MUNICIPAL WASTE WATER TREATMENT FOR IRRIGATION, PAKISTAN

By

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Abstract

Today the most immediate and the highest environmental issues of the world is degrading catchment and water shortage.In Pakistan the industrial sector is disturbing surface as well as ground water qualities by extensively diffusing their effluents into streams, water courses, agricultural lands, rivers, lakes and ocean that have hazardous effects on human health apart from threatening the water quality. Therefore, the added effluent in water pollutes surface and ground water, which has aggressive threats on human, animal, plants and other ecosystems. In Pakistan, little municipal waste water treatment facilities are available. Gujranwala is the 7th biggest industrial city of Pakistan. In the city, most of the local drains are unlined and uncovered, seepage causes the ground water contamination and the bad fume disturbs the environment. Disposal of untreated municipal waste water into drains and finally into canal and rivers, deteriorate the water quality of the water body and harmful for aquatic life, changes the structure of agro-land by adding the heavy metals, detergent, chemicals etc.The present study is based on chemical analysis of municipal waste water to produce an effluent that can be safely discharged into inland or sea waters. The study also involves for helping city planners to make water and sewage policies. The samples were taken from Gujranwala municipal waste water drain. The values of Sodium Absorption Ratio (SAR), Residual Sodium Bicarbonate (RSC), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), pH, Turbidity, Electrical Conductivity (EC), Chloride (Cl^{-1}), Carbonates (CO_3^{-1}) and Bicarbonates (HCO_3^{-1}) were measured and compared with National Environmental Quality Standards (NEQS) to check the water quality. According to NEQS all the samples were unfit for irrigation purpose. To make the waste water fit for irrigation the chemical treatment of waste water was done and again compared with water quality parameters with NEQS. Based upon the results, it is recommended, that waste water treatment plants should be installed to make water clean and fit for irrigation.

Introduction

Pakistan is a water stressed country. In most of the big cities such as Lahore, Gujranwala, Sialkot and Multan, the extraction is much higher than the ground water recharge.Municipal waste water is mainly including 99% water composed with relatively small concentrations of organic and inorganic solids. These organic and inorganic solids are present in water as total dissolved solids (TDS) and total suspended solids (TSS). Among the organic substances present in effluents are carbohydrates, lignin, fats,soaps, synthetic detergents, proteins and their decomposed products, as well as various natural and synthetic organic and inorganic chemicals. The major constituents of domestic waste waters are total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), Nitrogen (N), Phosphorus (P), Chloride (Cl^{-1}), Alkalinity as ($CaCO_3$), biological oxygen demand (BOD_5) and grease. In arid and semi-arid countries like Pakistan, water use is often fairly low and sewage tends to be very strong. Municipal waste water from domestic and industrial usage also contains a variety of inorganic substances including a number of much toxic metals such as Arsenic (Ar.), Cadmium (Cd.), Chromium (Cr), Copper (Cu), Lead (Pb.), Mercury (Hg), Zinc (Zn), etc. (FAO 47). Khurshid *et al.,* (1999) evaluated river water qualities in Pakistan and reported that disposal of municipal waste water in drains and finally in rivers deteriorate the water quality and harmful for aquatic life. Discharge of untreated municipal waste water increased BOD and TDS in River Ravi.

In Gujranwala a waste water line of 35 km, on both sides of municipal waste water drain, people use contaminated waste water for irrigation to grow vegetables (Nasir*et al.,* 2012). All these

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grown vegetables contain heavy metals and pathogenic micro-organisms which are much poisonous for human being. These pathogenic micro-organisms are generally considered to pose greatest threat to human health (Toze, 2006). Lack in municipal waste water treatment facilities and municipal effluent in developing countries are the major reasons for rapidly degrading environment. The industrial activities cause air and water pollution which tends adverse effects on mankind, aquatic life and vegetation (Mubin *et al.,* 2002). Use of untreated municipal waste water to irrigate agriculture land is a common practice throughout the world (Ahmed *et al.,* 2010). Municipal waste water effluent for irrigating agriculture land, could be a valuable source of water supply, and should not be continuously wasted. Re-use of municipal effluent decreases the fresh water demand and disposal of water to environment (Jasem*et al.,* 2003). Use of waste water for vegetation purpose without any treatment affects the human and animal health as well as deteriorates the water quality of aquifer (Nasir *et al.,* 2012).

The use of municipal waste water for irrigation causes serious environmental problems. In Pakistan, water quality and quantity are the major ecological concerns. The municipal waste water which includes domestic and industrial effluent causes water pollution. There is a chance of uptake of contaminants (heavy metals) from irrigation water by crops,as a consequence affecting human health. These can be eliminated by applying various types of waste water treatment processes such as: physical, chemical and biological treatments. These methods developed for small scale waste water treatment process. These are also reliable and cost effective for developing countries like Pakistan (Pak-U.S 2010-11).

Material and Methods

Municipal or domestic waste water treatment is the process of removing contaminants from waste water by using physical, chemical, and biological processes to remove physical, chemical and biological contaminants. The objective of the study is to produce an environmental friendly fluid waste stream or treated effluent and a solid waste or treated sludge suitable for disposal or reuse.

Study Site

The study was undertaken in District Gujranwala, the 7th largest city of Pakistan having population approximately 2.8 million. It is ranked 27th fastest growing cities in the world. The geographic location of Gujranwala is 32.16° North, 74.18° East shown in Fig.-1. ***Wapda Town*** disposals situated on canal bank at ***Khyali*** bypass road Gujranwala was selected. The ***Wapda Town*** disposal carries domestic waste water. A huge volume of waste water discharged daily. Six motors of 3 ft^3 / sec discharge capacity, discharges water about 12 hours daily, the approximate volume discharged 129600 ft^3 / day. There is need to treat the waste water and dispose off environment friendly effluent or safe reuse for irrigation of agriculture lands.

Water Sampling

A number of sampling methods are available such as point, grab, composite, etc. As the domestic waste water of ***Wapda Town*** disposed-off in municipal waste water drain passes nearby it. Composite sampling of waste water was done by selecting three different points named as S_1, S_2 and S_3. First sample (S_1) was collected from ***Wapda Town*** disposal point. Second sample (S_2) was collected from 1 km ***Upstream*** of the point where disposal waste water of Wapda town was added to municipal drain and the third sample (S_3) was 1.5 km ***Downstream*** of disposal point after mixing / dilution of domestic waste water in it. These samples were collected in 1000 ml sized bottles. After collecting municipal waste water samples, the bottles were properly tightened, to protect from leakage and then sent carefully to Soil and Water Testing Laboratory, Gujranwala for analysis. Different equipment can be used to determine municipal waste water quality parameters. Fenway Meter was used for dissolved oxygen and pH. Hanna Meter was used for determining EC and TDS. Carbonates and bicarbonates were examined by titration method. TDS was measured by filtration method and turbidity was found by using turbidity meter. The parameters of these three samples S_1, S_2, and S_3 were examined by Soil and Water Testing Laboratory, Government of Punjab, Pakistan and were compared with NEQS.

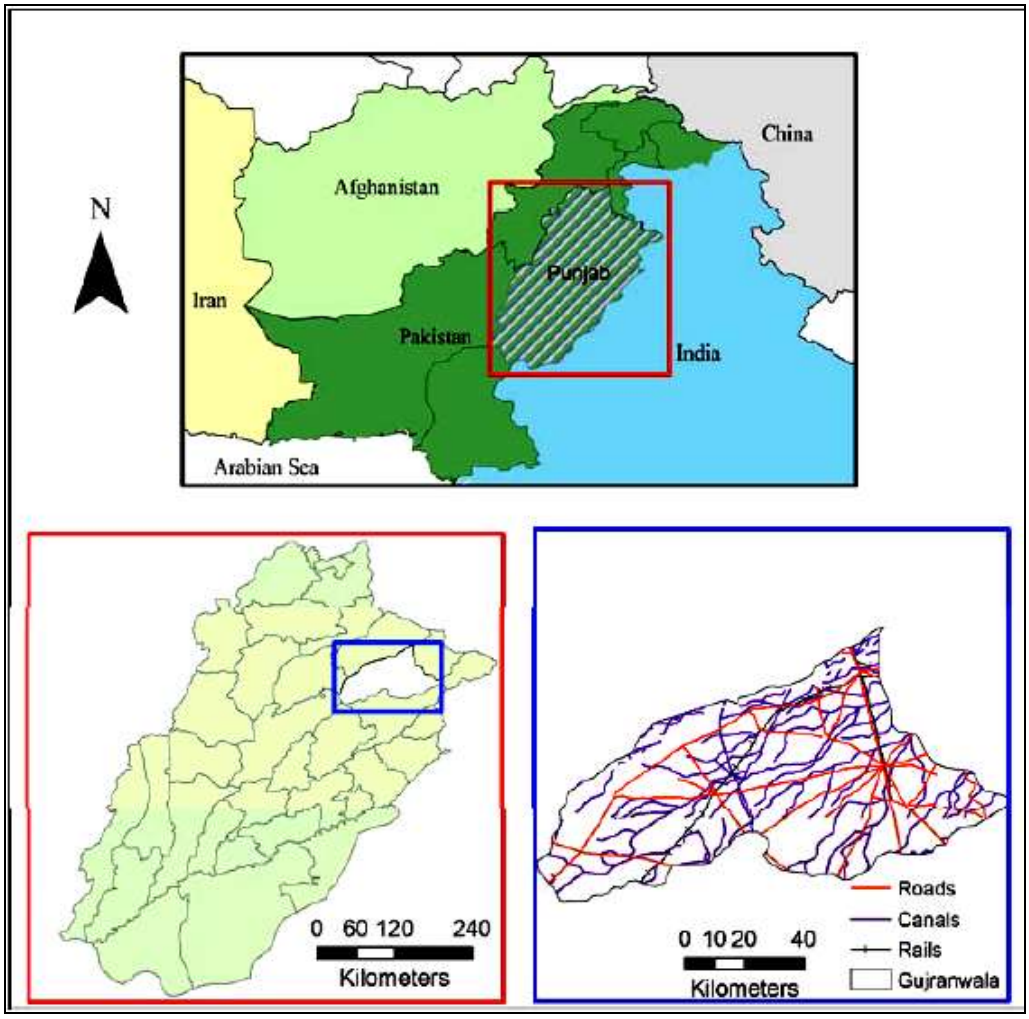

Fig.-1: Location of study area, Gujranwala (Punjab) Pakistan by Arc GIS 9.3.0

Chemical Treatment of Waste water

On the basis of available resources, the chemical treatment of municipal waste water was adopted. Four drums of volume 210 litters were taken as pilot and named as sample 1, 2, 3 and 4 on the basis of chemical concentration. Different chemicals at different concentrations and different combination were used which are shown in Table-1.

Table-1: Chemicals used in Waste water Treatment

Sample Sr. No.	Sulphuric Acid (H_2SO_4)	Potash Alum	Bleaching Liquid/Solid	Potassium per Magnate ($KMnO_4$)
	gm.	gm.	gm.	gm.
1	30	5	30	-
2	25	-	20	5
3	20	10	25	-
4	40	15	30	5

Post Treatment Waste water Tests

The above discussed chemicals were added in domestic waste water to treat and reuse it for irrigation and waited for 24 hours. After 24 hours, the samples of 1000ml from each water drum were collected. The chemically treated waste water examined in Soil and Water Testing Laboratory, Government of Punjab, Pakistan. Water quality parameters such as Sodium

Absorption Ratio (SAR), Residual Sodium Bicarbonate (RSC), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), pH, Turbidity, Electrical Conductivity (EC), Chloride (Cl^{-1}), Carbonates (CO_3^{-1}) and Bicarbonates (HCO_3^{-1}) were tested and compared with NEQS. It was noted that water quality of municipal waste water improved after treatment.

Results and Discussion

Samples were carefully examined before and after waste water treatment and results were being reported to retrieve the useful information. Results were categorized to evaluate and assess the impact of treated and untreated municipal effluent for different levels of waste water quality.

Total Suspended Solids (TSS) and Total Dissolved Solids (TDS)

The acceptable value of TSS for industrial waste water by NEQS is 150 mg / l. The measured mean value of TSS in untreated municipal waste water is 577 mg / l (385, 526 and 820 mg / l). The TSS values higher at the downstream of the disposal point of Wapda Town. After chemical treatment of domestic waste water (Wapda Town), the mean value of TSS reduced to 250 mg / l (200, 160, 280,300 mg / l). The graphical representation of TSS is shown in Fig.-2. In case of TDS, NEQS for industrial effluent are 3500 mg / l. The measured mean value of TDS in untreated municipal waste water is 5200 mg / l (3400, 5500 and 6700 mg / l). The TDS values higher at the downs tream of the disposal point of Wapda Town. After chemical treatment of domestic waste water (Wapda Town) the mean value of TDS reduced to 3200 mg / l (3000, 3500, 3400 and 2900 mg / l). The graphical representation of the TDS concentration is shown in Fig.-3.

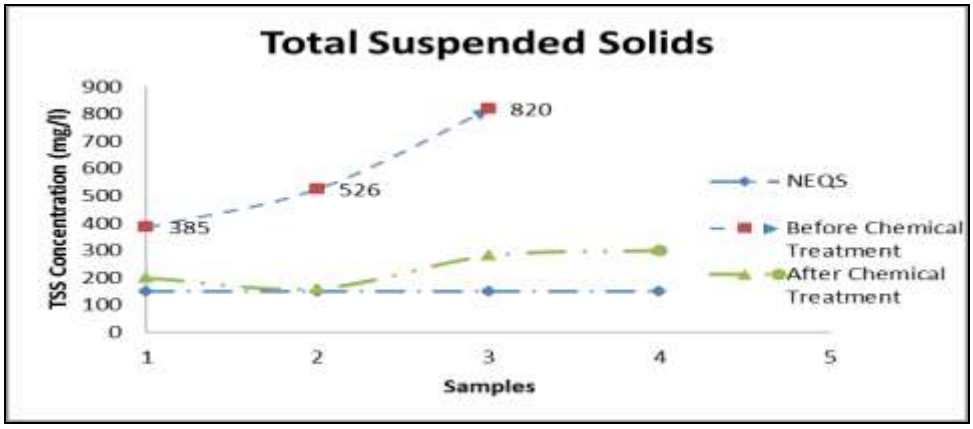

Fig.-2: Comparison of Total Suspended Solids (TSS) with NEQS

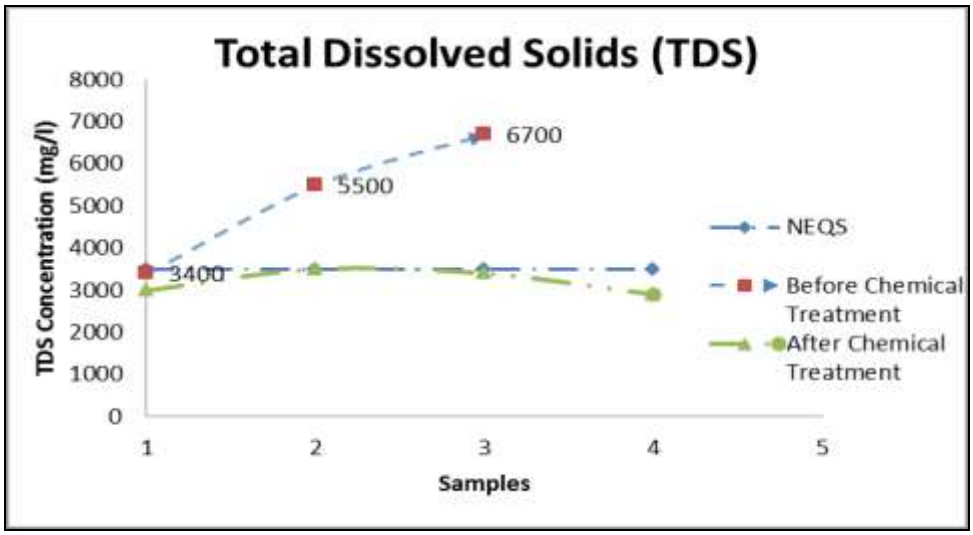

Fig-3: Comparison of Total Dissolved Solids (TDS) with NEQS

Electrical Conductivity (EC), Turbidity, pH

The electrical conductivity (EC)for untreated waste water was measured.The mean value of EC was 1071 m-mohs (800, 1014 and 1400m-mohs). According to NEQS, EC should be less than 1000m-mohs (>1000). After chemical treatment the mean value of waste water, EC reduced to 540m-mohs (368, 422, 650, 720m-mohs). The graphical representation of EC is shown in Fig. 4. The NEQS for pH ranges 6-9. The untreated waste water was slightly basic in nature. After treatment, it becomes slightly acidic in nature. Turbidity of the waste water decreased after treating it with chemical (potash alum and sulpheric acid).

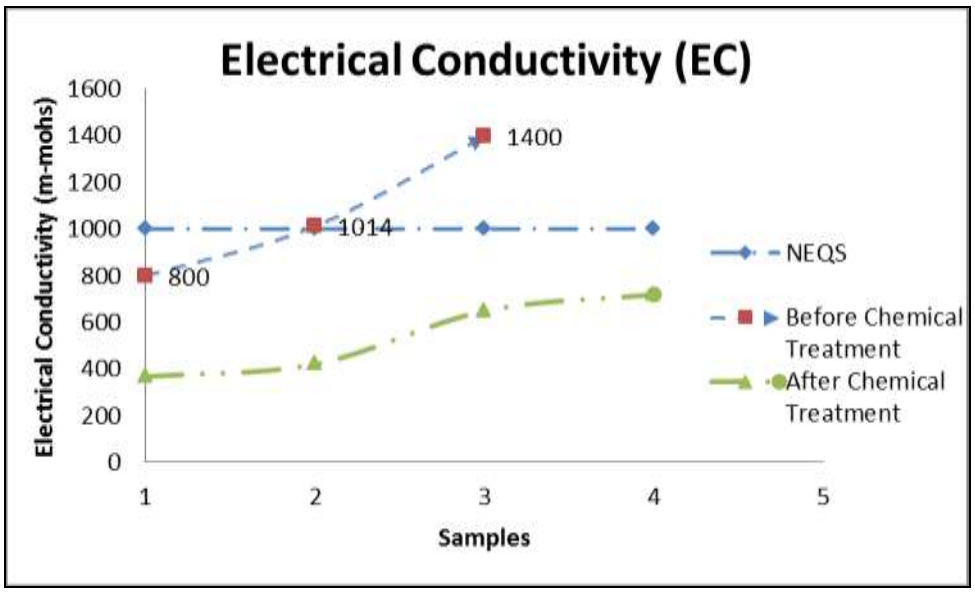

Fig-4: Comparison of Electrical Conductivity (EC) with NEQS

Carbonates (CO_3^{-1}) and Bicarbonates (HCO_3^{-1})

The carbonates were observed in untreated waste water. After chemical treatment of waste water the carbonates eliminated. Water containing high concentration of bicarbonates (HCO_3^{-1}), there is tendency for Mg^{+2} and Ca^{+2} to precipitate as carbonates (CO_3^{-1}) and concentrates the soil solution. Bicarbonates excess 1.5-2.0 meq / l cause a white chalky deposit on plant leaves and irrigation channel. With the addition of acid bicarbonates reduced up to acceptable limits.

Conclusion

The fresh water resources are under strain in all over the world.In Pakistan, most of the big cities such as Lahore, Gujranwala, Sialkot and Multan, the extraction is much higher than the ground water recharge.After chemical treatment of municipal waste water, reuse of treated waste water may lower the water stress arising by over extraction and water pollution. The cost of extraction of ground water will reduce; ultimately there will be less energy demand.

Potash Alum and Sulphuric Acid is known for its effectiveness in removing organic chemicals from waste water. The advantage of the using of these two compounds (Potash Alum and Sulphuric Acid)reducing chemical consumption, eliminating sludge disposal, cost effective and recycling the clean waste water back to the irrigation purposes.The transmission of diseases through vegetables, irrigated by untreated waste water, will reduce. Emission of greenhouse gases which pollute the environment will also reduce.

Using chemically treated waste water for irrigation will improve the soil structure. It is recommended for farmers to use 7-8 kg sulpher at seed bed preparation to dilute the impurities in water. If treated waste water used for irrigation, it will help to improve the water quality as well as soil structure.

Study Outcomes

Behavioral change towards water consumption will be good outcomes of this study. Community will have more sense of responsibility, improving health hygiene, lower medical expense, superior moral values more civilized urban society, having enough and safe drinking ground water for our future generation.

This study will help city master planner, Water and Sanitation Authority (WASA), urban resource centers, Town Municipal Administrator (TMA) provincial and federal government departments for future planning.

References

1. Ahmad, M., Bajahlan A. S. and Al-Hajery K. A., 2010. Potential impacts of industrial reclaimed water on landscape irrigation. Int. J. Agric. Biol. Vol. 12, Page 707-712.

2. FAO 47, Waste water treatment and use in Agriculture, FAO- Irrigation and Drainage paper 47.

3. Jasem, M.A., Behbehani H. S. and Abdullah T. H., 2003. Waste water reuse practices in Kuwait. The Environmentalist vol. 23, Page 117-126.

4. Khurshid, A.W. 1999. Evaluation of water quality of rivers in Pakistan. National workshop on water resources achievement. June 28-30, 1999. Proceedings of the Pakistan Council of Research in Water Resources.

5. Koca, S.B., Yigit N. O., Dulluc A., Erol G., CılbızN. and Kucukkara R., 2011. Appropriate usage level of shrimp waste meal as chitin source for feeding young cray fish (*Astacusleptodactylus*esch. 1823). Pakistan Veterinary Journal. Vol. 31, Page: 207-210.

6. Mubin, S., Gul S.,Khokhar M. I. A. and Ashraf M., 2002. Statistical solution for the industrial waste problem. Journal of Drainage and Waste Management. Vol. 6, Page 55-68.

7. Nasir A. Arslan C. Khan M. A. Nazir N. Awan UK., Ali M. A., and Waqas U., 2012. Industrial Waste water Management In Distract Gujranwala of Pakistan-current status and future suggestions. Pakistan journal of Agriculture Sciences. Vol. 49(I), Page 79 – 85.
8. Pakistan-U.S. science and technology co-operation program annual technical report. Project named: Small scale sewage treatment and waste water reuse system in Pakistan (2010-2011)

9. Toze, S., 2006. Reuse of effluent water benefits and risk, Journal of Agriculture Water Management, Vol. 80. Page 147-159