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Monitoring of Wastewater Quality of Gadoon Amazai Industrial Estate NWFP Pakistan

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Abstract: 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 three months period of time i.e., December, January and February 2001 from the five drains and were analyzed for different parameters. The results revealed that collector drains had high concentration of BOD, TS, SS, DS, Sulfate and Sulfide while pH, EC, Nitrite and nitrate were found within the permissible limits as recommended by the US EPA. To combat with the pollution problem at GAIE the treatment of the industrial effluents prior to its discharge was strongly felt through constructed wetlands.

Key words: GAIE, wastewater quality, permissible limit

Introduction

Many chemical substances emitted by the industries enter the water bodies and pose serious threat to the users and routine functioning of aquatic ecosystem. Such contaminated water is unsafe for drinking, unfit for industrial activities and irrigation purposes and make the life impossible in the sink. Researchers/scientists have studied (Ahmed and Khan, 1983; Ahmed *et al.*, 1982; Ahmed and Noor, 1986. Claton *et al.*,1995; Ahmad *et al.*, 1989) water pollution in urban and industrial areas of NWFP especially Amangarh Industrial Estate Nowshera, and Peshawar and others counties Srinivas *et al.*, 1985, 1985a; Reed, 1995). Hence effective and efficient treatment of industrial effluent is essential to maintain water quality and prevent danger to man and its environment.

Gadoon Amazai Industrial (GAIE), one of the three major industrial estates of NWFP is also experiencing the same situation. There are no planned pollution control technologies available or implemented at the moment and wide range of chemicals are discharged in the environment in the form of liquid, gaseous and solid waste, hence the problem of air, soil and water pollution have developed.The most acute problem at GAIE is water pollution. The effluent contains organic and inorganic toxic materials which goes untreated to the surrounding dry seasonal nallah and ending up in the River Indus, the ultimate sink and destroy its ecological status. To cope with the problem, remedial measures and immediate treatment of effluent is necessary.

Materials and Methods

a) Location of the study area and its drainage system: The study was conducted at Gadoon Amazai Industrial Estate, one of the major industrial estates in NWFP Pakistan. All the industrial plots have been served with cemented drains, 2 feet wide in bed and 3 feet wide in the edges. The collector drains five in number i.e., D_1, D_2, D_3, D_4 and D_5, take the effluent to two seasonal nallah in the North and in the South of the industrial estate which ultimately leads to Indus river.

Drain-1 (D_1): The drain flows towards the North of the industrial estate and enters dry nullah near Hattar Textile Industry. It carries the effluents of PEL Electrical Appliances, M.B. Dyes Chemicals, Taj Syringes and Gadoon Chemical Industries. Sampling point was in part of Hattar textile Mills where effluent of all the contributing industries were completely mixed and it was easy to note the width, depth and flow of effluents.

Drain-2 (D_2): The drain flows North West and joins the dry seasonal nallah. The D_2 carries effluent of shopping bags manufacturing, steel industries alongwith domestic and laundry wastewater of Gadoon Labor Colony. The sampling point was 20 meters North of the main gate of Labor Colony.

Drain-3 (D_3): This drain is located to the western side of the GAIE, joined by drain along road 6 and finally enters into open agricultural fields where effluent is used for irrigation. The drain carries mostly the effluents of steel industries. Sampling point was the end of the cemented drain, before its entrance to agricultural fields.

Drain-4 (D_4): The drain flows South West across the agricultural fields collecting effluents from Road No.7, 8 and 9 sub drains. The drain carries the effluent of textile, chemicals, steel, plastic pipe manufacturing and ghee industries. The sampling point was near Gandaf Steel mills

Drain-5 (D_5): The drain flows Southwards; receive effluent from sub drain along road 10,11,12 and 13. It carries the effluent of marble, steel, chemicals and ghee industries. Sampling point was near the end of Road 13 on west side.

Analytical Parameters: Keeping in view, the type of industries at GAIE, existing literature and expert opinion, the parameters like electrical conductance (EC), pH, biological oxygen demand (BOD), total suspended solid (SS), total dissolved solids (DS), total solids (TS), sulphide (S), sulphate (SO_4^{-2}), chloride (Cl^-), Nitrate-Nitrogen (No_3-N) and Nitrite-Nitrogen (No_2-N) were determined. To monitor the pollution load and variation in effluent quality and quantity, discharged by GAIE, a properly designed sampling proramme was implemented. Samples were collected for three months duration i.e., December January and February 2001, during which a total of 60 samples were collected, 20 samples each month on a single day i.e., 4 samples from the five collector drains. The samples were collected in polyethylene bottles of one and half liters plastic botls from pre-selected sites. PH and conductivity were determined on the spot while other parameters were analyzed, within their holding time and according to the "standard method for examination of water and waste water.

Results and Discussions

The average values of the physio-chemical parameters analyzed for three month, 2001 are summarized in Table 1. During that period, the average BOD concentration in effluent of the entire 5 collector drains was several times higher than the standard 80mg/L for the industrial effluent. However, the variation in BOD concentration was not much significant and ranged from 189.85 15.33 mg/L in D_4 to 264.17 52.11 in drain 5. The average concentration of BOD in D_1, D_2 and D_5 was three times higher than the standard while D3 and D_4 had less than three times BOD concentration than the standard. The high BOD level in D_1 and D_5 may be attributed to chemical industries, which release high oxygen demanding wastes. While in case of D_2 the high BOD level is due to the

Table1: Average three months concentration of biological oxygen demand (BOD) (mg/L), pH, Electrical Conductivity (us/cm), Nitrate-Nitrogen (mg/L), Nitrate-Nitrogen (mg/L), suspended solids (SS) (mg/L), Dissolved solids (DS) (mg/L) and total solid (TS) (mg/L) in all he five collector drains at GAIE , NWFP, Pakistan.

Parameters	NEQS	D_1	D_2	D_3	D_4	D_5
BOD	80	251.43	262.13	218.18	189.85	264.17
		77.18	±63.13	±31.32	±15.33	±52.11
pH	6 - 9	6.78	7.28	6.90	8.32	8.33
		±1.01	±1.02	±1.05	±1.12	±1.17
EC	400	294.33	271.13	173.07	182.56	344.98
		±44.12	±39.12	±25.21	±17.17	±41.12
SO_4^{-2}	20	139.08	79.02	52.13	37.33	121.33
		±30.90	±31.03	±21.05	±5.51	±61.33
S^{-2}	6.00	7.87	8.01	12.33	12.01	9.85
		±1.97	±0.81	±1.85	±1.33	±1.02
Cl^-	1000	175.03	171.31	126.33	136.19	167.81
		±7.07	±6.82	±7.33	±9.11	±5.51
NO_3-N	--	0.75	0.57	0.49	0.31	0.98
		±0.20	±0.01	±0.05	±0.03	±0.02
NO_2-N	--	1.66	0.93	0.07	0.13	0.06
		±0.29	±0.01	±0.001	±0.001	±0.001
SS	3700	422	417.01	350.17	521.13	833.31
		±81.50	±61.30	±29.13	±63.39	±59.38
DS	200	733.33	607.19	201.19	333.93	525.52
		±264.73	±231.13	±33.13	±41.22	±169.33
TS	3500	1273.2	1030.31	575.18	858.11	1362.11
		±261.40	±221.05	±97.18	±169.13	±181.31

NEQS = National Environmental Quality Standard.

sewage and laundry waste coming to the drain from the labour colony. The low BOD concentration in D_3 is because of this drain receive little amount of effluent from one or two industries. The effluents are less polluted as major contributing industries of this drain are steel units, the effluent of which is comparatively less contaminated. Similarly, the reason for the low level of BOD in effluent of D_4 may be that this drain receives effluent from a number of steel industries, which cause dilution of the wastewater stream in drain-4. Average pH value in the five collector drains was the minimum in D_1 i.e., 6.78 1.01 while maximum (8.33 1.17) in D_5, during the three month duration. D_1 had effluent of acidic nature due to the mixing of the acidic discharges from M.B. dyes chemical industries. D_3 which had the least polluted effluent had pH values of 6.90 1.05 indicating its neutral state. Effluent of D_2 was slightly basic i.e., pH; 7.28 1.02, may be due to the addition of laundry discharge from the labor colony which had high soap content. D_4 and D_5 that had very much basic effluent with pH of 8.32 1.12 and 8.33 1.17 respectively may be due to the discharges from marble units, Majeed Soap and Sardar Chemical Industry etc. Although the variation in the pH value of the five collector drains was quite significant, the overall pH level of all the drains were well within the NEQS limits of 6-10 for industrial effluents.

The minimum average EC value 173.07 25.21 us/cm was found in effluent of D_3 during the three month duration while the maximum of 344.98 41.12 us/cm was found in effluent of D_5. The highest value of EC 1362.11 181.31 in drain-5 is justified by the presence of large amount of total solids i.e. 1362.11 181.33 in the same drain. Similarly the lowest value of EC in D_3 is due to the minimum amount of total solid 575.18 ±97.18 mg/L in the same drain. The mean concentration of SO_4^{-2} in the five collector drains of GAIE in three months duration varied from the minimum of 37.33 ±5.51 in D_4, then 52.13 ±21.05mg/L, 79.02 ±31.03 mg/L and 121.33 ±61.33 mg/L in D_3, D_2 and D_5 respectively, to the maximum of 139.08 ±70.90 in D_1. The overall results showed that SO_4^{-2} concentration was well below the standard i.e., 600 mg/L for industrial effluent.

The average Cl^- concentration in the collector drains during monitoring period were 175.03 ±7.07, 171.81 ±6.82, 126.32 ±7.13, 136.91 ±9.11 and 167.81 ±5.51 mg/L in D_1, D_2, D_3, D_4 and D_5 respectively. The high Cl^- value in D_1 may be attributed to the polluted effluent discharged from Gadoon and M.B. Dyes Chemical Industries while in D_5, high Cl^- concentration is the result of discharges from Sardar Chemical Industry and its associated ice manufacturing unit and in D_2 due to addition of sewage water. The low Cl^- concentration in D_3 and D_4 may be due to the high dilution of their effluent by the addition of wastewater from steel industry. NO_3-N was almost negligible in effluent of the collector drains throughout the monitoring programme and in most of the sample, no NO_3-N was detected. The average NO_3-N in the collector drains were 0.75 ±0.20, 0.57 ±0.01, 0.49 ±0.051, 0.31 ±0.001, 0.98 ±0.002 mg/L respectively in D_1, D_2, D_3, D_4 and D_5. In all the drains the average NO_3-N concentration was well below the standard 40 mg/L for industrial wastewater.

The average nitrate (NO_2-N) concentration in the five collector drains varied from the lowest 0.13 ±0.001 mg/L in D_4 to the highest 1.66 ±0.29 mg/L in D_1. NO_2-N in most of the sample was not detected or was found very less in concentration in those samples in which it was detected. The average three month amounts of SS in D_1, D_2, D_3, D_4 and D_5 were 422 ±81.50, 417.01 ±61.30, 350.17 ±29.13, 521.13 ±63.39 and 833.30 ±59.38 mg/L respectively. The highest amount of SS in D_5 was due to presence of Mir Marble and Mufti Marble Industries, which released very high amounts of suspended solids. In D_1 and D_4, the high amount of SS may be attributed to the effluent from chemical industries and sewage from labour colonies. The average SS values in effluent of all the five drains were several times above the NEQS.

The average DS value was lowest in D_3 (201.19 ±33.13 mg/L) and highest in D_1 (733.33 ±264.73 mg/L) during the three months duration. In D_4 the DS concentration was lower (333.93±41.22 mg/L), while in D_2 and D_5, it was moderately high (607.19 ±231.13 and 525.52 ±169.33 mg/L, respectively). M.B. Dyes Chemical Industry and Gadoon Chemicals are responsible for the high DS in the effluent of D_1. In all the five collector drains, average DS was found well below the NEQS limits of 3500 mg/L. The average TS amount in D_1, D_2, D_3, D_4 and D_5 is well below the NEQS limits of 3700 mg/L for industrial effluents.

Gadoon Amazai industrial estate is served by five collector drains for receiving the untreated effluents from various industries, ending up in the River Indus and posing a threat to the flora and fauna of the River. The results of the study revealed that all the five collector drains receiving the waste water from GAIE had high concentrations of BOD, TS, SS, DS and Sulfide when compared with the standard limits fixed for waste waters according to the US EPA. The other parameters including pH, EC, Nitrite and nitrate were found within permissible limits. In order to safeguard the area

from getting polluted, treatment of the effluent was strongly recommended.

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