EFFLUENT TREATMENT PLANT(ETP); A Comparative Study of Drains and Industries Effluents in Faisalabad City

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Abstract : Pakistan had ample water supply in the past but now it is facing an unprecedented water deficit crisis over a past few decades. The supply of water has declined from 1299 m^3 per capita in 96-97 to 1100 m^3 per capita in 2019 and by 2025 is expected to be less than 750m^3 per capita. Hence, it has become necessary to search into other sources of water supplies for irrigation, for example wastewater. Domestic and commercial wastewater in Pakistan is either dumped directly into sewerage, a natural drain, a surrounding field or in an internal septic tank. Most often, this pollution is not handled because only few cities have the treatment facility and even these cities handle just a limited proportion (less than 8%) of their effluents. The wastewater of drains is fertile for irrigation purposes and has a good demand in farmers, primarily due to its nutrient quality and continuity of supply, which has positive effects on agricultural land prices, families, monthly income, due to the reuse of wastewater.

The new research aimed at characterizing the Faisalabad, Pakistan's industrial effluent standard. The tests of the effluent were obtained from two separate drains, along with the accumulated effluent of several industries. Both the samples were classified according to normal protocols for pH, TDS, TS, TSS, BOD, COD, turbidity, different heavy metals. Majority of the water quality parameters surpassed the country's national standards of environmental quality. Such contaminants may have significant impacts on the soil composition, groundwater safety, and freshwater habitats and thus require policymaker's commitment to build a consolidated wastewater treatment facility.

Key Words: Effluent, Treatment, wastewater, Environmental issues, Sampling.

1. INTRODUCTION

The total population of Faisalabad is 3.54 million having an area of 5856 km2. Faisalabad is located between the rivers Ravi and Chenab (Wikipedia, 2016). Faisalabad was famous for its agricultural products around the country before the partition of India. The development of the city brought modern industries including textile and Argo-based industries in the city. In 1947 there were only five industries in the city. With the passage of time the city gained a status of Manchester city of Pakistan and now has many small and large industries. There are 512 industries in the city from which textile industries are 328 and remaining industries are 184 in total. Moreover, there are over 12000 small industries working in the city (Wikipedia, 2016). Major industries are installed on Jhang road, Samundri road, Jaranwala road, Sargodha Road and Canal Road. The study was focused on major and populous industrial areas such as Jaranwala road and Sargodha Road [1]. That is a large number, in comparison to the ten that was needed for drinking, which is somewhere in the region between 20& 5 liters [2].
The sewage and industrial effluent are threatening the environmental aspects of the city. The increasing amount of harmful effluent is affecting the human health, aquatic life, and atmosphere and causing many waters borne diseases. The rising crisis has such a diverse affect that it has surpassed no point of return. Despite the protective measures taken by WASA and environmental policy makers the effluent is creating many environmental problems. The increased demands of goods due to increasing population has called for more industries which in return will increase the effluent twice. Effluent runoff requires specialized care to minimize the effects on human safety and the atmosphere before it is collected [3]. Wastewater generally contain suspended solids (SS), high color, suspended solids (SS), temperature, pH, chemical oxygen demand (COD), biological oxygen demand (BOD) other organic matters [4].

There must be a way to properly dispose wastewater. The main objective of the study:

- Determine the quality of effluent used for irrigation.
- Develop the familiarity with ETP processes.
- Evaluation of industrial effluents and major drains collecting effluents.

General study showed that wastewater carries huge number of pathogenic organisms, in where may have a risk for the agriculture related workers, the persons who control crop and for the consumers [5] [6].

2. SAMPLING

The collection of samples for laboratory testing involves processing, storage, and examination of a water sample. Their water collection causes two types of problems. The problem is to decide the scope and extent of taking results out of a source of water. Interests of taking a specific result may depend upon climatic condition, season, time of the day, or is affected by certain human or animal activities. The distance of laboratory to the sampling location also plays crucial role in deciding the scope and extent of sampling.

2.1 Types of Samples

Two types of samples can be taken, grab samples or composite samples[1].

2.1.1 Grab Samples

The sample obtained at a specific time and place only represent the composition of the source at that time and place. This requires manual sampling and limited resources, which can be unduly expensive and time-consuming for regular or large-scale sampling tasks. Like the name suggests, 'Pull tests' are basic scoops of the wastewater being collected and are suitable when the conditions are stable or well balanced. For instance, this form of sample may be used for the sampling of Balance Tank or the calculation of sludge solids in the aeration basin. Care will also be taken to ensure that the study is reflective of the population and should be drawn from well-mixed places on all times

2.1.2 Composite Samples

Composite samples are either amalgamated or made up of smaller sub-samples that may be processed in two forms. Automatic samplers may eradicate human error in manual sampling, reduce labor costs, have means for more regular sampling, and are widely used. The simplest method is time-related composites made up of equal-volume sub-samples collected at different time periods, e.g., sub-samples per hour composited to produce a single regular sample. In certain determinations, a standardized sample covering a 24-hour duration is assumed to be normal. Nevertheless, under certain cases, a combination reflecting a longer time span, or a shorter time can be preferred. The other method is a flow-proportional sampling, which includes a purpose-built sampler. Such systems take measurements of wastewater in relation to the discharge and are normally attached to an automated flow meter. This latter method of sampling is highly reliable and can be used to calculate the overall load of wastewater. Owing to its precision, flow-proportional composite sampling is preferred.

Choosing the right location for sampling was indeed a difficult task. Various sites have been chosen based on criteria.

2.2 Sampling Procedure

Sampling procedure is not that tough but there are some basic requirements and protocols that one must follow:

- Sampling shall be carried out with due care to avoid personal risk or injury arising from the nature of the sample itself or the location of the sample point.
- Sample bottles/containers must be clearly named and marked. The period/date shall be reported along with all necessary information of the position and sampling factors that may be present at the time of sampling, e.g., environmental conditions.
- Sample bottles must be securely sealed after sampling and stored securely for safe transport to the laboratory in cooler boxes where necessary.
- Samples must be evaluated generally within 24 hours of sampling.

2.3 Equipment

Equipment includes the required devices and utensils needed for sampling and their specifications:

- Bottles of sample 1, 11/2or 2 1/2 liters of new PVC bottles to be used for all samples taken except samples taken for bacteriological, oil-based, or solvent analysis.

- Sampling of a hand pump with an extended tube to be used for depth sampling at low flow. Otherwise, a sampling beaker (250ml, 500ml or

[1] *Wastewater Sampling GENSOP3.01*, https://epawebapp.epa.ie/licences/lic_eDMS/090151b28036bb01.pdf.

1000ml) with screw-in extension rods to be used for depth sampling with sufficient flow.

3. RESULTS

3.1 Effluents in Drain

The samples were taken from two main drains Paharang and Madhuana drain. The effluents were taken from various industries of Faisalabad which flows into the Paharang and Madhuana drains. The analysis of the effluents of drains and industries are
done separately. The map of Faisalabad is shown in Figure 1. The water samples were collected and analyzed based on biological, chemical, and heavy metals. The results were compared to national environmental quality standards and a detailed discussion is made on the results.

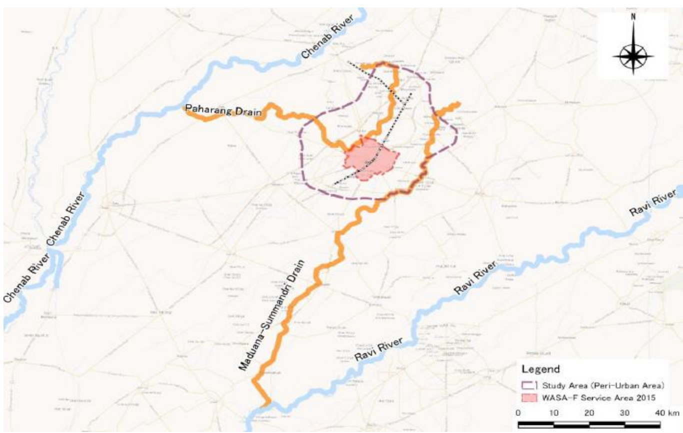
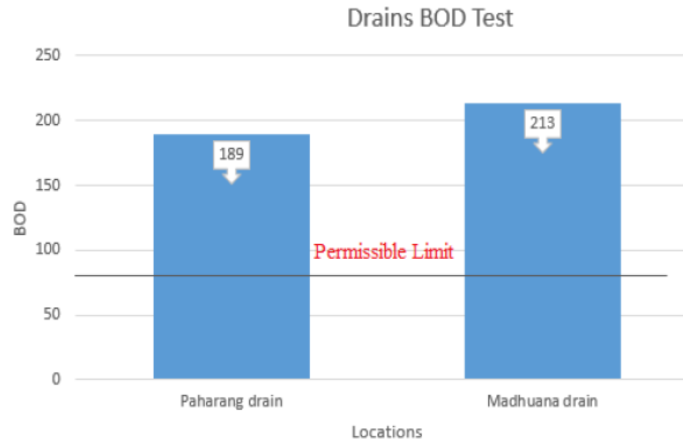


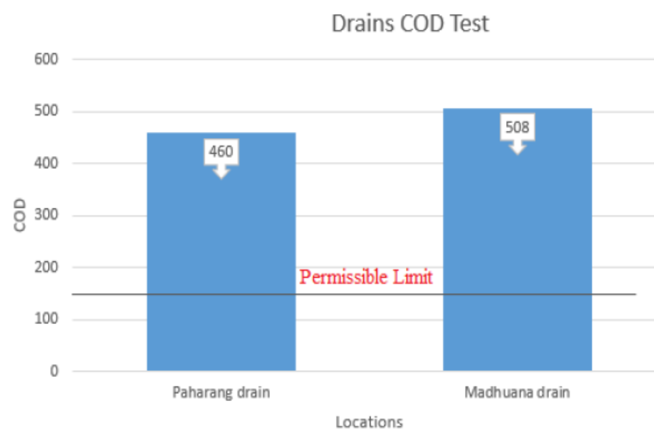
Figure -1: Locations of the WASA-Service Area, Study Area, Drains, and Rivers

3.1.1 Biological Analysis

The BOD and COD values of Paharang and Madhuana drains were much higher than the standard limits. The main cause of elevated values is the extensive construction of industries and almost negligible treatment before flowing into the drains. High levels of BOD and COD indicate high levels of organic and inorganic compounds in the sample. Starch being an effluent of the textile industry may also be the cause of increased levels of BOD and COD in the drains.



Graph -1: Drains BOD Test



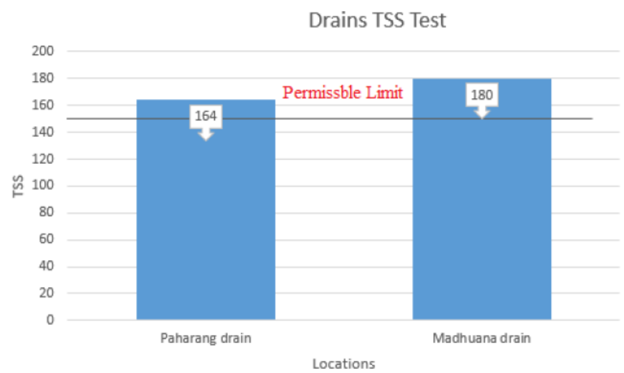
Graph-2: Drains COD Test

3.1.2 Chemical analysis

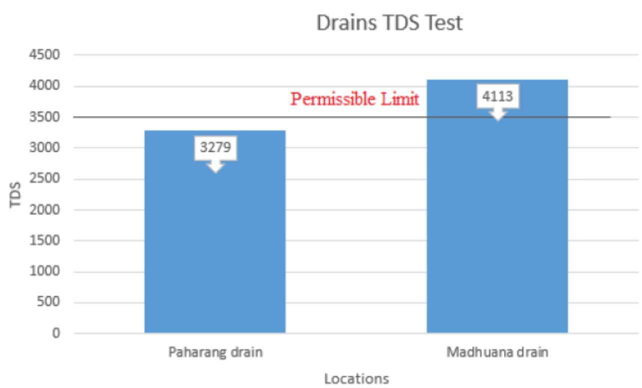
The wastewater samples were tested and analyzed for chemical parameters. The test results and permissible limits of these chemical parameters are shown in the table below.

Table -1: Chemical Analysis

Sr. No	Parameters	Unit	PD.	MD.	PL.
1	**pH**	Nil	7.7	7.6	6-10
2	**TDS**	mg/l	3279	4113	3500
3	**TSS**	mg/l	164	180	150
4	**Cl**	mg/l	939	1150	1000
5	**SO_4**	mg/l	328	505	600



Graph -3: Drains TSS Test



Graph -4: Drains TDS Test

3.1.3 Heavy metals analysis

The third portion of the testing was the detection of heavy metals in the wastewater. The metals are majorly discharged from industries which flows in the streams and drains and eventually that water is used for irrigation purpose. The heavy metals enter the food chain and may cause fatal diseases and cancers. The industries discharge heavy metals as they are used in the manufacturing process, but they are used in very small quantity.

Table -2: Heavy metals analysis for drains

Sr. No	Parameters	Units	PD.	MD.	PL.
1	**Mn**	mg/l	0.73	1.3	1.5
2	**Ni**	mg/l	3.8	6.5	1
3	**Pb**	mg/l	0.65	0.62	0.5
4	**Cd**	mg/l	0.5	0.78	0.1
5	**Cu**	mg/l	0.56	0.82	1
6	**Cr**	mg/l	2.3	8.7	1
7	**Fe**	mg/l	11.6	13.7	2

3.2 INDUSTRIAL EFLLUENTS

The samples of effluents from various industries were taken to examine and analyses the effects of effluents on the water quality of Faisalabad. The samples were tested against following parameters discussed below:

3.2.1 Selection of industries

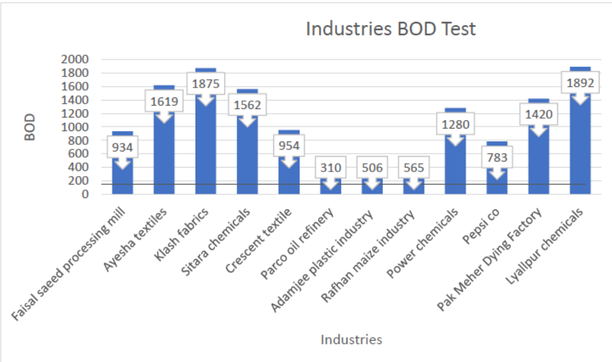
There are thousands of big and small industries in Faisalabad. The industries were selected by following two factors:
1. Its type

2. Its location

There are various types of industries, textile, plastic, dying, processing, and others. The representative industries were also selected according to their location. The cluster of industries on Madhuana drain (MD) was selected as part of sampling. Few industries were selected on Paharang drain (PD) as well. Most of the industries are constructed on the Madhuana drain due to the availability of water, cheap land cost and others.
It is obvious that the samples couldn't be collected from all the industries of Faisalabad. The industries selected for sample collection were selected based on type and cluster. Few industries located on Paharang, and others located on Madhuana drain were selected as part of sampling. Few big and representative industries were selected out of cluster of industrial units. It was a focus to select every type of industry to obtain a representative sample of every large industry.

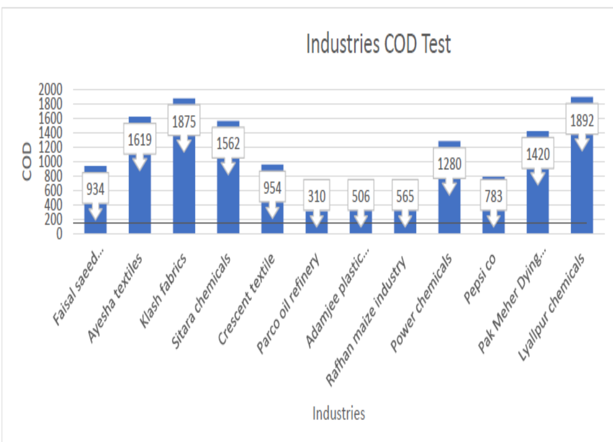
3.2.2 BOD and COD analysis

The biological oxygen demand of all the industries except one was exceeding the permissible limit. This indicates the usefulness of effluent treatment plant to be installed in the premises of each industry. There is an increased culture of treating the effluents and controlling the amount of BOD, COD, heavy metals, and other parameters due to strict policies of government and international quality standards.



Graph -5: Industries BOD Test

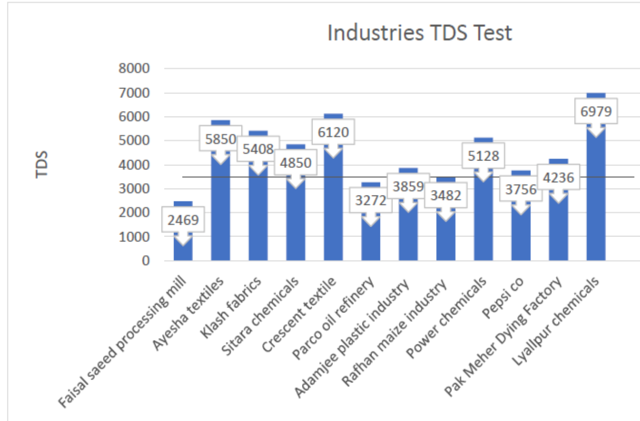
The COD of all the industries came out to be greater than the permissible limits. The chemical oxygen demand was high due to the possible use of organic and inorganic compounds. There is a much saturation of textile industries in Faisalabad. The textile industries use starch which may cause the increased levels of COD.



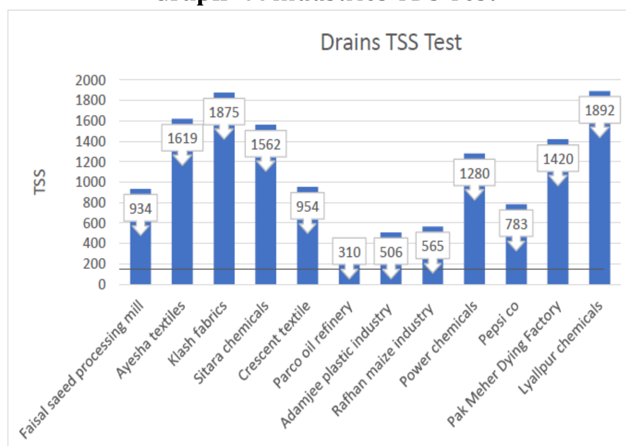
Graph -6: Industries COD Test

3.2.3 Chemical Aanalysis

The chemical parameters were analyzed, and the results were way beyond the allowed boundary line set by national standards of Pakistan. It proves that the dissolved and suspended solids in the effluents are much higher and should be controlled. The dissolved solids may prove fatal when the wastewater is used for irrigation purposes. It may scant the growth of plants and may make the vegetation unhealthy for consumption.



Graph -7: Industries TDS Test



Graph -8: Industries TSS Test

Table -3: Chemical Parameters

Sr. No	Industries	pH	TDS (mg/l)	TSS (mg/l)
1	Faisal Saeed processing mill	7.5	2469	934
2	Ayesha textiles	7.8	5850	1619
3	Kalash fabrics	8.6	5408	1875
4	Sitara chemicals	9.1	4850	1562
5	Crescent textile	11.5	6120	954
6	Parco oil refinery	7.9	3272	310
7	Adamjee plastic ind.	7.2	3859	506
8	Rafhan maize ind.	7.2	3482	565
9	Power chemicals	8.9	5128	1280
10	Pepsi co	8.9	3756	783
11	Pak Meher Dying Fact.	7.8	4236	1420

Table -4: Heavy metals

Sr. No	Industries	Fe	Mn	Ni	Pb	Cd	Cu	Cr
	Permissible limit	**2**	**1.5**	**1**	**0.5**	**0.1**	**1**	**1**
1	Faisal Saeed processing mill	1.08	1.31	0.75	nil	0.001	0.07	1.53
2	Ayesha textiles	1.86	0.32	traces	0.55	0.01	0.32	1.66
3	Kalash fabrics	1.16	1.1	0.96	0.62	0.001	1.37	1.86
4	Sitara chemicals	1.72	1.31	0.61	0.67	0.01	0.5	1.42
5	Crescent textile	2.61	1.85	1.21	0.59	0.18	4.51	1.05
6	Parco oil refinery	11.7	0.2	traces	0.03	traces	traces	0.03
7	Adamjee plastic industry	1.01	1.22	1.16	0.72	0.07	0.96	1.21
8	Rafhan maize industry	0.49	0.23	traces	traces	traces	traces	0.21
9	Power chemicals	0.98	0.83	0.39	0.56	0.02	0.45	1.56
10	Pepsi co	0.16	0.11	1.59	0.27	0.02	0.35	0.16
11	Pak Meher Dying Factory	0.56	0.28	0.14	0.34	1.8	0.5	0.86

3.2.4 Heavy Metals

The most important parameter to be looked for in industrial effluents are the use of heavy metals. These are most toxic and may cause severe diseases if consumed in direct or indirect ways. The metals are generally within the allowed limit NEQs. But many industries do violate the standards and limit. The amount of lead and chromium were exceeding in most of the industries due to the wide scope and application of these metals. Lead is widely used in batteries, cable sheaths, machinery manufacturing, light industry, radiation protection and other industries [7]

3.3 Design of Effluent Treatment Plant

This layout **figure-2** shows the MantisIW model for industrial wastewater treatment. The system includes influent refinery wastewater, caustic wash water, and chemical dosage units for pH and nutrient control. The plant uses a neutralization tank followed by an API separator for oil removal. The API effluent is then sent to a DAF and conventional activated sludge treatment system.

3.3.1 Model Assumptions

With model constraints as per ASM1 [8], the assumptions are adopted for the development of the
model in this study are as follows

1. ASP operates at a content temperature
2. A consistent grouping of broke down oxygen (DO) is kept up with, and there is adequate blending inside the reactor
3. pH is steady and near-neutral value.
4. The model's coefficients are thought to be constants for any influent attributes
5. There are enough inorganic nutrients to ensure sufficient growth.
6. There is simultaneous hydrolysis of organic and nitrogenous compounds

4. CONCLUSIONS

- City is generating a total of 5.28 m^3 of wastewater every second and after the addition from nearby villages and cities along the drains the total discharge of drains into rivers go up to 7.29 m^3/sec wastewater is seeping through the drains and mixing with ground water.
- All the samples were found exceeding the standard values or allowed limits of BOD and COD from both drains and industries. Highest mean values recorded for BOD was 425 mg/l and for COD was 928 mg/l.
- The samples of wastewater from drains found worst while discussing about the parameters like total dissolved solids (TDS), total suspended solids (TSS) and ph. After the addition of wastewater from all the industries into drains the quality gets worst.
- The chemical quality for wastewater to be used as irrigation water is not good. Wastewater is totally unfit for its use for growing crops. The chemicals found to be exceeding the permissible limits include HCO3, Na, Cl and TDS. Concentrations for these chemicals were high and needs to be treated for its use in agriculture.
- The concentration of sulphates was high in Madhuana drain as compared to Paharang drain.
- The ETP undergoes three major processes as primary, secondary, and tertiary treatment.

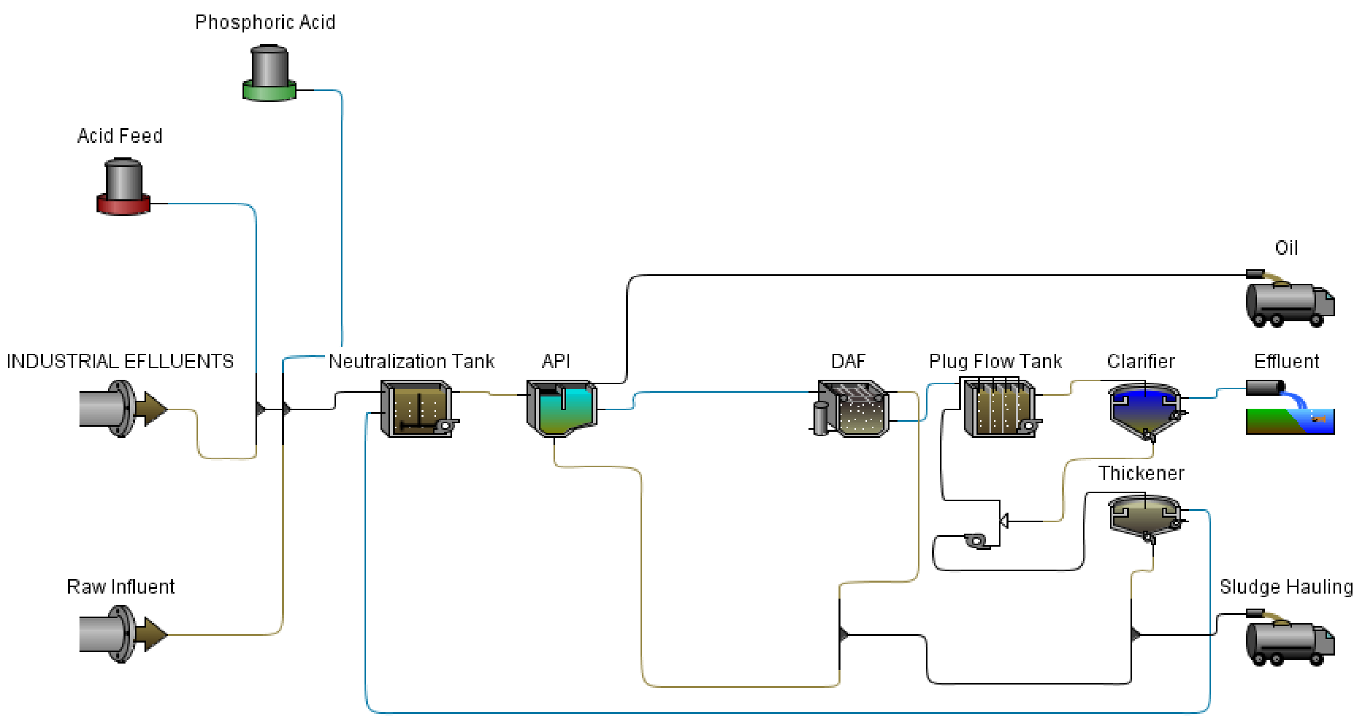


Figure -2: Design of Effluent Treatment Plant

- Wastewater treated by WASA found fit for irrigation purpose. However, this water is not used for irrigation and again got mixed with Paharang drain. People prefer untreated wastewater for irrigation because of rapid growth while ignoring the side effects.
- Few farmers reported about better growth of crops and improved results for their crops production, but they did not know the unhygienic quality of that water and the fruit from that water.

5. RECOMMENDATIONS

- Wastewater should also be treated before its discharge into rivers and freshwater streams to save aquatic life. This is also necessary to maintain a balance in ecosystem.

- There should be proper lining of wastewater drains and channels to avoid the seeping problem to save groundwater and its quality.
- One should take care of the seepage of wastewater in treatment ponds of WASA to avoid it mixing with groundwater. A proper check-up procedure should be adopted.
- Groundwater should not be used as drinking water near drains.
- The crops and vegetables grown using industrial wastewater are highly toxic and this wastewater must be treated before its use in agriculture.

6. REFERENCES:

[1] F. M. A. &. L. H. Sher, "'Industrial polymer effluent treatment by chemical coagulation and flocculation," Journal of Environmental Chemical Engineering, vol. 1, no. 4, pp. 684-689, 2013.

[2] D. P. A. R. H. M. Amoah P, "Irrigated urban vegetable production in Ghana: microbiological contamination in farms and markets and associated consumer risk groups," J Water Health, vol. 3, no. 5, p. 455–466, 2000.

[3] K. a. A.-A. N. Al-Zboon, "Performance of wastewater treatment plants in Jordanand suitability for reuse.," African Journal of Biotechnology, pp. Vol. 7 (15), pp. 2621-2629, 2014.

[4] L. M. K. P. Z. A. P. D. Vlyssides A.G., "Electrochemical oxidation of a textile dye wastewater using a Pt/Ti electrode," Journal of Hazardous Material, pp. 70(1-2), 41-52., 1999.

[5] S. M., "Wastewater reuses potential in Pakistan: Guidelines for environment and public health protection.," Int. Journal of. Environ. Eng., pp. 1(3), 306-320., 2009.

[6] B. A. a. A.-M. M. Saleem M., "Seasonal variations in the bacterial population in an activated sludge system," J. Environ. Eng. and Sci., vol. 2, no. 2, pp. 155-162, 2003.

[7] "Asianmetal.com," Lead: uses, applications-Metalpedia, [Online]. Available: http://metalpedia.asianmetal.com/metal/lead/application.shtml.. [Accessed 23 March 2021].

[8] M. Henze, Gujer., T. Mino and M. van Loosedrecht, Activated Sludge Models ASM1, ASM2, ASM2d and ASM3, London, UK: IWA Publishing, ISBN 9781780402369, 2015.