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Research Article

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Physio-Chemical Assessment of Industrial Effluents in Chattogram, Bangladesh

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Abstract

Rapid industrialization is adversely impacting the environment globally. The study was carried out to evaluate the biophysical properties of samples contaminated by unplanned industrialization in terms of Effluent Treatment Plant (ETP) efficiency and availability. So, the study aims to evaluate the present scenario of water and air pollution by industrial discharges in order to create public awareness and its impact on public. The study area is Chittagong, the second largest metropolis of Bangladesh and the economic gateway of the country, is situated on the right bank of the river Karnaphuli. This research study was carried out in five industries as a sampling station before and after treatment of industrial discharges and covered mainly winter and dry seasons from Nov 2016 to July 2019.The obtained range of results of waste water were 151-454 mg L^{-1} for total suspended solids (TSS), 2129-2,999 mg L^{-1} for total dissolved solids (TDS), 2284-5710 mg L^{-1} for Total solids, 107-864mg L^{-1} for hardness, 2.26-7.02mg L^{-1} for dissolved oxygen, 61-191 mg L^{-1} for biochemical oxygen demand (BOD), 196-260 mg L^{-1} for chemical oxygen demand (COD), 0.009 mg L^{-1} for Cd, Here almost all the parameters of industrial discharges are out of range prescribed by the Department of Environment (DoE), Bangladesh which is so much frightening. So, the properly untreated industrial discharges mainly heavy metals are deposited in human bodies through food cycle and inhalation particulate matters impacts on human body. It was observed that all of the industries in the selected area did not establish the ETP section. Most of the used experimental industries almost possessed similar types of ETP and their effluent treatment ways were capable to decrease their different parameters but not effective to maintain the standard discharge limit prescribed by the DoE. Finally, it can be said that like terrorism, our government should take zero tolerance policy against industrial pollution for our existence and then we can save our environment.

Keywords: Effluents, Dry and Wet Seasons, ETP, Environmental Impact

Introduction

Over the last 3 decades, there has been increasing global concern over the public health impacts attributed to environmental pollution, in particular, the global burden of disease. The World Health Organization (WHO) estimates that about a quarter of the diseases facing mankind today occur due to prolonged exposure to environmental pollution. Most of these environment-related diseases are however not easily detected and may be acquired during childhood and manifested later in adulthood. Bangladesh lies in the northeastern part of South Asia between 20°34′ to 26°38′ North latitude and 88°01′ to 92°41′ East longitude [1]. It is one of the least developed countries with a low resources base under high population pressure, a low land man ratio. Bangladesh is an agricultural country and is now converting to industrial country but unplanned industrialization creates great impact on our environment degradation. According to world famous medical science related journal "The Lancet", Bangladesh is the most polluted country among the world [2]. In every parameter, the waste water and industrial emissions of our country is too much higher than acceptable limit which is so much alarming for our existence. Because, waste water and industrial emissions contain different kinds of hazardous heavy metals, smoke, dust, fume etc. which create great impacts on our health, our eco system as well as our biodiversity also [3]. Due to unplanned industrialization in terms of Effluent Treatment Plant's (ETP) efficiency and availability, most of the industries in our country have been established randomly here and there. That's why all the industries in our country do not establish Effluent Treatment Plant (ETP) and polluted our environment [4]. Moreover, the industries whose have Effluent Treatment Plant (ETP) do not treat the effluents properly and impacts on our environment as well as public health [5]. The industrial areas in Bangladesh are situated in the midst of densely populated regions and the growth of industries has generally been unplanned without keeping the issue of environmental protection in careful consideration [6]. In the production process industries, a lot of solid, semi-solid and liquid wastes are generated that may contain substantial amount of toxic organic and inorganic pollutants, and if dumped in the environment without treatment then this may lead to serious environmental consequences. This will also undoubtedly deteriorate soil productivity and adversely affect crop production in the surrounding land area [7]. Industrial effluents had remarkable changes in the distribution of ions and

their concentrations in wheat and bean plants [8]. The quality of dissolved minerals in water depends upon the source of water and its path before use [9].

Materials and Methods

During experimental process analytical grade E. Merck, BDH and Aldrich brand chemicals were used in all analysis. Chittagong, the second largest metropolis of Bangladesh and the economic gateway of the country, is situated on the right bank of the river Karnaphuli. In this research work, five sampling industries have been selected to collect the waste water for laboratory analysis. The study was carried out in 5 industries as a sampling station before and after treatment of industrial discharges and covered mainly winter and dry seasons between November 2016 and July 2019. The waste water samples were collected for physico-chemical and heavy metal analysis from 5 stations of the industrial discharge. Samples were collected in 100 ml Plastic bottles. All samples for laboratory analysis had been pre-washed with 10% nitric acid and rinsed with D.W. before use. Each bottle was rinsed 3 times with the appropriate amount of sample before final sample collection. For heavy metal 90 ml of effluent samples from each sampling point was transferred to 100 ml plastic bottles. For the analysis of heavy metals 10 ml 2M HNO_3 solution was taken to protect water samples from any fungal and other pathogenic attack. These samples were placed in a lightproof box to protect from direct sunlight and then taken to the laboratory for analysis. To provide necessary information for each sample, date of collection, location etc. were recorded in the note book and each sample collected in a plastic bottle was labeled separately with a unique identification number. Effluent samples were then filtered through filter paper (Whatman No. 42) to remove undesirable solid and suspended materials. In the laboratory, the bottles were kept in a clean, cool, dark and dry place. The chemical analyses of effluent were performed as quickly as possible on arrival at the laboratory of DoE.

Electrical Conductivity (EC)

The conductivity meter and cell were calibrated using 0.005 M KCl solution. Water samples were used directly for measurement of specific conductance within 5-10 min of sample collection by using Combo meter.

Dissolved oxygen (DO)

The DO meter was calibrated before every measurement using 2% Na_2SO_3 solution, MK Mohanta et al. 2010. DO was measured immediately after collection of each sample within 5-10 min at the sampling spot by using DO meter.

Biochemical Oxygen Demand (BOD_5)

The sample was taken in the bottle and diluted with the water. The probe of the multimeter was placed inside the bottle and the reading was taken and finally the bottle was placed inside the refrigerator at 200 ° C of temperature for 5 days. After 5 days, the data was taken again trough the multi meter and the result was obtained.

BOD= Initial DO-Final DO

Chemical Oxygen Demand (COD)

Turned on the reactor and preheated to 150°C. Hold the vial at 45 degree angle and 2ml of sample. Then the sample was mixed by inverting the vial. The sample was heated for two hours with a strong oxidizing agent. After the vial was placed inside, the spectrophotometer and compared it with the blank vial. Thus the result was obtained.

Total Dissolved Solids (TDS)

TDS were measured after collection of sample within 5-10 minutes at the sampling spot by using Combo meter.

$$\text{Total solid (ppm)} = \frac{\text{mg of total solid}}{\text{ml sample}}$$

Total Solids (TS) and Total Suspended Solids (TSS)

Here, 100 ml of water sample was taken in a beaker or glass dish and evaporated to dryness in an oven at 103-105 °C then cooled in a desiccator and weighed.

Total suspended solids = Total solids – Total dissolved solids

Total Dissolved Solids (TDS)

The sample water was taken in the beaker and the probe of the multimeter was placed inside the beaker for few minute. The static result shown on the screen of the multimeter was the TDS of the water.

Results and Discussion

Alkalinity

Table 1: Comparison of ETP outlet water Alkalinity values with standard

	Before treatment (mg L-1)		After treatment (mg L-1)		Standard value of Dept. of Environment, Bd. (mg L-1)
Name of plant	Dry Season ± SD	Winter Season ± SD	Dry Season ± SD	Winter Season ± SD	
Berger Paint Ltd,	213± 5	45 ± 4.5	162± 5	159± 6	
Smart Jeans ltd	361± 6	380 ± 7	197 ± 5	204 ± 6	
Chittagong Asian Paper Mill	505±4.5	597± 5	376± 5	454± 6	150
Imran Batton Industry	178± 5	169± 4	161± 5	158± 5	
Sanji Textile Factory	341± 7	376± 8	187± 8	193± 8	

Turbidity

Table 2: Comparison of ETP Outlet Water Turbidity Values with Standard

Name of plant	Before treatment (NTU)		After treatment (NTU)		Standard value of Dept. of Environment, Bd. (NTU)
	Dry Season ± SD	Winter Season ± SD	Dry Season ± SD	Winter Season ± SD	
Berger Paint Ltd,	33± 5	31± 6	11± 5	14± 6	<10
Smart Jeans ltd	29± 8	32± 10	14± 6	13± 7	
Chittagong Asian Paper Mill	67± 5	89± 6	57± 6	43± 7	
Imran Batton Industry	25± 5	24± 5	15± 5	16± 5	
Sanji Textile Factory	31± 6	28± 8	10± 7	12± 6	

Electrical Conductivity (EC)

Table 3: Comparison of ETP Outlet Water EC Values with Standard

Name of plant	Before treatment ($\mu S\ cm^{-1}$)		After treatment ($\mu S\ cm^{-1}$)		Standard value of Dept. of Environment, Bd. ($\mu S\ cm^{-1}$)
	Dry Season ± SD	Winter Season ± SD	Dry Season ± SD	Winter Season ± SD	
Berger Paint Ltd,	2307± 10	2289± 12	1407± 5	1501± 6	<1200
Smart Jeans ltd	2403 ± 8	2453 ± 9	1309 ± 8	1387 ± 10	
Chittagong Asian Paper Mill	2580 ± 8	2601 ± 9	1415 ± 8	1502 ± 10	
Imran Batton Industry	2298 ± 7	2310 ± 8	1274 ± 6	1309 ± 5	
Sanji Textile Factory	3177 ± 10	3204 ± 11	1238 ± 8	1256 ± 9	

Total dissolved solids (TDS)

Table 4: Comparison of ETP Outlet Water TDS Values with Standard

Name of plant	Before treatment ($mg\ L^{-1}$)		After treatment ($mg\ L^{-1}$)		Standard value of Dept. of Environment, Bd. ($mg\ L^{-1}$)
	Dry Season ± SD	Winter Season ± SD	Dry Season ± SD	Winter Season ± SD	
Berger Paint Ltd,	4180± 10	3898 ± 11	2306± 7	2365± 5	<2100
Smart Jeans ltd	4505± 12	4097 ± 11	2379± 9	2999± 10	
Chittagong Asian Paper Mill	4687± 8	4421 ± 9	2405± 7	2768± 8	
Imran Batton Industry	4368± 7	4375± 8	2264± 6	2587± 7	
Sanji Textile Factory	5477± 11	5502± 13	2129± 10	2645± 10	

Total suspended solids (TSS)

Table 5: Comparison of ETP Outlet Water TSS Values with Standard

Name of plant	Before treatment (mg L-1)		After treatment ($mg\ L^{-1}$)		Standard value of Dept. of Environment, Bd. ($mg\ L^{-1}$)
	Dry Season ± SD	Winter Season ± SD	Dry Season ± SD	Winter Season ± SD	
Berger Paint Ltd,	317± 3	342± 4	175± 4	181± 4	<150
Smart Jeans ltd	406± 4	397± 5	151± 3	157± 2	
Chittagong Asian Paper Mill	392± 2	401± 3	184± 2	198± 3	
Imran Batton Industry	289± 3	304± 2	179± 2	187± 2	
Sanji Textile Factory	454± 4	468± 5	153± 3	159± 2	

Total solids (TS)

Table 6: Comparison of ETP Outlet Water TS Values with Standard

Name of plant	Before treatment (mg L-1)		After treatment (mg L^{-1})		Standard value of Dept. of Environment, Bd. (mg L^{-1})
	Dry Season ± SD	Winter Season ± SD	Dry Season ± SD	Winter Season ± SD	
Berger Paint Ltd,	4497± 11	4502± 13	2284± 5	2301± 5	< 2250
Smart Jeans ltd	4911± 12	5002± 14	2557± 8	2498± 8	
Chittagong Asian Paper Mill	5979± 10	5120± 11	5710± 3	5001± 10	
Imran Batton Industry	4657± 9	4703± 10	2450± 8	2487± 8	
Sanji Textile Factory	5530± 11	5611± 14	2283± 7	2297± 8	

Hardness

Table 7: Comparison of ETP Outlet Water Hardness Values with Standard

Name of plant	Before treatment (mg L-1)		After treatment (mg L^{-1})		Standard value of Dept. of Environment, Bd. (mg L^{-1})
	Dry Season ± SD	Winter Season ± SD	Dry Season ± SD	Winter Season ± SD	
Berger Paint Ltd,	344 ± 5	351 ± 6	107± 5	124± 5	< 120
Smart Jeans ltd	348± 7	360± 8	196± 6	203± 5	
Chittagong Asian Paper Mill	876± 9	881± 10	654± 4	864± 4	
Imran Batton Industry	607± 4	597± 3	248± 2	239± 2	
Sanji Textile Factory	768± 10	774± 11	198± 5	201± 5	

Dissolved oxygen (DO)

Table 8: Comparison of ETP Outlet Water DO Values with Standard

Name of plant	Before treatment (mg L-1)		After treatment (mg L^{-1})		Standard value of Dept. of Environment, Bd. (mg L^{-1})
	Dry Season ± SD	Winter Season ± SD	Dry Season ± SD	Winter Season ± SD	
Berger Paint Ltd,	2.64± 0.25	2.49± 0.52	5.03± .5	7.02± .6	5.00
Smart Jeans ltd	2.97± 0.5	3.54± 0.35	5.98± 0.5	5.39± 0.45	
Chittagong Asian Paper Mill	5.19± 0.25	6.96± 0.63	2.26± 0.5	6.04± 0.35	
Imran Batton Industry	3.57± 0.41	3.49± 0.35	6.11± 0.56	6.42± 0.64	
Sanji Textile Factory	2.39± 0.5	2.68± 0.3	5.06± 0.46	5.12± 0.5	

Biological oxygen demand (BOD)

Table 9: Comparison of ETP Outlet Water BOD Values with Standard

Name of plant	Before treatment (mg L-1)		After treatment (mg L^{-1})		Standard value of Dept. of Environment, Bd. (mg L^{-1})
	Dry Season ± SD	Winter Season ± SD	Dry Season ± SD	Winter Season ± SD	
Berger Paint Ltd,	124± 5	139± 6	61± 5	64± 3	<50
Smart Jeans ltd	186± 7	178± 7	179± 4	174± 5	
Chittagong Asian Paper Mill	169± 4	195± 5	186± 3	191± 3	
Imran Batton Industry	128± 3	117± 3	107± 2	102± 1	
Sanji Textile Factory	154± 6	138± 5	93± 3	81± 3	

Chemical oxygen demand (COD)

Table 10: Comparison of ETP Outlet Water COD Values with Standard

Name of plant	Before treatment (mg L-1)		After treatment (mg L^{-1})		Standard value of Dept. of Environment, Bd. (mg L^{-1})
	Dry Season ± SD	Winter Season ± SD	Dry Season ± SD	Winter Season ± SD	
Berger Paint Ltd,	344± 10	351± 11	240± 5	231± 2	< 200
Smart Jeans ltd	348± 12	360± 10	196± 7	203± 8	
Chittagong Asian Paper Mill	876± 5	881± 8	254± 3	260± 4	
Imran Batton Industry	607± 3	597± 4	248± 5	239± 4	
Sanji Textile Factory	768± 11	774± 12	198± 6	201± 7	

Arsenic

Table 11: Comparison of ETP Outlet Water Arsenic Values with Standard

Name of plant	Before treatment (mg L-1)		After treatment (mg L^{-1})		Standard value of Dept. of Environment, Bd. (mg L^{-1})
	Dry Season ± SD	Winter Season ± SD	Dry Season ± SD	Winter Season ± SD	
Berger Paint Ltd,	0.16± 0.04	0.20± 0.03	0.09± 0.03	0.07± 0.04	0.05
Smart Jeans ltd	0.09± 0.001	0.13± 0.002	0.06± 0.001	0.08± 0.003	
Chittagong Asian Paper Mill	0.97± 0.074	0.88± 0.013	0.11± 0.019	0.10± 0.012	
Imran Batton Industry	0.08 ± 0.006	0.10± 0.01	0.03 ± 0.005	0.02± 0.004	
Sanji Textile Factory	0.93± 0.008	0.72± 0.011	0.09± 0.006	0.10± 0.002	

Cadmium

Table 12: Comparison of ETP Outlet Water Cadmium Values with Standard

Name of plant	Before treatment (mg L-1)		After treatment (mg L^{-1})		Standard value of Dept. of Environment, Bd. (mg L^{-1})
	Dry Season ± SD	Winter Season ± SD	Dry Season ± SD	Winter Season ± SD	
Berger Paint Ltd,	0.043±0.009	0.056±0.006	0.003±0.005	0.004±0.006	0.005
Smart Jeans ltd	0.075±0.002	0.068±0.003	0.005±0.001	0.008±0.002	
Chittagong Asian Paper Mill	0.025±0.003	0.019±0.008	0.004±0.001	0.002±0.001	
Imran Batton Industry	Not detected	Not detected	Not detected	Not detected	
Sanji Textile Factory	0.063±0.006	.072± 0.008	0.008±0.001	0.009±0.001	

Conclusion

It was observed that all of the industries in Bangladesh do not establish the ETP section. In many of the industries, effluent treatments were not up to the mark and were not checked frequently by the factory authority, Department of Environment or Concerned bodies. The another vital problems experienced by different factories with ETPs were inadequate treatment due to inappropriate, inaccurate dosing of chemicals needed in the treatment process and also the compliance and enforcement of these regulatory measures were not optimum and satisfactory. The other problems experienced by different industries, many industries start their ETP plant just before entering the monitoring officers of DOE in their factory. As a result, dangerous heavy metals and non-metals in water were existed which create huge impact in our body as well as aquatic environment. Finally, it can say that like terrorism, our government should take zero tolerance policy against industrial pollution for our existence. Then we can save our environment.

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