissolved solids (TDS):

Total dissolved solids (TDS) is the measure of total inorganic salts and other substances that are dissolved in water. TDS was determined following the procedure of Richard (1954) by using Electrical Conductivity (EC) meter.

Biological oxygen demand (BOD):

Biological oxygen demand (BOD) is expressed as weight of oxygen consumed per unit volume of water during a defined period of time at a defined temperature was calculated following the procedure of Hamer (1986). For this the sample of waste was incubated for 5 days at 20^{0}C in the dark. The reduction in dissolved oxygen concentration during the incubation period yields a measure of the biochemical oxygen demand.

Heavy metals analysis:

For the analysis of heavy metals viz Copper (Cu), Zinc (Zn), Iron (Fe), Manganese (Mn), Nickel (Ni), Cadmium (Cd), Led (Pb), and Chromium (Cr). Samples were analyzed on Atomic Absorption Spectrophotometer (Perkin Elmer model 2380) for concentration by using specific cathode lamp. AAS was calibrated for each element using standard solution of known concentration before sample injection (APHA, 1992).

RESULTS AND DISCUSSION

Industrial effluents are the main source of surface and ground water pollution. To evaluate the pollution content eight samples from different industries were analyzed for various physical and chemical parameters such as temperature, pH, electrical conductivity (EC), total suspended solids (TSS), total dissolved solids (TDS), biological oxygen demand (BOD) and heavy metals .The results were compared with the standard values of

National Environmental Quality Standards (NEQS) for industrial effluents given in (Appendix-A), while the values of ground water were compared with the values recommended by United States- Environmental Pollution Agency (US-EPA) and World Health Organization (WHO) for drinking water given in (Appendix-B).

Industrial effluents analysis:

Temperature:

Temperature values for various samples are presented in Table-1, ranged from 26.5 to 30.2^{o}C. The highest value was found in the sample of M/s Frontier Steel Ltd, Utman Ghee Industry (Pvt) Ltd and Amrat Cola Industry, while the lowest value of temperature was in the sample of M/s MIR Marble Factory. The temperature values were with in the permissible limits of NEQS (Appendix-A).

pH:

The pH of the samples ranged from 6.47 to 8.48 is presented in Table-1. Lowest pH value was that of sample of main drain, while the sample of Frontier Steel Mills has the highest pH value of 8.48. All the pH values were with in the permissible limits for industrial effluents set by NEQS (Appendix-A).

Electrical conductivity:

EC of the samples shown in Table-1, ranged from 0.258 to 0.865dSm$^{-1.}$ The sample of MIR Marble Industry was with the lowest EC (0.258 dSm^{-1}), while it was highest (0.865 dSm^{-1}) in Main Drain.

Total suspended solids:

The TSS values (Table-1) of the samples ranged from 119.8-1670.8 mg L^{-1}. The NEQS for TSS is 150 mg L^{-1} (Appendix-A). So it is clear that all the samples have very high TSS values except Amrat Cola Industries and Saif Textle Mills with lower TSS value of 119.8 and 140.5 mg L^{-1} respectively. The maximum value of TSS (1670.8 mg L^{-1}) was recorded in the effluent of MIR Marbles. Effluents of such high TSS may cause handling problem, if directly applied to agricultural field, or if this effluent is discharged to river or stream, it will make it unsuitable for aquatic life.

Total dissolved solids:

The TDS values of the samples ranged form 143-1050 mg L^{-1} (Table-1). The lowest value was found in that of MIR Marble Industry while the highest value was found in that of Sardar Chemicals Industry. The NEQS for TDS is 3500 mg L^{-1} (Appendix-A). All the samples have values with in the permissible limits of NEQS.

Biological oxygen demand:

The BOD values ranged from 72.9 to 463.2 mg L^{-1} as presented in Table-1. BOD of effluent of Amrat Cola Industry was lowest 72.9 mg L^{-1} and the Main Drain BOD value was highest 463.2 mg L^{-1}.The BOD values of samples collected from MIR Marble Ltd, Frontier Steel Ltd and Amrat Cola Ind. were below the NEQS level i.e. 80mg L^{-1} While other samples have its value above the permissible limits of NEQS. These effluents on entering fresh water (rivers, stream etc) make the O_2 depleted, causing suffocation of fish and other aquatic fauna and flora resulting in the death of aquatic life.

Table-1. Analysis of selected samples of industrial effluents.

S.NO	Sample description	Temp ^{o}C	pH	EC (dSm^{-1})	TSS (mgL^{-1})	TDS (mg L^{-1})	BOD (mg L^{-1})
1	MIR Marble Ind.	26.9	7.60	258	1670.8	143	76.65
2	Sardar Chemicals	27.2	7.55	275	518.2	1050	369.5
3	Saif Textile Mills	26.9	7.47	512	140.5	209	183.9
4	Frontier Steel Ltd.	30.2	8.48	548	229.2	223	77.84
5	M. B. Dyes	27.0	6.71	676	607	268	379.3
6	Amrat Cola Ind.	27.6	6.47	473	119.8	194	72.9
7	Utman Ghee Ind.	27.8	7.56	459	455	265	114.8
8	Main Drain	27.2	6.49	865	563.1	341	463.7

Heavy metals:

Investigated heavy metals in the industrial effluents of various industries are presented in Table-2. The NEQS standards were violated in case of Pb by samples of Saif Textile Mills, Frontier Steel Ltd. and M. B. Dyes, while Cu was found above the permissible limits in samples of MIR Marble Industry and Main Drain. Rest of the samples, were having heavy metals with in the permissible limits set by NEQS (Appendix-A).

Table-2. Heavy metal contents (mg L^{-1}) of selected samples.

S.No	Sample description	Ni	Cd	Pb	Cr	Cu	Zn	Fe	Mn
1	MIR Marble Ind.	0.099 ±0.002	0.010 ±0.001	0.49 ±0.05	0.022 ±0.02	1.088 ±0.5	0.004 ±0.000	4.511 ±0.85	0.116 ±0.09
2	Sardar Chemicals	0.058 ±0.007	0.043 ±0.009	0.20 ±0.015	0.031 ±0.08	0.778 ±0.016	0.025 ±0.00	0.137 ±0.028	0.096 ±0.009
3	Saif Textile Mills	0.009 ±0.00	0.027 ±0.002	0.83 ±0.02	0.034 ±0.003	0.967 ±0.12	0.003 ±0.000	0.036 ±0.001	0.113 ±0.009
4	Frontier Steel Ltd.	0.015 ±0.001	0.004 ±0.00	1.84 ±0.19	0.053 ±0.02	0.749 ±0.25	0.097 ±0.006	0.008 ±0.001	0.163 ±0.004
5	M. B. Dyes	0.110 ±0.001	0.018 ±0.006	1.31 ±0.27	0.042 ±0.009	0.774 ±0.058	0.025 ±0.00	0.235 ±0.002	0.073 ±0.001
6	Amrat Cola Ind.	0.059 ±0.002	0.016 ±0.004	0.24 ±0.009	0.004 ±0.000	0.552 ±0.002	0.010 ±0.000	0.483 ±0.006	0.082 ±0.00
7	Utman Ghee Ind.	0.794 ±0.005	0.031 ±0.007	0.39 ±0.006	0.28 ±0.009	0.381 ±0.100	0.018 ±0.000	0.48 ±0.05	0.024 ±0.05
8	Main Drain	0.157 ±0.002	0.003 ±0.00	2.84 ±0.05	0.039 ±0.00	1.136 ±0.05	0.048 ±0.001	0.045 ±0.007	0.014 ±0.00

Mean value ± SD value

Ground water analysis:

Temperature:

Temperature of the ground water samples ranged from 26.1 to 26.7°C (Table-3). The lowest temperature was with in the sample of Tube well-1 and the highest temperature was that of sample of Tube well near PEL Industry. All the values were with in the permissible limits of US-EPA and WHO for drinking water standards (Appendex-B).

pH:

The pH value is presented in Table-3, varied between 6.82 and 7.9. Maximum pH 7.9 was of the sample of tube well near PEL Industry. All the samples were with in the permissible limits of US-EPA and WHO standards for drinking water (Appendex-B).

Electrical conductivity:

Electrical conductivity of ground water is also an important parameter for water quality and is given in Table-3. The values of EC ranged from 351 to 511dS m^{-1}. All the samples were with in the permissible limits of US-EPA and WHO standards for drinking water (Appendex-B).

Total suspended solids:

Total suspended solids in ground water sample were 1.78 mgL^{-1}, 2.05 mg L^{-1} and 2.09 mg L^{-1} in sample 1, 3 and 2, respectively (Table-3). All the values for TSS were with in the permissible limits of US-EPA and WHO standards for drinking water (Appendix -B).

Total dissolved solids:

TDS (Table-3) gives fair idea of water pollution strength. The values observed for samples 1, 2 and 3 were 139mg L^{-1}, 513mg L^{-1} and 511mg L^{-1}, respectively. All the values were with in the permissible limits of US-EPA and WHO standards for drinking water (Appendix -B).

Biological oxygen demand:

BOD of ground water samples were 0.802mg $L^{-1,}$ 0.397mg L^{-1} and 0.294mg L^{-1} in samples 1, 2 and 3, respectively (Table-3). All the values were with in the safe limits of US-EPA and WHO standards for drinking water (Appendix -B).

Table-1. Analysis of ground water samples for different parameters.

S. NO	Sample Description	Temp °C	pH	EC (dS m^{-1})	TSS (mg L^{-1})	TDS (mg L^{-1})	BOD (mg L^{-1})
1	Tube Well-1	26.1	6.82	351	1.78	139	0.802
2	Tube Well Road, No. 5	26.0	7.32	509	2.09	513	0.397
3	Tube Well near PEL Ind.	26.7	7.9	511	2.05	511	0.294

Table-4. Heavy metal contents (mg L^{-1}) of ground water samples.

S #	Sample description	Ni	Cd	Pb	Cr	Cu	Zn	Fe	Mn
1.	Tube Well-1	0.030 ±0.0001	0.009 ±0.000	0.73 ±0.005	0.044 ±0.0000	0.893 ±0.0025	0.066 ±0.000	0.011 ±0.000	0.164 ±0.003
2.	Tube Well Road, No. 5	0.047 ±0.000	0.025 ±0.0008	0.21 ±0.009	0.111 ±0.0004	0.780 ±0.0007	0.007 ±0.000	0.037 ±0.000	0.059 ±0.001
3.	Tube Well near PEL Ind.	0.066 ±0.0002	0.007 ±0.000	1.20 ±0.090	0.017 ±0.001	0.870 ±0.0019	0.053 ±0.0010	0.004 ±0.000	0.079 ±0.0007

Mean Value ± SD value

CONCLUSION

The major source of surface and ground water pollution is injudicious discharge of untreated industrial effluents directly into the surface water bodies resulting in serious surface and ground water pollution. This loss of water quality is causing health hazards and death of human beings, livestock and death of aquatic lives, crop failure and loss of aesthetics. This problem is aggravated by lack of awareness, lack of wastewater treatment facilities, lack of financial resources and the inefficient environmental laws. From the present research study, it can be concluded that although the results are some what inline with the safe limits of NEQS as well as WHO but the toxic level of harmful materials can mix up with the ground water if no precautionary measures were taken for filtering of the industrial effluents.

RECOMMENDATIONS

The following technically and economically applicable options can be adopted to minimize wastes:

- Identify industrial units that are the biggest polluters of river water. The national Environmental Quality Standards (NEQS) regarding wastewater should be strictly enforced on these industries to install wastewater treatment plants.
- The drainage system should properly be constructed, covered and lined to reduce the leakage and overflow of the effluents, and the addition of solid materials like paper and plastic bags to the effluent drains which reduces the flow velocity and increasing the percolation chances to ground water causing ground water contamination.
- Regular government (EPA) monitoring should be introduced to improve environmental condition.
- Awareness should be created among the industrialists, workers and the inhabitants of the Estate for environment friendly activities.
- Trees play an important role in cleaning the environment. Trees not only consume high concentrations of carbon dioxide but also act as filters to absorb dust and toxic particulate matter. It is strongly recommended that tree plantation be undertaken by Sarhad Development Authority (SDA) and Environmental Protection agency (EPA) in and around the Industrial Estates.

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APPENDIX-A

National Environmental Quality Standards (NEQS)
For Industrial Effluents

S. No.	Parameters	Standards
1.	Temperature	40°C
2.	pH value (acidity/basicity)	6-10 pH
3.	5-days Biochemical Oxygen Demand (BOD) at 20°C	80 mg/L
4.	Chemical Oxygen Demand (COD)	150 mg/L
5.	Total Suspended solids	150 mg/L
6.	Total dissolved solids	3500 mg/L
7.	Grease and oil	10 mg/L
8.	Chloride (Cl)	1000 mg/L
9.	Fluoride (F)	20 mg/L
10.	Cyanide (CN)	2 mg/L
11.	Sulphate (SO_4^{-2})	600 mg/L
12.	Sulphide (S)	1.0 mg/L
13.	Ammonia (NH_3)	40 mg/L
14.	Pesticides, herbicides, fungicides and insecticides	0.15 mg/L
15.	Cadmium	0.1 mg/L
16.	Chromium	1.0 mg/L
17.	Copper	1.0 mg/L
18.	Lead	0.5 mg/L
19.	Mercury	0.01 mg/L
20.	Solenium	0.5 mg/L
21.	Nickel	1.0 mg/L
22.	Silver	1.0 mg/L
23.	Total toxic metals	2.0 mg/L

APPENDIX-B

US-EPA and WHO standards for drinking water

Contaminants	**U.S.EPA** (mg L^{-1})	**WHO** (mg L^{-1})
Color	Colorless	Colorless
Odor	Odorless	Odorless
Taste	Tasteless	Tasteless
Temperature °C	---	12°C
PH	6.0-8.5	6.5-9.2
DO	4-6	3 ppm
TDS	500 ppm	500
TSS	0-5	5
Cl-	250	200-500
Sulphates	250	200-400
Nitrate/Nitrite	100	45
Calcium	100	100
Magnesium	30	150
COD	4.0	10
Sodium	20	200
Potassium	---	12
E.C	300	400
Arsenic	0.05	0.05
Cadmium	0.01	0.05
Fluoride	2.2	1.5
Mercury	0.002	0.001
Iron	0.3	0.3

Manganese	0.05	0.1
Zinc	5.0	5.0
Selenium	0.01	0.01
Lead	0.05	0.05

Pollution load in industrial effluent and ground water of Gadoon Amazai Industrial Estate (GAIE) Swabi, NWFP. RN Nasrullah, H Bibi, M Iqbal, MI Durrani. Journal of agricultural and biological science 1 (3), 18-24, 2006. 56. 2006. A study was conducted for the analysis of pollution load in industrial effluent and ground water of Gadoon Amazai Industrial Estate, Swabi, NWFP, in April 2004. Samples were collected from eight different industrial units including chemical, marble, soap and oil, textile, ghee and steel industries and main drain and were analyzed for various physical and chemical parameters like pH, EC, TSS, TDS and heavy metals content. Samples of ground water were collected from three different tube wells. The pH of the samples of the industrial effluents ranged from 6.47 to 8.48, temperature ranged from 26. The untreated effluent of Gadoon Amazai Industrial Estate (GAIE) is a serious threat to the receiving surface and ground water. The study was carried out to evaluate the pollution load of five collector drains. A total of 60 samples were collected during t...Â To combat with the pollution problem at GAIE the treatment of the industrial effluents prior to its discharge was strongly felt through constructed wetlands.