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Comparison of Different Parameters of Four Selected Industrial Effluents in Chittagong Metropolitan, Bangladesh

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ABSTRACT

A study was executed at Nasirabad Industrial Area, Chittagong to compare important parameters of industrial effluents viz. physical, chemical and heavy metals from four types of industries such as steel, textile, chemical and garments. For sample collection three points were selected from each industry – discharging, mixing and universal points. Then all collected samples were analysed by using pH electrode, DO electrode, sension 156 portable multi-parameter meter, and spectrophotometer etc. It revealed that effluents from garment industry were awfully polluted, they exposed the lowest DO value (1.0 mg/L) and highest TDS (512 mg/L), EC (1135 mho/cm) and BOD (76.66 mg/L), COD (326 mg/L), Chromium (0.283 mg/L), Zinc (0.041 mg/L) and Lead (0.69 mg/L). Most of the cases the second point showed surpassing effluents accumulated. Comparatively, steel industry was found less contaminated as-well-as in all industries universal points wherein all parameters showed the values is under standard level due to natural assimilative capacity.

Keywords: Industrial effluent, parameters, pH, TDS, BOD, COD, EC, and Heavy metals.

I. INTRODUCTION

Bangladesh is a developing country and currently its economy is growing fast along with industrial expansion. Therefore, there are total 30 industrial estates in Bangladesh wherein the Bangladesh Export Processing Zones Authority (BEPZA) was established to setup and operate export processing zones in Bangladesh under the Bangladesh Export Processing Zones Authority Act, 1980. Later, the Chittagong Export Processing Zone (CEPZ) was established in 1983, following the Dhaka Export Processing Zone (DEPZ) was created in June 1993 [18]. After the creation of Pakistan in 1947, much trade was diverted to Chittagong from Calcutta, and the port was considerably improved [8]. Further, international trade of any country mainly depends on sea ports facilities wherein the chief sea port of Bangladesh is situated in Chittagong through which about more than (80%) exports and imports are accomplished annually. Hence, it is the prime zone for new industrial establishments and expansion of old ones too. Consequently, a few industrial zones have already been established in Chittagong. About (40%) of the heavy industries of the country are located in Chittagong wherein small industrial parks are namely Nasirabad, Kalurghat, Patenga, Bhatiary etc. Unfortunately, what makes it so useful, such as economic growth, also makes it problematic when these industries discharge untreated effluents into water bodies which contain verities of hazardous and toxic components [3, 19] and they are liable to contaminate our surrounding environment. Dearth-of proper technology and fund along with skilled technician, this tough task is performed through rough and conventional way.

Industrial effluents (IEs) are unavoidable by-products of industrial activities. With the growth of industries, IEs are also producing in large volume wherein most of the IEs are directly thrown away into the adjacent water bodies' paradigm river, lake, stream, lagoon etc. and contaminate surface water sources [11]. Besides, characteristics of IEs vary widely from one factory to another viz. wet processing of textiles, steels, paper, fertilizers, cements, and pharmaceuticals generate a large volume of IEs with a-great-deal of inorganic and organic chemicals, detergents, soaps, oils, corrosive substances and other impurities which effects in temperature, BOD and COD load of water [9]. The most significant physical features of IEs is its total solids (TS) content, which is composed of floating matter, matter on suspension, colloidal matter, and objects in solution wherein chemical and physical appearances are formed by dissolved ingredients. Then biological features are identified by the presence of bacteria, and algae [15]. There are manifold components of IEs – organic substances and synthetic combinations. As example: NH_3 pollutant is discharged from urea fertilizer plants and the maximum absorption limit is 100-400 ppm [2]. Then chromium waste is released primarily from tanneries and the threshold limit is 0.1 ppm. In addition, phenols are common pollutants in the chemical industries and the acceptable limit in potable water is 0.0002 ppm. Color may be of burden when the diffusion factor of the receiving water is low and light penetration is minimized, affecting plant growth. Miniature industries viz. metal, machine tools, tannery and textile colouring plants are more responsible for environmental deterioration and pollution [8].

Bangladesh, basically an agricultural country and experienced its industrialization very beginning of the fifties based on primarily agricultural raw materials and the expansion of the industrial sector has been very crawling due to the-start-of industrialization process. Afterwards, the rest industries which are more harmful for environment like tanneries, textile, pulp and paper, oil refineries, paint, fertilizer manufacturing industries etc. were established gradually. These industries consume a gigantic volume of water in their manufacturing channel and discharge hazardous effluents without pre-treatment [10] where most of the industries are located on the river banks and therefore IEs flow directly in the vicinity of water bodies. However, industrial advancement is the crying demand for economic development but rapid and unplanned industrial growth is responsible for committing manifold mistakes. Therefore, Bangladesh has the advantage of being a comparatively late starter, can learn from the mistakes done of first world countries and avoid those technologies consume more energy and resource [1]. A wide variety of pollutants are present in IEs which are coming out from verities of factories containing oil, greases, plastic, metallic wastes, suspended solids, phenols, toxins, acids, and salts, dyes, cyanides, DDT etc. myriad of which are not readily susceptible to degradation and thus antecedents drastically pollution troubles [11]. As a result, environmental toxicities are occurred due to indiscriminate industrial growth and discharge of untreated wastewater into natural aquatic resources especially in river or canal flow which finally reach to the sea. Then the pollutants in sea may become dispersed by turbulence and oceans currents or concentrated in the food chain which may result in the loss of species diversity. Moreover, the pollution in inland water bodies is sometimes so serious that they are not fit even for irrigation [7].

But reviewing all published literatures, its stark clear that test of different parameters of IEs in commercial city of Bangladesh is not sufficient and informative. In Chittagong, there are many types of industries amidst; the extreme polluting ones are tanneries, pulp and paper, fertilizer, chemicals etc. [8]. Wherein, Nasirabad Industrial area is enclosed by various sorts of factories among them bigger types are iron and steel mills, textile and dyeing, garments, chemical industries, packaging etc. which together are 142 units. Therefore, we conducted this study with the motto of investigating current wastewater quality and to compare among different parameters from four types of selected factories.

II. METHODS AND MATERIAL

Sample Collection and Preservation

Four types of effluent discharging factories were selected from Nasirabad Industrial Area for modelling which are steel, textiles, chemical, and garments. From each category of industry 3 units were selected randomly due to barricade to enter into factories to conduct investigation. Then, we pointed out three points for each unit paradigm discharging point (before mixing), mixing point (with nature and similar sort of industry) and universal point (where diverse types of effluents get mixed and far away). For the vision of accurate assessment of effluent qualities, the fragments were assembled with intensive care. There was no way to separate effluents with respect to their origins, so three samples were collected from little distance. For taking samples plastics bottles were first washed thoroughly with soda water and distilled water before collecting the sample to confirm that it is absolutely free from any undesirable materials or micro-organisms. Then samples were stored plastic bottle and filled the whole volume of the container and a cap was locked enough so that no air space can be remained inside the bottle. The clustered water segments were then carefully brought and preserved in refrigerator for analysis in the laboratory of Chittagong WASA.

Required Apparatus and Reagents

Required apparatus are DO and pH electrode, sension156 Portable Multi-parameter Meter, 250 ml beaker, pipette, stirrer, and spectrophotometer. On the other hand, reagents are distilled water; seed (mixed micro-organisms solution solution), Na2O3, H2SO4, Potassium, Dichromate, Hg2SO4, Ag2SO4, KHP, standard buffer solution, Potassium 1, Chromo Ver 3, Cu Ver 1, Zinco Ver 5 buffer powder pillow, and Chloroform.

Analytical Procedure for Sample Analysis

The analytical work was accomplished quickly after collection of samples to certify better results. The assembled fragments were analysed in the laboratory to detect pH, TDS, DO, BOD, COD, EC, Cl^- and heavy metals (Pb, Cd, Cr, Cu, Zn) in Chittagong WASA and Institute of Forestry and Environmental Sciences, University of Chittagong lab by adopting required apparatus and reagents. For determining actual value of each parameters, we adopted individual process suchlike pH test of effluent was conducted by practicing pH electrode and sension 156 Portable Multi-parameter Meter. TDS was determined by utilizing buffer solution at ambient temperature. Wherein after standardization the electrode was washed with distilled water and then about 50 ml of water was taken in a clean beaker and electrode was completely submerged in the sample. After stirring gently for sometimes the TDS meter gave a stable TDS reading in mg/L unit.

Dissolved Oxygen (DO) was determined using the DO electrode and sension 156 Portable Multi-parameter Meter. DO electrode was set by sliding the switch on the top of the meter. Then the electrode was immersed into the solution to be tested. After, the electrode was stirred gently and waited for the reading to stabilize. Similarly, BOD test was carried out by diluting the sample with de-ionized water saturated with oxygen, inoculating it with a fixed aliquot of seed, measuring the DO and sealing the sample. The sample was kept at 200 °C in the dark to prevent photosynthesis for five days, and the DO was measured again. BOD was calculated by using the following formula:

BOD (for diluted sample) = Initial DO – Final DO × Dilution Factor

Then for detection COD 0.4g HgSO4 was placed in reflux flask. Then 20 ml of sample was diluted with 20 ml of distilled water. 10 ml standard $K2Cr_2O_7$ was added slowly followed by 30 ml H_2SO_4 which already contained silver sulphate. This slow addition along with swirling prevents loss of volatile materials such as fatty acids in the sample. Then it was mixed well with glass beads. After, the flask was connected to a condenser and refluxed for 2 hours and then cooled and washed down with condensers with small quantity of distilled water. After that the flask was removed and added with about 80 ml distilled water. Then cooled and titrated against standard ferrous ammonium sulphate using ferrion as indicator. Color changed sharply from green blue to wine red. In the reflux flask, a reagent blank reading under identical condition was taken simultaneously with sample water and finally COD was calculated. In contrast, Electric Conductivity (EC) was identified by using the conductivity electrode and sension156 Portable Multi-parameter Meter and following almost similar steps as DO test.

Spectrophotometer (model- HACH: DR/4000V) was adopted to determine the volume of heavy metals (Cr, Zn, Pb, Cu and Cd) in the effluent water. At first 25 ml of sample was filtered by filter paper and HACH programme was on. The stored program for hexavalent chromium was selected by pressing 1560 then 'Enter' was pressed and displayed "HACH PROGRAM: 1560 Chromium, Hex." Then a cell of sample was filled with 10 ml of filtered sample and one 'Chroma Ver 3' reagent powder pillow was added to the sample cell. After it was swirled to mix and 'START TIMER' was pressed then 8-minute reaction period began. Another sample cell was filled with 10 ml of sample (the blank) and when the timer beeped, and then the blank was placed into the cell holder. The light shield was closed and the zero key was pressed and displayed '0.000 mg/l Cr6+'. Similarly, other heavy metals were identified but Wagtech International Series (As Test Kit) operational manual was adopted to calculate the volume of As in the effluents.

Data Analysis

The analytical data of various parameters were carefully recorded and then compiled in MS-excel sheet. Latter, we made re-arrangement of the assembled data for the convenience of analysis and achieving expected outputs. Then we consulted with the experts about our graft results. Finally, all the data were converted into Minitab software format and was analysed by using both Minitab, Microsoft Excel program (2007) and SigmaPlot12.

III. RESULT AND DISCUSSION

Total Dissolved Solids (TDS)

The experiment reveals that the level of TDS did not vary significantly ($p < 0.05$) amidst different types of factories but there lies symbolic variations among the sampling stations. The maximum TDS (512 mg/L) was observed in the second post of garments industries and the under most (226 mg/L) was in discharge point of chemical factories (figure 1). In the third position TDS obtained 336.66 mg/L. However, TDS of all categories of industry remained the standard value (2100 mg/L). TDS are the total mineral content of the water, primarily salts, carbonates and metals. High TDS greater than 1000 mg/L is commonly objectionable or causes offensive taste [18]. A maximum concentration of dissolved solids escalates the density of water, affects osmoregulation of fresh water organisms and reduces solubility of gases and utility of water for drinking, irrigational and industrial purposes. Moreover, high TDS can result in corrosion of metal equipment and accessories and also permit algae bloom [6].

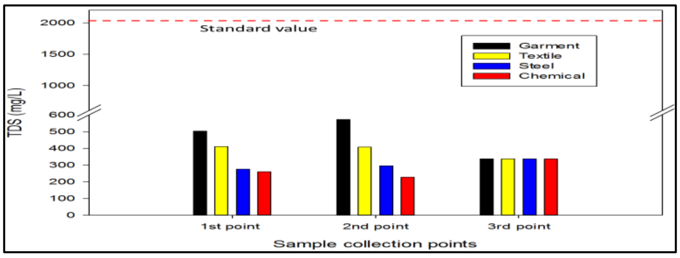

Fig. 1: Normal total dissolved solid (TDS) levels in industrial effluents.

Acidity or alkalinity measurement (pH)

The highest pH (6.0) was hoarded from the acquittal station of garment industry and the slightest pH from the second terminal of chemical and the second point of steel industry. Third station of sample values overtook curtailed standard level; otherwise other industries remain within standard equivalent (6.0 to 9.0). The investigation disclosed that the degree of pH did not vary significantly ($p < 0.05$) amidst diverse groups of factories but there lies meaningful variations betwixt the segmenting posts. The effluents of chemical industries are acidic in nature probably due-to the practice of un-similar chemicals paradigm HCl, H_2SO_4, Ca(OCl)Cl etc. [8]. Acids or alkalis fabricate the inheriting stream ill-suited for the vegetation of fish and other aquatic lives and brought-about austere hindrances. In contrary, the unpleasant feature of foul-tasting water, minor pH assessments usually have few negative health effects. Acidic but potable water can incite humourless troubles, however, through the leaching of heavy metals from plumbing channels. The non-profit 'Water Systems Council' warns that these toxic metals can include substances such-as lead. The 'New York State Department of Health' explains that lead exposure can divert to a host of neurological and reproductive problems. Ingestion of lead-tainted water is one way adults can become exposed to this toxin. Aquatic wildlife also suffers from the effects of pH extremes [13].

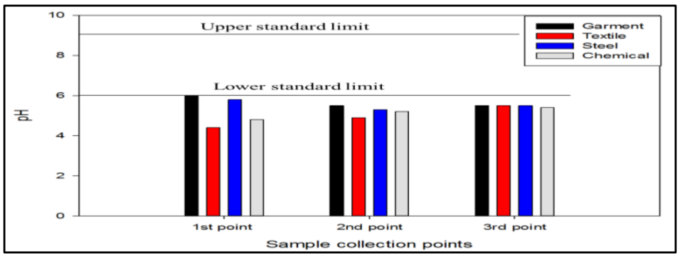

Fig. 2: Average pH value in industrial effluents.

Electric Conductivity (EC)

It was revealed that electric conductivity (EC) was highest (1135 mho/cm) in the second position of garments whereas lowest (456 mho/cm) in second position of chemical industries (figure 3). Among the three positions of sampling points steel and chemical industries showed lower concentration. In the garments and steel industries EC gave higher value in the second position but reduced in textile and chemical industries. From third point, we observed that EC of steel and chemical industries increased (670 mho/cm). However, EC of all categories of industries remained within the standard value (1200 mho/cm). The study revealed that the level of EC did not vary significantly ($p < 0.05$) among different categories of industries but there lies significant variations among the sampling points. Wherein the EC of the water depends on the water temperature: the higher the temperature, the higher the EC would be. The EC of water increases by 2-3% for an increase of 1 degree Celsius of water temperature. Many EC meters nowadays automatically standardize the readings to 25°C. The same EC values can be measured in low quality water and in high quality irrigation water.

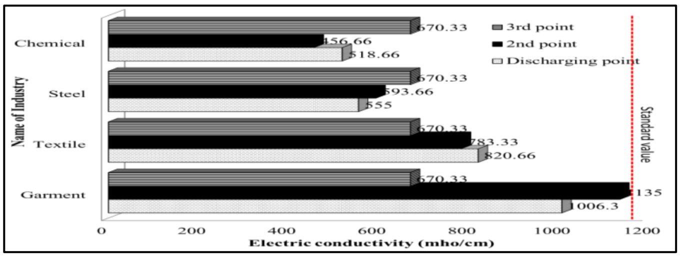

Fig. 3: Average EC levels of effluent from different industries studied.

Dissolved Oxygen (DO)

The study revealed that DO value was not varying significantly among different categories of industries but there lies significant variations among the sampling point except steel industry. DO reading of all categories of industries was below the level of standard value. DO levels of chemical industries in its discharge point is lowest (1.0 mg/L) and highest value (3.21 mg/L) obtained from second point of steel effluents (Figure 4). Among the three points of sample third point is nearer to optimum level. In third point DO concentration increased and reached nearer to optimum level. Low DO concentrations in fresh water aquatic systems indicate high pollution level in water. Lower DO level in the effluents may be due to presence of chemically oxidized and biodegradable organic compounds in effluents. These organic compounds are readily degraded in aqueous medium by soil and microorganism present in the sewage. During this process, DO in the stream is used up. When the DO is reduced below a certain limit, aquatic life is affected adversely. Many organic chemicals may be used by microorganisms in watercourse as sources of energy and chemicals necessary for growth. When DO is used faster than it will be replenished, its concentration in water bodies decreases. Reduction of DO less than perhaps 3-5 mg/L can cause an adverse impact on fish that need a relatively high oxygen concentration to meet their metabolic needs. A further increase in oxygen demand would result in an even lower DO and progressively worse conditions for fish and other aquatic lives. The absence of DO would result in the growth of microorganisms that produce by-products that cause foul odors in the water and its surroundings [12]. (Table 1) showed that each garments industries discharged effluents which either untreated or not properly treated. Standard value of DO varies from 4.5-8 mg/L, but we didn't see any industry discharging nearer to optimum level, moreover DO level Sirina garment obtained below 1.5 mg/L which is very alarming. Further, (table III) showed that each steel industry except Bayezid discharged effluents which either untreated or not properly treated. Effluents from Bayezid steel properly treated as its DO reading was 4.8 mg/L which is nearer to standard value. But (table 3) showed that chemical industry discharged same untreated or not properly treated effluents wherein we didn't observe any industry discharging nearer to optimum level; moreover DO level of elite paint marked below 1.5 mg/L. Additionally, (table 4) showed that among all chemical industries only Chowdhury textile discharged treated effluents. Similarly, we didn't observe any industry discharging closer to optimum level without Chowdhury textile.

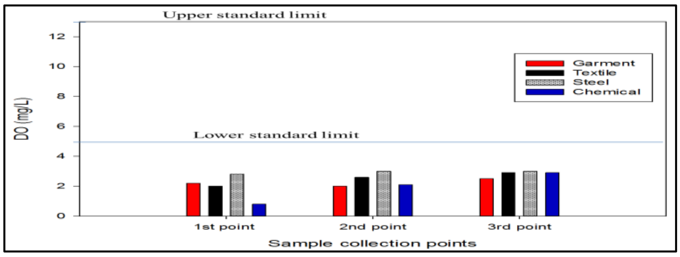

Fig. 4: Average DO levels of effluent from different industries studied.

Biological Oxygen Demand (BOD)

The study revealed that the level of BOD was not varying significantly among different categories of industries but there lies significant variations among the sampling point**.** However, chemical industries showed highly significant variation. From the experiment the highest BOD (76.66 mg/L) was found in first point of chemical industry and the lowest (32.33 mg/L) was found in second point of steel industry. In every points BOD level of garments and chemical industry exceed standard value (50 mg/L) (Figure 5). Whereas in the second position of textile and steel industry is on optimum level. Higher BOD level indicates more bacterial activities and in these cases bacteria rob the available DO necessary to survive by the other aquatic organisms like fishes. Many organic chemicals may be used by micro-organisms in watercourse as sources for energy and chemicals for necessary growth which may cause breakdown of organic constituents to simpler compounds and often ultimately to inorganic ashes and gases. These biochemical reactions result in utilization of oxygen dissolved in the water imposing a high BOD [12]. The BOD test serves an important function in stream pollution-control activities. It is a bioassay procedure that measures the amount of oxygen consumed by living organisms while they are utilizing the organic matter present in waste, under conditions similar in nature. BOD indicates the amount of organic matter present in water. Therefore, a low BOD is an indicator of good quality water, while a high BOD indicates polluted water. DO is consumed by bacteria when large amounts of organic matter from sewage or other discharges are present in the water. Fish kills and an invasion and growth of certain types of weeds can cause dramatic changes in a stream or other body of water. Energy is derived from the oxidation process. (Table 2) showed that each steel industry except Bayezid discharged effluents which either untreated or not properly treated. Effluents from Bayezid steel properly treated as its BOD reading is nearer to standard value (50 mg/L). Whereas Saleh steel discharged huge amount untreated waste. Here, BOD crossed the standard limit and so effluents are needed to be treated.

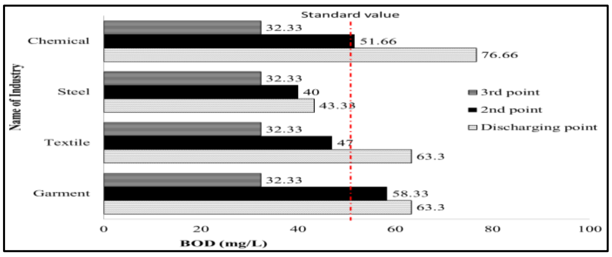

Fig. 5: Average BOD levels of effluent from different industries studied.

Chemical Oxygen Demand (COD)

The highest COD equivalent (326.66 mg/L) was noticed in the chemical industry at releasing point and the lowest (220 mg/L) was found in second position of both textile and steel industries. It was also seen that in the two stations COD level of all factories exceeded the standard level (200 mg/L) (figure 6). Meanwhile, third point represented a COD value of 163.33 mg/L lies below the standard level. The COD test reflects an indication of the impact of discharged water on aquatic life by means of DO depleting nature. Effluents from steel, textile, chemical and garments industry contain various volumes of chemicals which are adopted by micro-organisms for their metabolic process and accelerate high COD demand. The study showed that the level of COD did not differ significantly ($p < 0.05$) among dissimilar types of industries but there lies symbolic variations among the sampling station. High COD levels shrink the quantity of DO available for aquatic organisms. Low (generally under 3 mg/L) DO or hypoxia causes reduced cell functioning, disrupt circulatory fluid balance in aquatic species and can result in death of individual organisms. Hypoxic water can also release pollutants stored in the sediment. In case of tannery industry, soluble COD varies from 0.46 for raw effluents to 0.54 for chemical treatment effluents [14]. Further, COD test is useful in pin-pointing toxic condition and presence of biological resistant substances. The COD test is important to monitor and control the discharge of effluents and for assessing treatment plant performance [20]. (Table 2) showed that each steel industry except Bayezid discharged effluents which either untreated or not properly treated. Effluents from Bayezid steel properly treated as its COD reading is nearer to standard value (200 mg/L). Wherein Saleh steel discharged huge amount untreated waste. Here, COD crossed the standard limit and effluents needed to be treated.

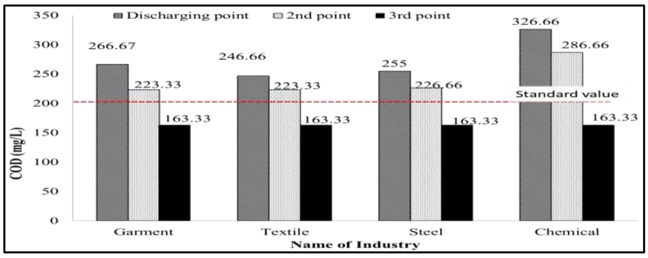

Fig. 6: Common COD values in industrial effluents.

Chloride (Cl^-)

Similarly, it was observed that volume of chloride is the apical (500.00 mg/L) in the second position of textile industry and the lowest (132.66 mg/L) in emitting point of garment industry (figure 7). In the third station, Chloride level is 121.66 mg/L which is the slightest than others. The study reveals that the value of Chloride did not deviate significantly ($p < 0.05$) betwixt different tiers of industries but there lies important variations among the sampling points. However, level of chloride in effluents of all categories was within the standard value (600 mg/L).

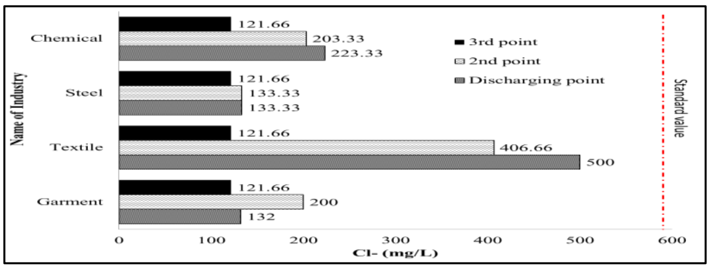

Fig. 7: Average Cl values in industrial effluents.

Chromium (Cr)

In case of Chromium, the maximum level (0.283 mg/L) of Cr was detected in steel industry in the second station. And the value (0.11 mg/L) was found in garment factory at its discharge point. In the third position, Cr concentration obtained 0.03 mg/L (figure 8). The investigation represented that the degree of Cr did not vary significantly ($p < 0.05$) between different groups of industries but there places momentous variations among the sampling stations. Else, steel and chemical industries utilize chromium for various objectives. This element is carcinogenic which may cause severe effect on aquatic lives [5] but our finding of Cr releasing is not so serious.

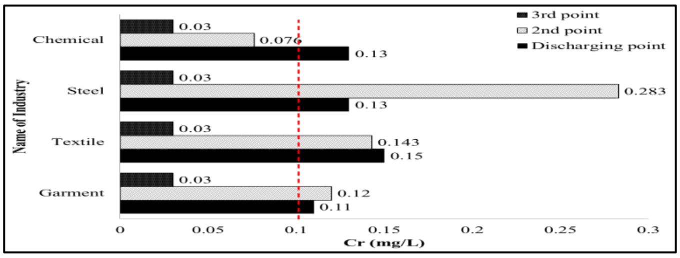

Fig. 8: Normal Cr levels in industrial effluents.

Zinc (Zn)

The supreme level (0.041 mg/L) of Zinc was found in garment industry in it's the second point and the lowest value (0.013 mg/L) was detected in the second point of chemical factory (figure 9). No concentration of zinc observed in the third position. The analysis shows that the level of Zinc did not alter significantly ($p < 0.05$) in the midst of verities categories of industries but there remain meaningful variations among the sampling point. Zinc is an important dietary element, but concentrations above 5 mg/L can impart an unpleasant taste to water. Exposure to gigantic amounts of Zinc can befall stomach cramps and anaemia, and also shrink good cholesterol. In marine waters, aquatic species suffer acute effects from Zinc at 90 µg/L. Adverse effects of dissolved Zinc, including altered behaviour, blood and serum chemistry, impaired reproduction, and reduced augmentation, occur to salmon at very low levels (5.6 µg/L in freshwater). In mammals, ingesting huge volume of Zinc can cause infertility and underweight offspring [17]. (Table 1) heavy metal concentration obtained from this experiment is not satisfactory. Report showed that zinc absent in jakmur fashions and their effluents free from heavy metal. But Sirina garments and design apperals discharging a significant concentration of heavy metal, though the value is minute. Standard value of zinc is 5 mg/L wherein zinc concentration is not alarming among all heavy metals. Besides, (table 3) showed that chemical industry discharged untreated or not properly treated effluents. Heavy metal concentration obtained from this experiment is not satisfactory. Report showed that zinc absent in Al-karim paint. Further, (table 4) showed that among all chemical industries only Chowdhury textile discharged treated effluents. Clifton group discharged high concentrated heavy metal.

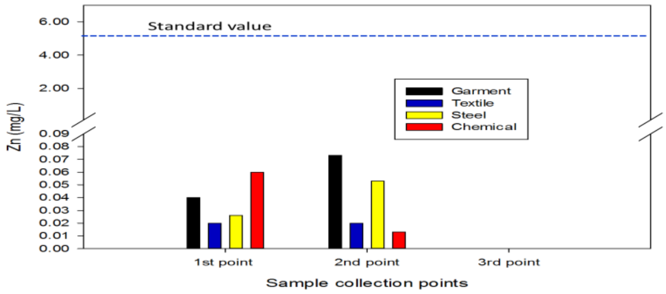

Fig. 9: Average Zn levels in industrial effluents.

Lead (Pb)

In case of lead the topmost level (0.69 mg/L) was shown in chemical industry at acquittal point and the under most level (0.016 mg/L) was found in the second post of textile factory. In the third station lead absorption was 0.16 mg/L (figure 10). Lead concentration of all tiers in every point exceeds the standard equivalent (0.1mg/L). The studied disclosed that the degree of Lead did not differ significantly ($p < 0.05$) among various categories of industries but there was found indicative variations among the sampling stations. Unlike other trace elements, lead is neither essential nor beneficial for living organisms. Organic compounds are generally more toxic than inorganic lead compounds. Adverse effects of lead in water on aquatic species occur at congregations of (1.0-5.1) ug/L and include shortened survival, impaired reproduction and abridged enlargement [16]. From (table 1), heavy metal concentration obtained from this study is not satisfactory wherein Sirina garments and design apperals discharging a significant concentration of heavy metal, though the value is minute. However, (table 3) showed that chemical industry discharged untreated or not properly treated effluents. Report showed that lead in elite paint crossed standard value. Contrary, (table 4) showed that among all chemical industries only Chowdhury textile discharged treated effluents. Clifton group discharged high concentrated heavy metal, lead exceed standard level (0.1 mg/L).

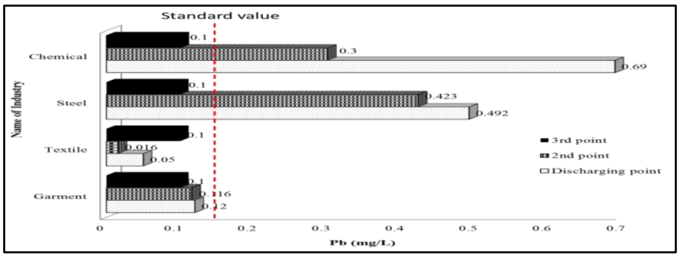

Fig. 10: Common Pb levels in industrial effluents.

Cadmium (Cd)

The maximum level (0.09 mg/L) of cadmium was noticed in chemical factory at acquittal point and the lowest level (0.03 mg/L) was found in the second post of textile industry. In the third station cadmium consolidation was 0.006 mg/L (figure 11). Two positions of steel and two points of chemical industry exceed its optimum level (0.05mg/L). Nevertheless, all other stations of the preferred stations observed value are below under standard level. From (table 1), heavy metal concentration obtained from this study is not satisfactory. Report showed that cadmium absent in jakmur fashions and their effluents free from heavy metal. But Sirina garments and design apperals discharging a significant concentration of heavy metal, though the value is minute (standard value of cadmium 0.05mg/L). Besides, (table 3) showed that chemical industry discharged untreated or not properly treated effluents. Heavy metal concentration obtained from this research is not satisfactory. Report showed that cadmium absent in Al-karim paint. But in case of elite paint cadmium crossed standard value (0.05mg/L). Moreover, (table 4) showed that among all chemical industries only Chowdhury textile discharged treated effluents. Heavy metal concentration obtained from this study is not satisfactory. Clifton group discharged high concentrated heavy metal but cadmium remains below than standard in different positions (standard value of cadmium 0.05mg/L).

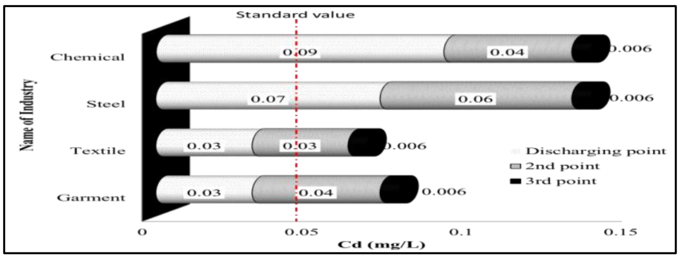

Fig. 11: Average Cd levels in industrial effluents.

Arsenic (As)

The apical value (0.23mg/L) of arsenic was noticed in chemical factory at discharge station and no absorption (0.0mg/L) of arsenic observed in sample of textile industries. In the third point arsenic concentration was in an average of 0.003 mg/L (figure 12). Two positions of chemical industry exceed its optimum level (0.2 mg/L). Then the rest studied points of other factories remain under standard equivalent. Contrary, since 2006, the American state of New Jersey has enforced an arsenic drinking water standard or maximum contaminant level (MCL) of 5 μg l−1 instead of the federal MCL of 10 μg l−1 [4].

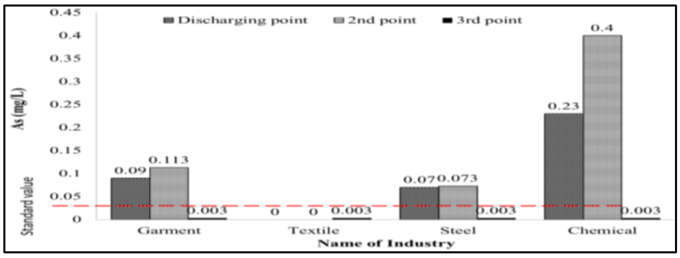

Fig. 12: Common As levels in industrial effluents.

Copper (Cu)

The study shows that the level of Copper did not vary significantly ($p < 0.05$) among different categories of industries but there lies significant variations among the sampling point. The highest level (0.09mg/L of copper was found in textile industry at discharge point and no concentration (0.003mg/L) of copper found in textile industry (figure 13). In third point copper concentration was nil. Two points of chemical, two points of textile and one point of steel industry exceed its optimum level (0.05mg/L).

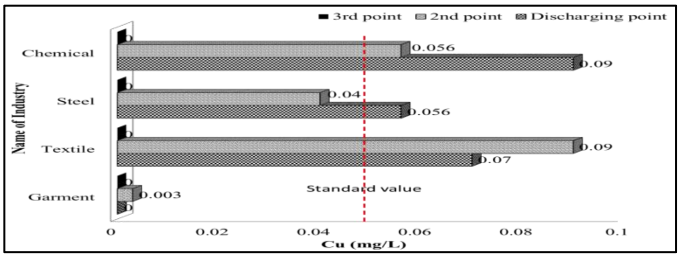

Fig. 13: Average levels of Cu in industrial effluents.

TABLE 1

COMPARATIVE ANALYSIS OF EFFLUENT PARAMETERS OF DIFFERENT GARMENTS

Name	Collection point	Parameters						
		Chemical			Heavy metal			
		DO (mg/L)	COD (mg/L)	BOD (mg/L)	Cr (mg/L)	Pb (mg/L)	Cd (mg/L)	Zn (mg/L)
Jakmur Fashion	DP	2.5	280	70	0.15	0.15	0	0
	MP	2.7	180	55	0.15	0.13	0	0
Sirina Garment	DP	2.0	210	65	0.1	0.12	0.05	0.12
	MP	1.5	250	75	0.13	0.12	0.50	0.13
Design Apparel	DP	2.5	300	55	0.08	0.1	0.04	0
	MP	2.3	200	45	0.08	0.1	0.04	0.09

DP = Discharge point (Sample taken before mixture); MP = Mixed point (Sample taken from drain)

TABLE 2

COMPARATIVE ANALYSIS OF EFFLUENT PARAMETERS OF DIFFERENT STEEL INDUSTRIES

Industry	Collection point	Parameters						
		Chemical			Heavy metal			
		DO (mg/L)	COD (mg/L)	BOD (mg/L)	Cr (mg/L)	Pb (mg/L)	Cd (mg/L)	Zn (mg/L)
Saleh Steel	DP	2	320	65	0.15	0.92	0.07	0.03
	MP	2	320	55	0.15	0.1	0.01	0.07
Bayezid Steel	DP	4.8	195	45	0.05	0.21	0.08	0.01
	MP	4.8	180	35	0.5	0.021	0.08	0.03
BSRM Steel	DP	3.0	220	40	0.2	0.14	0.08	0.04
	MP	3.5	180	40	0.2	0.14	0.08	0.06

TABLE 3

COMPARATIVE ANALYSIS EFFLUENTS PARAMETERS OF DIFFERENT CHEMICAL INDUSTRIES

Name	Collection point	Parameters						
		Chemical			Heavy metal			
		DO (mg/L)	COD (mg/L)	BOD (mg/L)	Cr (mg/L)	Pb (mg/L)	Cd (mg/L)	Zn (mg/L)
Al Karim Paint	DP	2.0	320	80	0.15	0.95	1.24	0.03
	MP	3.0	50	220	0.12	0.02	0	0
Eastern Chemical	DP	2.5	320	75	0.15	0.68	0.8	0.05
	MP	2.1	320	55	0.05	0.03	0.01	0.04
Elite Paint	DP	1.5	350	75	0.1	0.45	0.95	0.1
	MP	2.0	320	50	0.06	0.04	0.1	0

TABLE 4

COMPARATIVE ANALYSIS OF EFFLUENT PARAMETERS OF DIFFERENT TEXTILE INDUSTRIES

Name	Collection point	Parameters						
		Chemical			Heavy metal			
		DO (mg/L)	COD (mg/L)	BOD (mg/L)	Cr (mg/L)	Pb (mg/L)	Cd (mg/L)	Zn (mg/L)
Chowdhury Textile	DP	2.5	250	65	0.2	0.01	0.05	0.02
	MP	3.5	200	36	0	0	0.05	0.02
KDS Textile	DP	2	220	55	0.05	0.04	0.02	0.01
	MP	2.2	230	50	0.18	0.05	0.02	0.01
Clifton Group	DP	2	70	270	0.2	0.01	0.03	0.03
	MP	2.5	55	240	0.25	0.03	0	0.03

IV. CONCLUSION

Effluents discharge from industry is an unavoidable by-product of industrial activities which deteriorate environmental at alarming rate and may bring a great dilemma in future. This study represents that amidst manifold categories of factories at Nasirabad, effluents from four types viz. textile, garments, chemical and steel industries were highly adulterated which may be absence of any ETPs in the industrial parks. Among four types of factories garments showed maximum level of pollution while steel industries revealed little concentration than others. Effluents from garments industries are getting mixed with drain water and polluting water system of nearby areas. Similarly, chemical industries and textile industries are also higher polluters. Contrary, steel industries are comparatively less polluters. Finally, based on field experiences and literature review, we suggest concerning authority should come forward to establish industrial parks and common ETP to minimize hazardous substances releasing from different industrial units into environment through effluents.

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