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Effluents of Hayatabad Industrial Estate and Its Impacts on Human Health and Environment

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Abstract

Portable water is a gift of God, which is used by human beings both for domestic and industrial purposes, but when it is polluted by certain reasons it become useless and adversely effects human health, aquatic life and threats the ground water. There are many sources of water pollution and Industrial pollution is one major source and concern for today's world because toxic substances and chemicals used as raw products in industries is being discharged as residual to the water bodies if not treated. The HIE is no exception, where different industries are indiscriminately releasing their untreated effluents to open nallah, which ultimately makes its way into river Kabul while passing through urban and rural areas of Peshawar. The river Kabul water is widely used for irrigation purposes and is affecting the human and marine life because of the untreated toxic effluents.

The study deals with the estimation and characterization of pollutions load discharged by the HIE and possible solutions to control these effluents at source i.e. at individual industrial level or at a Combined Effluent Treatment Plant (CETP). The study concluded that toxic effluents with high BOD, COD and TSS along with number of other heavy metals are released untreated. These effluents cannot be treated at source due to high cost and non-availability of land in existing developed industries. Also it is not advisable to install individual treatment plants due to lack of technical knowhow and high maintenance costs. The solution for this is to install a CETP at a suitable location on common benefit and maintenance cost mechanism.

Keywords: Industrial estate, Combined Effluent Treatment Plant, Human health, Healthy Environment.

I. Introduction

Environmental pollution is an 'externality' in welfare economics. An externality is present whenever individual A's utility and production relationships include real (i.e. non-monetary) variables, whose values are chosen by others (persons, corporations, governments) without particular attention to the effects on. An externality can be either beneficial (positive) or harmful (negative). Negative externalities include noise pollution by aircrafts using an airport, which enters as a real variable in the utility functions of persons living in the neighborhood, and the pollution of a river, which enters as a real variable in the production function of water-supply undertakings drawing from the river or agriculture.

Waste water released from various industries is the major concerns for environmentalists now days. Industrial effluents contain various toxic metals, harmful gases, and several organic and inorganic compounds. Both the quality and quantity of effluent result in various impacts on the availability of good quality water as well as on marine environment. Due to the discharge of these toxic effluents, there has been a major loss in the ecological, social and economic perspective. The long-term consequences of exposure also cause fatal diseases like cancer, delayed nervous responses, mutagenic changes, neurological disorders etc.

Unfortunately, the developing countries also lack the potential research, effective legislation, adequate planning, skilled personnel, and awareness required for protecting the environment.

In Pakistan there are several industrial unit that are discharging million gallons of untreated effluent directly into the receiving stream, canals, rivers, etc., due to which the quality of receiving water courses are rapidly being polluted.

Every year thousands of people die all over the world, especially in the developing nations, due to such diseases. According to the World Health Organization, every year more than 2.2 million people from developing countries die from diseases associated with the lack of access to safe drinking water and inadequate sanitation (Global Water Supply and Sanitation Assessment, 2000; Report WHO)

It has been reported that 60 % of population in developing countries has no access to pure drinking water. Presently, some 2.4 billion people lack adequate sanitation and 3.4 million die each year in the world from water related diseases.

II. Scope of Work

1. To quantify the effluent/waste water flows/loads generated from various Industries in HIE by measuring the effluent flows for three consecutive days in the open drains.
2. To characterize the Industrial effluent load in terms of quality i.e. physiochemical characteristics such as BOD, COD, Turbidity, TSS, SS, TDS and metals like Na, Ca, Pb, Cd, Cu etc., by collecting flow proportionate grab samples from drains at point leaving the Industrial Estate and analyzing it in field and at laboratory.

3. Conduct accurate analysis of effluents / pollutants in each sector of industries in the industrial estate Peshawar including hydrological analysis, chemical contamination analysis & biological analysis and suggest the scientific method of its treatment.
4. To study various treatment options and select a possible treatment option for the effluents. To evaluate the impact of effluents on the environment and human life.
5. To suggest the industrial effluent treatment option that will improve the quality of water and bring it in (NEQS) limits, prior to its disposal into natural streams.
6. To study the impacts of Industrial pollutants on environment and human health.

III. Problem Statement

The untreated wastes from Hayatabad Industrial Estate are causing environmental problem in the area as the industrial waste is being drained out in the water bodies without any treatment. The effluents discharged from the industries are passing through urban and rural parts of Peshawar and makes its way to BudniNallah and finally disposes off in river Kabul.

The residents living in the vicinity of these streams complain of nuisance created by the toxic pollution originating from the Peshawar Industrial Estate. The emission of toxic gases and effluent has compromised clean atmosphere affecting adversely the human life. Downstream the water is highly colored, turbid and vegetation along the Nallah appears scorched despite the facts that that water from this Nallah is used for irrigation of vegetables, drunk by animals and birds, and children use it for recreation.

IV. Literature Review

Water is essential to all forms of life and makes up 50-97% of the weight of all plants and animals and about 70% of human body (Allan, 1995). Water is also a vital resource for agriculture, manufacturing, transportation and many other human activities. Despite its importance, water is the most poorly managed resource in the world [III].

The availability and quality of water always have played an important role in determining the quality of life. Water quality is closely linked to water use and to the state of economic development [IV].

Most of the water bodies in the areas of the developing world are the end points of effluents discharged from industries. The discharge of industrial effluents, municipal sewage, farm and urban wastes carried by drains and canals to rivers worsen and broadens water pollution. Ground and surface waters can be contaminated by several sources. In urban areas, the careless disposal of industrial effluents and other wastes may contribute greatly to the poor quality of water [VI].

Industrial estates are established to fulfill the demand of the growing population in the country. The introduction of industries on one hand manufactures useful products but at the same time generates waste products in the form of solid, liquid or gas that leads to the creation of hazards, pollution and losses of energy. Most of the solid wastes and wastewaters are discharged into the soil and water bodies and thus ultimately pose a serious threat to human and routine functioning of ecosystem.

The fast industrialization and elevated population growth rate are some of the major factors that are adversely disturbing the global environment. Not only is the accessible water quantity declining day by day, but they are being polluted at an alarming rate due to the discharge of untreated domestic and industrial effluent. Unfortunately, the developing countries also lack the potential research, effective legislation, adequate planning, skilled personnel, and awareness required for protecting the environment [V].

In Pakistan there are several industrial unit that are discharging million gallons of untreated effluent directly into the receiving stream, canals, rivers, etc., due to which the quality of receiving water courses are rapidly being polluted [IX]. Not only is aquatic life vanishing from these water courses, but they are also losing their aesthetic values. These water courses have become the major sources of a number of water borne diseases like Hepatitis A, Cholera, Typhoid, gastro-in-testinal diseases, etc. Every year thousands of people die all over the world, especially in the developing nations, due to such diseases [I].

In Pakistan, main contributors to the surface and ground water pollution are the byproducts of various industries such as textile, metal, dying chemicals, fertilizers, pesticides, cement, petrochemical, energy and power, leather, sugar processing, construction, steel, engineering, food processing, mining and others.. High levels of pollutants in river water causes an increase in biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), total suspended solids (TSS), toxic metals such as Cd, Cr, Ni and Pb and fecal coliform and hence make such water unsuitable for drinking, irrigation and aquatic life. It has been reported that 60 % of population in developing countries has no access to pure drinking water [II]. Presently, some 2.4 billion people lack adequate sanitation and 3.4 million die each year in the world from water related diseases [I].

Khan and Noor [X] reported that TSS, BOD and COD in industrial effluents were above the permissible limits set by NEQS. The study of [VIII] carried out in the industrial area in India suggested that highly variable pH of the industrial wastewater can leach heavy toxic metals from the sediments, soils and rocks and increase the concentration of heavy metals in groundwater.

In Pakistan, especially in KPK, no proper treatment facilities are available for treating city and industrial wastes. Hence the effluents are dumped into various water bodies causing surface/ground water pollution and endangering biodiversity and lowering agriculture production. A study on Kabul River indicated that surface water resources are highly vulnerable to pollution as the entire stretch in the surrounding is heavily polluted with sewerage and uncontrolled application of chemicals, so their effect on surface and ground water is an emerging concern.

Peshawar Industrial Estate located in District Peshawar, Khyber Pakhtunkhwa (KPK), was established in 1964 over 868 acres. A recent survey reveals that there are 196 medium and large industrial units in addition to 97 SIDB units in operation in the Industrial Estate. Different types of industries like Pulp and Paper, Ghee, Chemicals, Match Factories, Marble and Ceramics, Pharmaceuticals, Beverage & Food, Carpet, Textile, Steel Fabrication and Engineering Industries etc. have been established. The untreated waste of industries of Peshawar Industrial Estate are causing environmental problem in the area as the industrial waste is being drained out in the water bodies without treatment.

The effluents discharged from industries are passing Peshawar and populated suburb areas of Peshawar. Several complaints have been received from the residents of locals regarding the pollution of Peshawar Industrial Estate.

In the Industrial Estate Peshawar, there is no arrangement for industrial wastewater management; therefore there is a need to monitor the industrial wastes for both physical and chemical parameters. According to the independent testing conducted by the Institute of Chemical Sciences, Department of Environmental Planning and Management/IUCN and PCSIR laboratories etc. the effluent contains organic wastes, mineral acids, compounds, suspended solid etc., According to estimate the measured wastewater flow rate is 813.6 m3/h. Therefore this study recommends the establishment of a medium sized Combined Effluent Treatment Plant (CEPT) for the estate, to be designed on the "Common-benefit" principle. The discharge of industrial effluents is particularly damaging as some of them are discharged at high temperatures that further reduces the dissolved oxygen levels in water bodies and has had a debilitating effect on the water and environment part of these area.

V. Methodology

Methodology of study consists of following steps:

1. Reconnaissance survey of the HIE,
2. Locating and mapping of all drains, flow directions and their disposal points.
3. G.I.S mapping of the Project
4. Selection of points for measuring the hydraulic flows and for waste water sampling.
5. Collection of data on project area, types of industries, previous studies, literature.
6. Conducted hourly flow measurements for three consecutive days at point where all the main drains combine and leave the project area shown in Map.
7. Conducted the physical tests such as PH, Temperature and Turbidity at site during the sampling.
8. Collected flow proportionate effluent samples for laboratory analysis i.e. at Qarshi Laboratory.
9. Collected the effluent samples from pre-selected industry in each sector of the Industrial estate to investigate the quality of effluents at source.
10. Conducted random survey of various industries through questionnaire's for gathering of information on capacity, production, types of chemical used, flows and treatment prior to disposal etc.
11. Analyzed the field data collected through questionnaire's and laboratory results.
12. Studied and compiled the pollutants effects on environment and human health.
13. Studies various treatment options, at source and combined for effluent treatment.
14. Selected the most suitable treatment process for effluent treatment that could improve the quality of effluent and bring it within limits of NEQs
15. The final conclusions and recommendations were drawn based on the above study.

G.I.S Mapping of Project

A Detailed GIS Base Map shown in fig 1.1 was prepared to know the ground realities, the waste water network, services available and the ultimate disposal point of waste within the industrial estate. It ascertains and gives the topographic features of the industrial area.

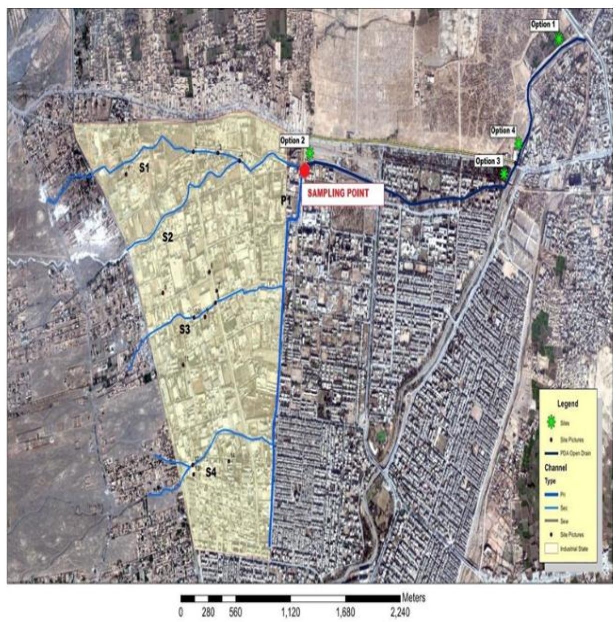

Figure 1. Mapping of Project

Reconnaissance Survey

A series of field visits and reconnaissance surveys have been conducted in support of mapping for the Project. It provided the necessary data helpful for early map deliverables in support of field observations on effluent sites, identification of sites and understanding of the design parameters.

Collection of Industrial Data

For identification of pollutants and industries causing threat to the water bodies, the study was carried out through a questionnaire, surveying each of the concerned Industrial unit. The industrial data campaigns was designed to know the scope and conduct of reconnaissance surveys along the effluent drains, processing of raw data and finalization of map updates. The survey enabled to have information on type of production, chemicals being used, discharge calculation, effluent disposal arrangement and its arrangement of treatment if any etc. The focus was towards specific mitigation measures starting with topographic surveys and leading to system design and cost estimation. We secured all necessary design information to finalize specific solutions to the industrial estate pollution problem.

VI. Data Compilation and Data Processing

The compilation of the data based on primary and secondary information followed by a coding mechanism for responses on each questionnaire (indices), analyzed the overall information and processed the data to tabular definitions. The data on all functional and nonfunctional and the type of industries have been complied and analyzed and depicted below in self-explanatory bar charts.

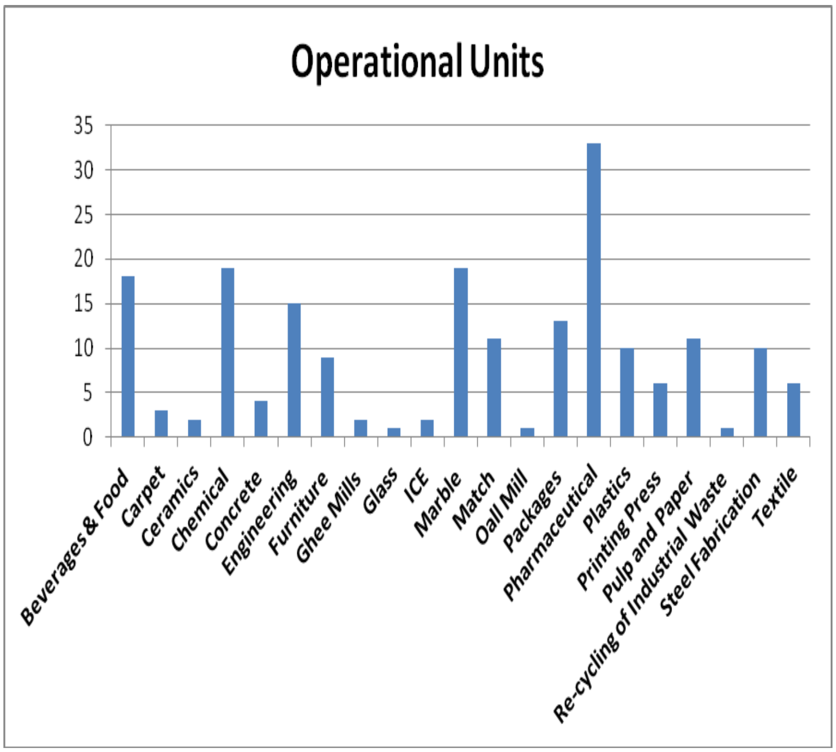

Figure 2. Operational Units

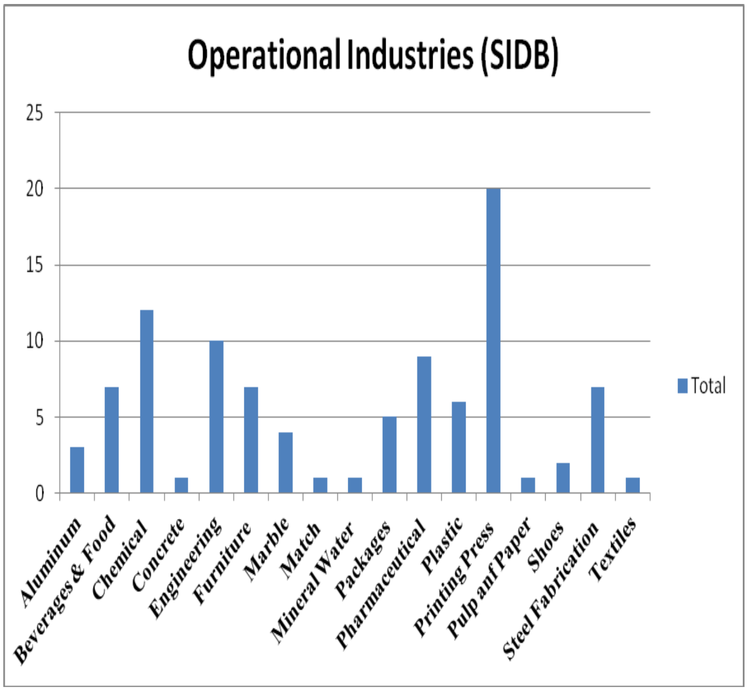

Figure 3. Operational Industries

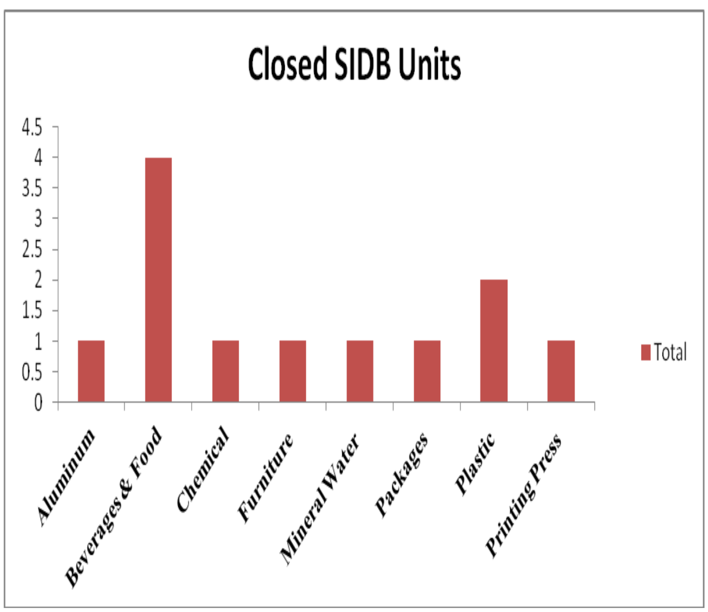

Figure 3. Closed SIDB

VII. Hydraulic Calculations

Good hydraulic design is a foundation of a well-designed waste water treatment plant. This chapter provides procedures adopted for calculation of waste water flow. Stream flow measurements are fundamental in every water management and water related projects. Different streams and rivers require appropriate flow measurements methods. i-e. Weir flume, Dilution Gauging, Velocity Area Method etc. Keeping in view the existing stream conditions we adopted following methods for estimation of waste water flow.

Method is more suitable for small streams. Since the existing stream is small therefore its flow has been calculated with the help of V- Notch.

Secondly PDA has constructed an intake structure (Weir) for diverting the stream waste in to a conduit therefore we have also applied the weir formulae for calculation of waste water flow. Discharge obtained from both the methods has approximately the same results i.e. 8 cubic feet per second.

VIII. Velocity Area Method

This method involves determining the area of flow of the stream as well as the average velocity of flow. The section of flow of the river is subdivided into sub sections and velocities representative of these areas are taken. The total discharge is the summation of all discharges in sub sections. Velocity can be calculated by two methods.

1. Using Current Meter
2. Float Method

We first selected a suitable cross section across the total width of the stream. A straight reach where the stream bed is uniform was selected. The selected section was relatively free of boulders and aquatic growth. The flow at this section was uniform and free of eddies. With measuring tape width of stream from bank to bank perpendicular to the flow was calculated. The total width of the stream was subdivided. Verticals have been spaced such that no subsection has more than 10% of the total discharge. The velocity obtained from float method and current meter was approximately the same and has been depicted in design calculations.

Types of Samples

The type of sample collected depends on the variability of flow, variability of water or waste water quality, accuracy required and the availability of funds for conducting the sampling and analytical program

Three main types of samples are

1. Grab samples
2. Composite samples
3. Integrated samples

The type of the samples to be collected are determined by a number of factors such as

1. The objectives of the study, including the variables of interest and the accuracy and precision needed.
2. The characteristics of the system being and non-point inputs and homogeneity of the system
3. The recourse available that are man power, time, equipment and the materials.

Grab Sample

A grab sample is defined as an individual discrete over a period of time. It can be taken manually using a pump, scoop. Vacuum or other suitable device.
The collection of a grape sample is appropriate when it is desired to:
1. Characterize water quality at a particular time.
2. Provide information about minimum and maximum concentrations.
3. Allow collection of variable sample volume.
4. Corroborate composite sample.
5. Meet a required of a discharged permit.

Composite Sample

A composite sample is defined as a sample formed by mixing discrete sample taken at periodic points in time or a continuous proportion of the flow the number of discrete sample, which makes up the composite, depends upon the variability of pollutant concentration and flow. A sequential composite is defined, as a series of periodic grab sample each of that is held in an individual container, then composite to cover a longer time period. Six methods are used for composting samples; choice of composite type is dependent on the program and relative advantage and disadvantages of each composite type.

Integrated Samples

An integrated sample may be through of a composite over depth of a system rather than time. The grab sample collected at various points and at different depths across the width may be mixed in proportion to relative flows at these points. The results of the analysis will provide average values are note useful and local variations are most important. In such cases, grab samples should he analyzed separately rather than integrating them.

IX. Sample Collection and Testing

Wastewater samples were collected for the purpose of determining characteristics of entire batch of wastewater. Flow propionate 24 hours Composite samples were collected for 3 consecutive days taking into account the above general considerations. All of these samples were collected in duplicate. One set preserved in a sterile bottle at 4C for BOD to avoid biological contamination and second for rest of the parameters in a manner that nothing is added or lost in portions taken and minimum changes occurs between the sample collection and testing time. Temperature and pH was measured at the sampling point on hourly basis. Sampling and preservation techniques were followed according to APHA, 1998.

Site Selection for Sampling

In a job like this, sampling point selection is always critical to make the sample representative of pollutants from various sources. To meet the objective, the area was thoroughly studied for several days to determine the direction of flow and identify the sampling collection point. During a visit to the site it was noted that the entire waste water from PIE is collected in four secondary natural drains flowing from west to east, all these drains are disposed of in a primary collecting drain ultimately collected at a single point for discharging into a sewer near Pak-Turk-School. A location plan clearly indicates that all the four drains S1, S2, S3, and S4 are collected in P1 at a single point to discharge into the sewer. In the situation above, it was decided to take sample and monitor the flow regime from this single point, indicated as sampling point on the plan

Figure 4. Site Selection

$$Grab\ sample\ volume, ml = \frac{\left(Flow\ rate\ at\ sample\ time, {}^{m^3}/_{h}\right) \times (Composite\ sample\ volume, ml)}{(number\ of\ grab\ samples) \times \left(average\ daily\ flow, {}^{m^3}/_{h}\right)}$$

Sample Identification and Testing Methods

Collected samples were marked with date time and name of person, collected the sample according to QRI Laboratory requirement. Samples were analyzed according to approved method (APHA, USAEPA and ASTM).

Figure 4. Samples Identification

A stratified multistage proportionate random sampling technique was applied to select adequate and representative sample to generalize survey findings at project level. Following stratification variables were taken into consideration for enhancing representative level for adopting appropriate sampling design.

X. Laboratory Tests

Based on the above sampling, the results of laboratory tests are given in Table 3.1. In addition to the large consumption of water and material, the estimated industrial wastes are 10717 million liters per year. The effluent from the industries is characterized by very high pollutant loads.

Industrial wastewater stagnant pools, heaps of industrial solid wastes fill the surrounding air with noxious odors and badly damage the landscape. This kind of discharge of effluent with a very high load into water bodies and farmlands and the odors being generated have been a serious cause of concern. Besides, the discharge of untreated wastewaters (with high BOD) to natural waters results into depletion of dissolved oxygen levels in them, thereby adversely affecting the aquatic life. This has resulted in number of directions by the Government to enforce environmental regulations and to comply the rules. Accordingly the industries have been directed to make arrangements for effluent treatment, yet there is no positive response from the individual industries and they are not meeting the effluent discharge norms.

Effects on Human Health and Environment

Industrial pollution has been and continues to be, a major factor causing the degradation of the environment around us, affecting the water we use, the air we breathe and the soil we live on. Industrial effluents contain various toxic metals, harmful gases, and several organic and inorganic compounds. Due to the discharge of these toxic effluents, they adversely affect the human health and environment.

The following are the few parameters which adversely affect the human health and environment which exceed the NEQS level.

PH

The pH of various industrial effluents ranged from 6 to 9. Highest pH was observed in marble, ghee and paper industry which is due to alkali and carbonates. Highly variable PH of the industrial waste water can leach heavy toxic metals from the sediments, soils and rocks and increase the concentration of heavy metals in ground water and adversely affecting the human health.

Temperature

Temperature is an important indicator of water quality with regards to survival of aquatic Organisms. The effluents temperature depends on the process of production in the industry. Temperature values of various industrial effluents ranged from 13.0–33.9 ˚C with a mean value of 17 ℃. The highest value was found in the effluents of oil and ghee, industries while lowest in that of Bilour match. The temperature values in all the effluents were within the permissible limits of NEQS.

Total Suspended Solid (TSS)

Total suspended solids determination is extremely valuable in the analysis of polluted water. Results suggest that these effluents may cause handling problem, if directly applied to agricultural field or if discharged in to river or stream it will not be suitable for aquatic life. Suspended solids are aesthetically displeasing and release obnoxious odors. Biologically active suspended solids may include disease causing organisms.

Total Dissolved Solids (TDS)

Estimation of total dissolved solids is useful to determine whether the water is suitable for drinking purpose, agricultural and industrial purpose. The higher TDS in stream/river water may cause salinity problems if discharged to irrigation water and increase the density of dissolving water and reduces the solubility of oxygen gas creating danger to the aquatic life. High TDS effect the normal growth of biological population. High concentration of dissolved solids may also produce distress in livestock.

BOD and COD

If wastewater of high BOD and COD values discharged into stream it dropped dissolved oxygen and this cause oxygen stress for aquatic species.

XI. Conclusion

The major source of surface and ground water pollution is injudicious discharge of untreated industrial effluents directly into the surface water bodies result in serious surface and ground water pollution. This loss of water quality is causing health hazards and diseases in human beings, livestock and death of aquatic life, crop failure, decrease in yield of crop and loss of aesthetic. This problem is aggravated by lack of awareness, lack of waste water treatment facilities, lack of financial resources and the non-enforcement of environmental laws.

From the present research study, it can be concluded that the pH was found from all industry within the permissible limits whereas TSS from all industry effluent were greater than standard values but marble, match and wood industry effluent contains extremely high TSS. The BOD and COD were above permissible limits from all effluents except marble and steel industry. Among heavy metals Pb, As, Cu, Ni and Cr were within permissible limits except match industry where Pb and Cr were greater than limits. In the effluent of steel mill industry all heavy metals were present but below the permissible limits except cyanide which was 15mg/L.

All industries in PIE discharge their untreated wastewater into Kabul River through number of natural drains, kwar and Budninallah. The absence of treatment of industrial waste has resulted in discharge of polluted and toxic waste into river adversely affecting aquatic life justifying establishment of proper treatment facility for PIE.

XII. Acknowledgement

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References

I. Anonymous. 2001: The NEWS International, 2001.Water Quality Assessment.

II. Ali, A., H.N. Hashmi, I.A. Querashi and S. Athar, 2009: 'Treatment feasibility of NSSC pulping effluent using UASB reactor,' HYDRO Nepal: Journal of Water, Energy and Environment (Kathmandu) 5:57-60.

III. Chillers, J. and A. Henrik. 1996: Effect of contaminated water. Global Water Hazards. Pp 25: 25-27.

IV. IUCN. 1996: Sarhad Provincial Conservation Strategy Document: A report of IUCN.

V. Industrial Estate Peshawar. Pakistan Journal of Agriculture Sciences 2: 457 461.

VI. Khan, S. and M. Noor. 2002: Investigation of pollutants in wastewater of Hayatabad.

VII. Pak-EPA, 1999: Environmental Technology Programme for Industries (Draft Environmental Report), Islamabad: Environmental Protection Agency,Pakistan.

VIII. Panayotou, Theodore, 1994:Economic Instruments for Environmental Management and Sustainable Development, UNEP Environmental Economics Series Paper No.16, Nairobi: UN Environment Program, Environment and EconomicsUnit.

IX. Shivkumar, K. and G. Biksham. 1995: Statistical approach for the assessment of water pollution around industrial area. Environ Monitoringand Assessment 36: 229-249

X. Steel, E.W., 1995:Water Supply and Sewerage (6th ed.), London: McGraw Hill.