

## Extent of Pollutants in the Effluents of Hayatabad Industrial Estate, Peshawar

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**Summary:** Wastewater samples from ten industries of Hayatabad Industrial Estate were collected and investigated for the physical and chemical parameters. The findings of the research show that; temperature of the samples at the spot was 26-42°C, while temperature in the lab. was 17-40°C, pH was 6.63-13.09, electrical conductivity was in the range 0.20-3.13 mS, T. S was 0.76-14.35 mg/L, T. D. S was 0.40-6.63 mg/L, S. S was 0.01-7.73 mg/L, total hardness was 210-1400 mg/L, alkalinity as CaCO<sub>3</sub> was 100-1413 mg/L, chloride was 86-580 mg/L, sulphate was in the range 120-794 mg/L, sulphite was 2.83-47.08 mg/L, nitrate was 0.5-11.6 mg/L, phosphate was 2.25-16 mg/L and fluoride was 0-11.0 mg/L. The values were compared with the standards and it was observed that, some of the parameters show deviations from the standards and may affect the life. Therefore the effluents must be processed before entering into the environment.

### Introduction

Pakistan is a developing country and its development is based on the industrial growth. The industries like chemical, pharmaceutical, match, soap, sugar, ghee/oil, textile, steel and glass etc. [1] can make significant and beneficial contribution to a country's overall economic development by providing jobs, promoting socio-economic infrastructure and so forth. But these industries on the other hand also have detrimental impacts on the environment by raising the level of pollution in the natural environment, which directly affect the local ecosystem. These wastes in solid, liquid and gaseous forms may adversely affect land, water and air and thus cause pollution. Water pollution of these industries is the most important to be explored [2]. Water pollution is any physical and chemical change in water that can harmfully affect the organisms (both aquatic and terrestrial) [3]. The continuous growth of population, urbanization, transportation, industrialization, mining, weathering of soil and municipal wastewater, discharges various pollutants into water such as oxygen demanding waste oil, synthetic organic compounds, inorganic radicals (acidic and basic), mineral substances, radioactive materials and heat etc [4]. The discharge of hazardous chemicals and other substances in to water make the life difficult on land. Polluted water affects human, wild and aquatic life and also agriculture. The range of adverse human health effects of exposure to toxicant introduced into the environment is very broad. Longer period exposure may produce acute effect

such as rashes; burns and poisoning etc, whereas prolonged exposure can cause chronic effects such as lung diseases, cancer, nervous impairment, bone abnormalities etc [5]. Earlier research workers have investigated various parameters in the industrial effluents as well as in drinking water using different techniques and also discussed their impacts [6-12].

The layout of the Peshawar division includes the districts of Peshawar, Nowshera, Charsada, Mardan and Swabi. The region is located from 33° and 42' to 34° and 32' North latitudes and 71° and 22' to 72° and 46' East longitudes over the globe. The area is enclosed by Kohat District in the south, Attock in the east, Mohammad and Khyber Agencies in the west, Malakand Agency, Bunner and Abbottabad Districts in the North and North East (map-1 and 2). The basic theme of the current experimental setup was to estimate pollutants in the effluents of Hayatabad Industrial Estate, Peshawar, which are toxic to human health and to compare the values with the standards of NEQS.

### Results and Discussion

Wastewater samples were collected from Hayatabad Industrial Estate and were studied for both physical and chemical parameters like pH, temperature, T.D.S, S.S, T.S, conductivity, total alkalinity, total hardness, NO<sub>3</sub><sup>-1</sup>, Cl<sup>-1</sup>, SO<sub>4</sub><sup>-2</sup>, SO<sub>3</sub><sup>-2</sup>, F<sup>-1</sup> and PO<sub>4</sub><sup>-3</sup>.

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Map-1: Location map of Peshawar division.

The temperature of different industrial effluents was in the range of 17 to 40°C in the lab and 26 to 42°C at the spot as given in Fig. 1. The permissible range for temperature according to NEQS is 40°C, thus the samples are with in this range; therefore it is not toxic to the aquatic media especially the plants and animals (fish). But the high level of it may result in declining the dissolved oxygen and rise in the suspended solids in water, which is regarded as damaging to aquatic life, flora and fauna and also provide a better habitat for the production of microorganisms.

The metal ions stability and solubility in the water solution is affected by high pH [13, 14]. pH of the industrial effluents was found in the range of 6.63-13.09 as can be seen from Fig. 2. Libra Pharmaceutical Industry showed the highest pH value i.e. 13.09 while Lahore Steel Mill showed the lowest pH value i.e. 6.63. The permissible range for pH recommended by NEQS is 6-10. The variation in the pH values of the effluents' was mainly due to the

utilization of different chemicals by these industries. The high pH results in the corrosion of metals. Whereas acidic water reduce life in the aquatic media and decrease the soil fertility. It may also cause

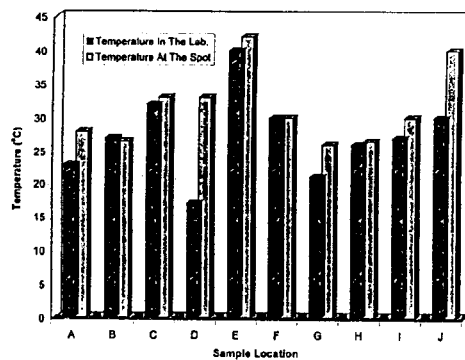
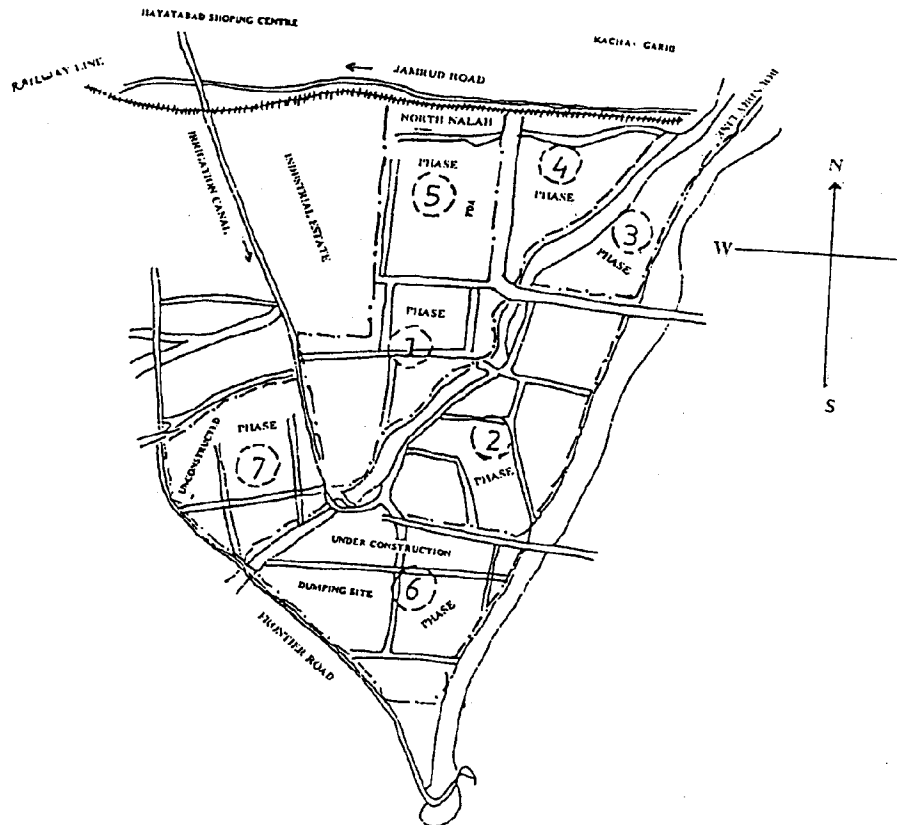


Fig. 1: Temperature of pollutant sample in the Industrial Effluents of Hayatabad Industrial Estate, Peshawar.



Map-1: Map showing the sampling area.

various acute and chronic diseases like esophagus and stomach irritation with pain and vomiting.

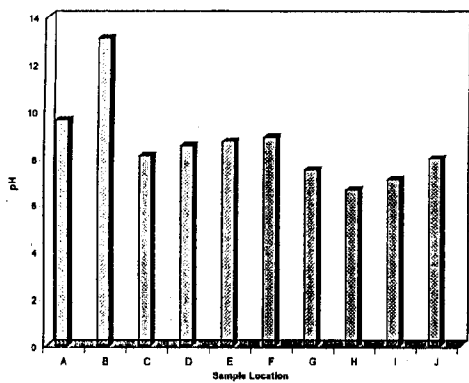


Fig. 2: pH of pollutant samples in the Industrial Effluents of Hayatabad Industrial Estate, Peshawar.

Fig. 3 shows the electrical conductivity of different industries, which is in the range of 0.20-3.13 (mille Siemenes). The electrical conductivity is due to the presence of soluble salts [15]. The highest value of electrical conductivity was recorded in the effluents of Olympia Paper and Board Mill which is due to the large quantities of dissolved salts of alkaline phosphate, sulphate etc., while the lowest E.C. value i.e. 0.20 (mille Siemenes) was shown by Alam Marble Industry showing the least amounts of dissolved salts.

The total solids in the industrial effluents were noted in the range of 0.76-14.35 mg/L as can be seen from Fig. 4. These are found to be within the permissible limit of NEQS. The permissible range for total solids according to NEQS is 150 mg/L. Beyond this limit it results into high turbidity in the receiving water bodies, which prevent light from entering into

the water and therefore affect the process of photosynthesis.

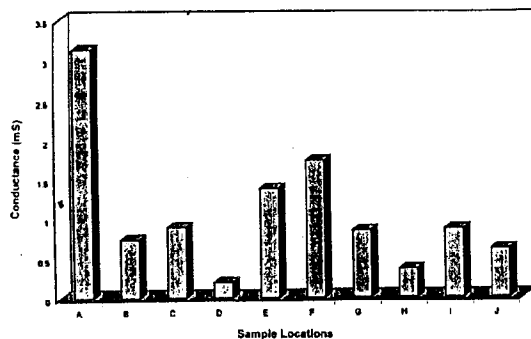


Fig. 3: Conductance of pollutant samples in the Industrial Effluents of Hayatabad Industrial Estate, Peshawar.

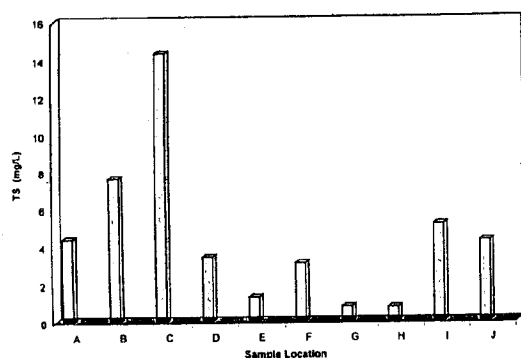


Fig. 4: Extent of Total Solids in the Industrial Effluents of Hayatabad Industrial Estate, Peshawar.

The Fig. 5 shows the TDS of various industrial effluents in the range of 0.40-6.63 mg/L. Thus all samples have TDS within the permissible range. The permissible range of TDS recommended by NEQS is 350 mg/L and FWPCA is less than 500mg/L [16]. High concentration of TDS increases the density of water and reduces the solubility of gases like Oxygen. It also causes high turbidity in the receiving water body.

The Fig. 6 shows the amount of suspended solids of various industrial effluents in the range of 0.01-7.72 mg/L. The lowest S.S value i.e. 0.01mg/L was shown by Omar Glass Industry and highest suspended solids (7.7 mg/L) was shown by Saqib

Vanaspathi Ghee Industry. No permissible limit was mentioned by Health Authorities for suspended solids, however the quality of suspended solids is very important in disinfecting process because these particles not only absorb the disinfecting agent at their surface but also surround the microbiological organisms and hence provide a double shield to bacteria disinfecting process. High amounts of S.S may injure the gills of fish and cause asphyxiation.

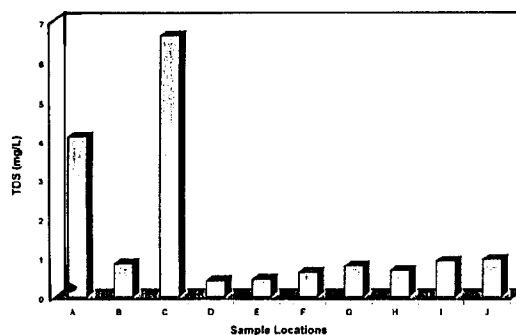


Fig. 5: Extent of Total Dissolved Solids in the Industrial Effluents of Hayatabad Industrial Estate, Peshawar.

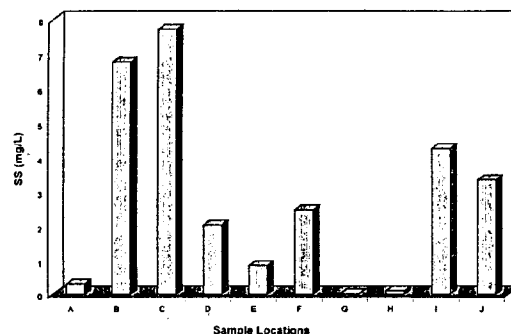


Fig. 6: Extent of Suspended Solids in the Industrial Effluents of Hayatabad Industrial Estate, Peshawar.

Total hardness, which is due to Ca and Mg carbonates and bicarbonates, was observed to be in the range 210-1400 mg/L as shown in the Fig.7. The desired limit mentioned by W.H.O. is 500 mg/L [17]. The lowest value of hardness i.e. 210 mg/L was shown by Gulab Soap Industry, which is below the permissible limit, and highest value of hardness i.e. 1400 mg/L was shown by Alam Marble Industry, which is beyond the limit. High values of hardness

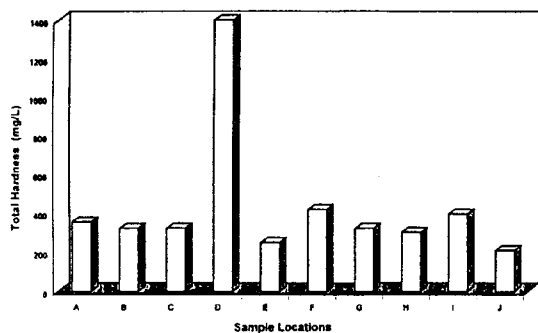


Fig. 7: Extent of Hardness in the Industrial Effluents of Hayatabad Industrial Estate, Peshawar.

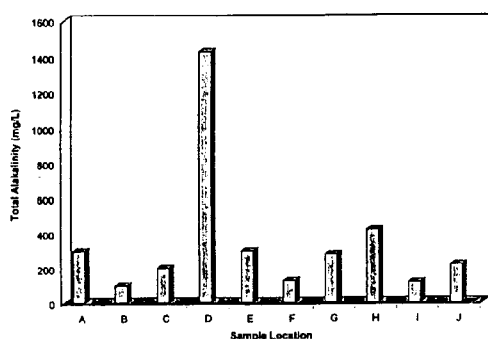


Fig. 8: Extent of Alkalinity in the Industrial Effluents of Hayatabad Industrial Estate, Peshawar.

Table 1: Symbols Used for the different industries of Hayatabad Industrial Estate, Peshawar.

| S. NO | Sampling Sites                    | Symbols |
|-------|-----------------------------------|---------|
| 1     | Olympia Paper and board Mill      | A       |
| 2     | Libra Pharmaceutical Industry.    | B       |
| 3     | Saqib Vanaspathi Ghee Industry.   | C       |
| 4     | Alam Marble Industry.             | D       |
| 5     | Sarhad Ghee Mill.                 | E       |
| 6     | Frontier Match Factory.           | F       |
| 7     | Umar Glass Industry.              | G       |
| 8     | Lahore Steel Mill                 | H       |
| 9     | Atlantic Pharmaceutical Industry. | I       |
| 10    | Gulab Soap Industry.              | J       |

may cause diarrhea, dehydration, gas trouble, kidney stone and heart problems [18].

The Fig. 8, show the alkalinity values of different industries in the range 100-1413 mg/L  $\text{CaCO}_3$ . The Libra Pharmaceutical Industry shows the lowest value i.e. 100mg/L  $\text{CaCO}_3$  while Alam Marble Industry shows the highest value i.e. 1413 mg/L

$\text{CaCO}_3$ . The maximum permissible and desirable level of alkalinity described by W.H.O [17], FWPCA [19] and AWWA [20] was found to exceed in one sample, which has value above 500mg/L  $\text{CaCO}_3$ . Bicarbonate ( $\text{HCO}_3^-$ ), carbonate ( $\text{CO}_3^{2-}$ ) and hydroxide ( $\text{OH}^-$ ) ions normally contribute to alkalinity of water. Beyond the permissible limit, alkalinity cause many problems like hardness, severe irritation of the eyes, skin and mucous membrane, kidney stone, gas trouble and explosion of metallic pipes [18].

Chloride in the water bodies is mostly present in combination with sodium, calcium and magnesium ions. Chloride makes its routes through natural mineral rocks, seawater, irrigation and discharge from industries. The Table-2 shows the chloride concentration of different industrial effluents in the range 86-580 mg/L whereas the permissible level for chloride mentioned by NEQS is 1000 mg/L [21]. Thus all samples have chloride concentration within the permissible range. The high concentration of chloride may be harmful to metallic pipes and agriculture crops [22]. It also causes problems like gastrointestinal, irritation, diarrhea and dehydration [14].

Sulphate in the domestic wastewater contributes to permanent hardness. Table-2 shows quantity of sulphate of various industrial effluents in the range 120-794 mg/L. Whereas the permissible limit for sulphate mentioned by EPA is 600 mg/L. Thus sulphate present in all industrial effluents is below the optimum concentration except Gulab Soap Industry, which shows the highest concentration. High concentration of sulphate impart taste and when combined with sodium or magnesium result into laxative effect. High level also has cathartic effects and corrosive mode of action [22].

Sulphite concentration of the industrial effluents was noted to be in the range 2.83-47.08 mg/L as can be seen from Table-2. The highest concentration was found in the effluents of Alam Marble Industry and lowest in the effluents of Gulab Soap Industry. Health Authorities has issued no standard for sulphite. High concentration of sulphite cause diarrhea and dehydration [18].

The concentration of nitrate in the industrial effluents was noted in the range 0.5-11.6 mg/L as can be seen from Table-2. The permissible range for nitrate according to PEPA is 0.021-1.25 mg/L. The

Table-2: Extent of Pollutants in the Industrial Effluents of Hayatabad Industrial Estate, Peshawar.

| Symbols for Industries | Cl <sup>-1</sup><br>(mg/L) | NO <sub>3</sub> <sup>-1</sup><br>(mg/L) | PO <sub>4</sub> <sup>-3</sup><br>(mg/L) | F <sup>-1</sup><br>(mg/L) | SO <sub>4</sub> <sup>-2</sup><br>(mg/L) | SO <sub>3</sub> <sup>-2</sup><br>(mg/L) | CU <sup>++</sup><br>(mg/L) | Mn <sup>++</sup><br>(mg/L) | Fe <sup>+++</sup><br>(mg/L) |
|------------------------|----------------------------|---|---|---------------------------|---|---|----------------------------|----------------------------|-----------------------------|
| A                      | 370                        | 11.6                                    | 12.6                                    | 8.55                      | 307                                     | 17.38                                   | 0.01                       | 0.9                        | 1.2                         |
| B                      | 90                         | 5.6                                     | 3.7                                     | 7.4                       | 476                                     | 15.8                                    | 0.08                       | 0.99                       | 1.8                         |
| C                      | 345                        | 5.6                                     | 2.25                                    | 4.8                       | 304                                     | 13.06                                   | 0.1                        | 0.8                        | 1                           |
| D                      | 86                         | 6.4                                     | 6.55                                    | 5.9                       | 333                                     | 47.08                                   | 0.01                       | 0.3                        | 1.6                         |
| E                      | 580                        | 5.2                                     | 16                                      | 6.3                       | 352                                     | 23.38                                   | 0.08                       | 0.2                        | 1.3                         |
| F                      | 120                        | 3.1                                     | 16                                      | 7.2                       | 457                                     | 29.42                                   | 0.09                       | 0.5                        | 0.99                        |
| G                      | 95                         | 3.9                                     | 24                                      | 0                         | 120                                     | 17.06                                   | 0.03                       | 0.4                        | 0.8                         |
| H                      | 90                         | 6.4                                     | 5.4                                     | 6.3                       | 284                                     | 20.54                                   | 0.05                       | 0.6                        | 0.6                         |
| I                      | 90                         | 5.8                                     | 16                                      | 11                        | 307                                     | 4.74                                    | 0.06                       | 0.8                        | 1.5                         |
| J                      | 300                        | 0.5                                     | 12.6                                    | 4.9                       | 794                                     | 2.83                                    | 0.04                       | 0.4                        | 1.6                         |

Table-3: National Environmental Quality Standards for Municipal and Liquid Industrial Effluent (mg/L) [21]

| S. No. | Parameter   | Standards |
|--------|---|-----------|
| 1.     | Temperature   | 40°C      |
| 2.     | PH value (acidity/basicity)                         | 6-10 pH   |
| 3.     | BOD at 20°C   | 80 mg/L   |
| 4.     | 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.     | Phenolic compounds (as phenol)                      | 0.1 mg/L  |
| 9.     | Chlorides (Cl <sup>-1</sup> )                       | 1000 mg/L |
| 10.    | Fluoride (F <sup>-1</sup> )                         | 20 mg/L   |
| 11.    | Cyanide (CN <sup>-1</sup> )                         | 2 mg/L    |
| 12.    | Anionic detergents (as MBAS)                        | 20 mg/L   |
| 13.    | Sulphate (SO <sub>4</sub> <sup>-2</sup> )           | 600 mg/L  |
| 14.    | Ammonia (NH <sub>3</sub> )                          | 40 mg/L   |
| 15.    | Sulphide (S <sup>-2</sup> )                         | 1.0 mg/L  |
| 16.    | Pesticides, Herbicides, Fungicides and Insecticides | 0.15 mg/L |
| 17.    | Cadmium 4   | 0.1 mg/L  |
| 18.    | Chromium 4 (trivalent and hexavalent)               | 1.0 mg/L  |
| 19.    | Copper 4  | 1.0 mg/L  |
| 20.    | Lead 4  | 1.0 mg/L  |
| 21.    | Mercury 4   | 0.01 mg/L |
| 22.    | Selenium 4  | 0.5 mg/l. |
| 23.    | Nickel 4  | 0.5 mg/L  |
| 24.    | Silver 4  | 1.0 mg/L  |
| 25.    | Total toxic metals                                  | 2.0 mg/L  |
| 26.    | Zinc  | 5.0 mg/L  |
| 27.    | Arsenic   | 1.0 mg/L  |
| 28.    | Barium  | 1.5 mg/L  |
| 29.    | Iron  | 2.0 mg/L  |
| 30.    | Manganese   | 1.5 mg/L  |
| 31.    | Baron   | 6.0 mg/L  |
| 32.    | Chlorine  | 1.0 mg/L  |

## Nomenclature

|                    |                                 |
|--------------------|---------------------------------|
| Z                  | = Zero Meter                    |
| T                  | = Twenty Meter.                 |
| M                  | = Mean Value                    |
| S                  | = Standard deviation.           |
| mg/dm <sup>3</sup> | = Milligram per Cubic decimeter |
| μ                  | = Micro                         |
| WHO                | = World Health Organization.    |
| T.A                | = Total Alkalinity              |
| T.H                | = Total Hardness                |
| S.L                | = Sample Locations              |
| Cond.              | = Conductance                   |
| TDS                | = Total Dissolved Solids        |

|       |  |
|-------|--|
| SS    | = Suspended Solids                               |
| TS    | = Total Solids                                   |
| NEQS  | = National Environmental Quality Standards.      |
| WHO   | = World Health Organization                      |
| EPA   | = Environmental Protection Agency                |
| USEPA | = United State Environmental Protection Agency   |
| EWPCA | = Federal Water Pollution Control Administration |
| AWWA  | = American Water Works Association               |
| APHA  | = American Public Health Association             |

high value i.e. 11.6mg/L was shown by Olympia Paper and Board Mill and lowest value i.e. 0.5 mg/L was shown by Gulab Soap Industry. All the samples except Gulab Soap Industry have nitrate concentration above the permissible level. Concentrations of nitrate above the permissible range in water are extremely toxic to infants because the bacteria in the digestive system convert the nitrate to nitrite, which then diffuse in blood stream and change the oxygen transporter, hemoglobin into the methemoglobin. The ingested nitrites react with the secondary and tertiary amines found in certain foods, forming nitrosamines that are potentially carcinogenic. The high concentration of nitrates also causes vasodilatory/cardiovascular effects [22].

The phosphate concentration of the industrial effluents was noted in the range 2.25-24.0 mg/L as can be seen from Table-2. Umar Glass Industry shows highest phosphate concentration while Saqib Vanaspathi Ghee Industry shows the lowest concentration. No standard was recommended for phosphate by health authorities. Phosphates are mainly responsible for the process of eutrophication, which results in depletion of water and eventually the water body turns into swamps and marshes [23].

The Table-2 shows the fluoride concentration of different industrial effluents which are in the range 0-11mg/L. Atlantic Pharmaceutical Industry shows the highest fluoride concentration i.e. 11mg/L. The optimum concentration for fluoride given by NEQS

Table-4: Standard Deviations for Physico-chemical parameters of Industrial Effluents of Hayatabad Industrial Estate, Peshawar.

| Symbols | Temp. at the spot | Temp. in the lab. | pH    | E.C  | T.D.S | T.S   | S.S   | T.A | T.H | SO <sub>4</sub> <sup>-2</sup> | SO <sub>3</sub> <sup>-2</sup> |
|---------|-------------------|-------------------|-------|------|-------|-------|-------|-----|-----|-------------------------------|-------------------------------|
| A       | 50                | 18                | 21.12 | 5.31 | 10.67 | 3.12  | 0.37  | 2.0 | 02  | 18                            | 10.12                         |
| B       | 08                | 08                | 9.07  | 0.02 | 0.00  | 8.90  | 14.60 | 50  | 02  | 32                            | 3.59                          |
| C       | 18                | 32                | 7.22  | 0.16 | 3.53  | 37.0  | 8.16  | 8.0 | 18  | 08                            | 8.82                          |
| D       | 08                | 00                | 20.48 | 0.00 | 0.00  | 2.04  | 2.12  | 18  | 32  | 02                            | 20.60                         |
| E       | 00                | 02                | 4.090 | 0.80 | 0.10  | 0.10  | 0.11  | 32  | 50  | 08                            | 2.42                          |
| F       | 02                | 50                | 32.16 | 0.12 | 0.05  | 3.64  | 2.46  | 02  | 08  | 50                            | 19.84                         |
| G       | 32                | 08                | 12.20 | 0.05 | 0.12  | 0.00  | 0.00  | 50  | 02  | 000                           | 0.07                          |
| H       | 4.5               | 0.5               | 20.60 | 0.01 | 0.07  | 0.04  | 0.00  | 08  | 18  | 32                            | 2.37                          |
| I       | 08                | 32                | 10.15 | 0.18 | 0.00  | 13.52 | 2.51  | 18  | 32  | 50                            | 9.33                          |
| J       | 32                | 08                | 4.56  | 0.10 | 0.00  | 8.33  | 2.94  | 32  | 50  | 18                            | 0.00                          |

Table-5: Standard Deviations of physico-chemical parameters of the Industrial Effluents of Hayatabad Industrial Estate, Peshawar.

| Symbols | Cl <sup>-1</sup> | NO <sub>3</sub> <sup>-1</sup> | PO <sub>4</sub> <sup>-3</sup> | F <sup>-1</sup> | Cu <sup>+2</sup> | Mn <sup>+2</sup> | Fe <sup>+3</sup> |
|---------|------------------|-------------------------------|-------------------------------|-----------------|------------------|------------------|------------------|
| A       | 08               | 2.88                          | 3.38                          | 0.12            | 0.01             | 0.002            | 0.012            |
| B       | 32               | 3.92                          | 0.50                          | 0.72            | 0.0002           | 0.002            | 0.005            |
| C       | 18               | 9.68                          | 0.14                          | 0.74            | 0.003            | 0.08             | 0.89             |
| D       | 08               | 10.58                         | 0.52                          | 2.04            | 0.000            | 0.005            | 0.18             |
| E       | 72               | 5.78                          | 0.64                          | 0.64            | 0.005            | 0.0004           | 0.08             |
| F       | 32               | 1.28                          | 1.65                          | 0.76            | 0.009            | 0.0008           | 0.033            |
| G       | 02               | 08                            | 2.00                          | 0.00            | 0.0002           | 0.005            | 0.336            |
| H       | 18               | 15.68                         | 0.69                          | 0.50            | 0.0004           | 0.001            | 0.135            |
| I       | 50               | 12.5                          | 2.12                          | 0.18            | 0.001            | 0.002            | 0.040            |
| J       | 98               | 0.08                          | 0.72                          | 0.32            | 0.001            | 0.008            | 0.0002           |

is 20 mg/L. Thus all samples have fluoride concentration within the permissible range. However beyond the optimum concentration fluoride causes both acute and chronic toxicity such as muscular weakness, vomiting, nausea, gastrulæ, collapse and myocardial failure and chronic toxicity include pain in legs and back, loss of weight and strength, mottling of teeth, forward bending of vertebral column and urticaria [22].

The concentration of copper in the industrial effluents was found to be in the range 0.01-0.1mg/L as can be seen from Table-2. The recommended value of NEQS is 1.0 mg/L. As our values are below the recommended level therefore the water can produce no toxic effects. However above 1.0 mg/L it can cause problems like gastroenteritis with nausea and haemochromatosis.

The manganese concentration varies from 0.2-0.99 mg/L (Table-2). The desirable value according to NEQS is 1.0 mg/L. All values are within the permissible limit. When the value exceeds 1.0 mg/L then it can cause acute effects similar to Parkinson's disease.

Table-2 shows the concentration of iron in the range 0.99-1.8 mg/L. The maximum value given by NEQS is 2.0 mg/L. Iron concentrations found in the industrial effluents studied, are lower than the value recommended by NEQS.

### Experimental

Industrial wastewater samples from ten industries in the Hayatabad Industrial Estate Peshawar were collected in clean polyethylene bottles, one each from the origin and one at 20 meters

down stream of each industry. Before sampling, the bottles were rinsed with the wastewater. The bottles were filled to overflow so that no air bubble is entrapped when capped. The bottles were then carried to the laboratory and stored in refrigerator till analysis. The samples were analyzed for both physical and chemical parameters like pH, temperature, TDS, SS, TS, conductivity, total alkalinity, total Hardness, NO<sub>3</sub><sup>-1</sup>, Cl<sup>-1</sup>, SO<sub>4</sub><sup>-2</sup>, SO<sub>3</sub><sup>-2</sup>, F<sup>-1</sup> and PO<sub>4</sub><sup>-3</sup>.

Temperature pH and conductivity were recorded in the laboratory. Temperature was also noted at the spot. Total hardness and total alkalinity were determined by titration with standard EDTA [24, 25]. TDS, SS and TS were investigated by the standard methods. Chloride [25] SO<sub>3</sub><sup>-2</sup> and SO<sub>4</sub><sup>-2</sup> [26] were investigated by the volumetric method while, PO<sub>4</sub><sup>-3</sup>, F<sup>-1</sup> and NO<sub>3</sub><sup>-1</sup> were determined spectrophotometrically [26, 27]. Copper, Manganese and Iron concentrations were found by atomic absorption spectrophotometer.

### Acknowledgement

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### Standard Deviation

The standard deviation for the extent of pollutants in the industrial effluents of Hayatabad Industrial Estate was calculated as given below [28].

$$S = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n}}$$

S - Standard Deviation

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