Characterization Of Treated Sewage Effluent Using Different Technologies In Punjab (Malwa Region)

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ABSTRACT
The study area includes the 7 towns and cities located in the Malwa region of Punjab where sewerage treatment plants are running at present. The influent and effluent samples are collected from different plants and tests are been conducted to analyze the different parameters. The technologies used for the treatment in these different stations include Waste Stabilization Ponds, Sequential Batch Reactors and Moving Bed Bio Reactors. The physico-chemical parameters of influent and effluents of Sewage treatment plants were studied. The present standards fixed by PPCB for analyzed parameters like BOD, COD, TSS, Fecal Coliform should be less than 10mg/l, 50mg/l, 20mg/l, 1000 MPN/100 ml respectively. The result indicated that WSP technology was used during the initial phase of development of sewerage treatment plants in Punjab. Now a days WSP technologies doesn’t meet the present standards of PPCB as the average values obtained are 28mg/l, 78mg/l, 29mg/l, 2800 MPN/100 ml respectively. Even the MBBR technology based plants gives the average values of 16mg/l, 68mg/l, 19mg/l, and 800 MPN/100 ml respectively. It was analyzed that only SBR technology based plants are meeting the present required parameters as the average values obtained are 8mg/l, 40mg/l, 15mg/l, 700 MPN/100 ml respectively. The study shows that the results are much better for SBR technology than WSP & MBBR technologies as WSP & MBBR technologies doesn’t meet the present standards of PPCB due to lowering the values of fixed standards whereas the SBR is meeting the standards at present.

I. INTRODUCTION
Sewage or wastewater is of three types; industrial sewage, domestic sewage and storm sewage. Domestic wastewater is used by residential areas which incorporate all the resources or materials in addition to the water during its use. Hence it is composed of human body wastes along with the usage of water for sullage and flushing toilets. Industrial wastewater treatment includes wastewater that is generated while commercial or industrial activities. Storm sewer is projected to take merely storm waters, surface runoff, street wash waters, and drainage. To assess the impact of existing wastewater disposal in Punjab, the wastewater generation and its characteristics is very important to understand. The impacts associated with the effluent of Sewer treatment plants practices are categorized into five areas, which included impacts on environment, agricultural land, aquatic life, surface and groundwater and human health and economy. Considerable agricultural lands close to the villages, especially in the vicinity of the wastewater drains use the wastewater for irrigation purposes. The farmers consider this source to be rich in nutrients and one of the most reliable sources for irrigation. The land application of the contaminated wastewater with high bacterial and chemical contaminants which may have heavy metals will contaminate the soil and hence affect the vegetation. The level of influence and accumulation of the heavy metals in crops depend upon many factors like soil type, plant species and contaminant concentration. These contaminants become part of the food chain as the contaminated crops are either directly used by human or by the animals. Polluted wastewater is also affecting the groundwater quality and making it unfit for drinking purposes. Land application of the wastewater and pounding of wastewater in certain area where proper disposal arrangements are not available may contaminate the groundwater. Improper design of the soakage pits and discharge of wastewater to a depth of water table have a very serious impact on the ground water. The amount of treatment required can be revealed by comparing the characteristics of influent waste water to the required treated or
effluent characteristics, sticking to the guidelines. To accomplish the treated wastewater quality a number of diverse treatment substitutes can be developed. Physical unit processes include screening, mixing, flocculation, sedimentation, flotation, and filtration. Chemical unit processes include precipitation, gas transfer, adsorption, and disinfection. Biological unit processes remove biodegradable organic matter from the wastewater, organic matter is transformed into gases that can discharge to the environment, Biological treatment is also employed for nitrogen deletion and for phosphorous and sulphate deletion from the wastewater.

Exponential growth of human population coupled with ways to attain high standards of living through technological advancement has resulted in widespread contamination of the environment at the global level. During the past few decades’ rapid industrialization, wanton exploitation of natural resources and excessive use of environmental disruptions threatening the life support system. In this literature review, the emphasis is mainly on the quantity of wastewater generated in the urban areas. The large number of cities in India is having sewerage treatment plants and some of the developing cities are setting up new sewerage system and STP’s. This entire are discuss under this section. Organization responsible for Construction of new STP’s & their operation & maintenance in cities and towns is Punjab Water supply and Sewerage board. As the water supply is also with the PWSSB so estimation of wastewater generated can be done with more precision. The plants are designed to cover the 100% population of the town or cities.

2. BRIEF INTRODUCTION OF TECHNOLOGIES

Technologies are invariably evolving or developing, conversely in general wastewater treatment plants can be categorized into anaerobic (also termed as septic) and aerating. Domestic wastewater is often treated through such wastewater treatment plants. Some of the methods or technologies used are waste stabilization ponds (WSP), moving bed bio reactor (MBBR) / fixed aerated bioreactor (FAB), sequential batch reactor (SBR), up flow anaerobic sludge blanket (UASB) Reactor

Waste Stabilization Ponds frequently termed as lagoons is a natural process for the treatment of wastewater that needs a significant amount of space and hence is inappropriate for urban regions. Domestic or municipal wastewater, polluted storm water or industrial effluent can be treated by using this technology. The wastewater is regularly treated when flows one reservoir to another. These processes do not demand power or any maintenance; though the treated water does not fulfill environmental requirements.

The MBBR technology is based on the principle of biofilms that merge the advantages of both the traditional fixed film methods and activated sludge system without their drawbacks. The fundamental principle of the moving bed process is the development of biomass on plastic supports that move in the biological reactor through turbulence generated by aerobic or anaerobic reactors. Awareness in biofilm methods for wastewater treatment is increased over the last decades.

Sequential Batch Reactor is an Aerobic Biological treatment process. It is a suspended growth process similar to extended aeration, activated sludge process etc. Bacteria and other living organisms degrade the waste and also feed on the waste. It is a batch progression where aeration, clarification/settling occur in a single tank. Both aeration and settling occurs in the same tank in batch mode. Former storage basin and/or more than one SBR are needed for continuous wastewater flow. Comparatively low capital cost and low space requirement. Quite simple to automate but then requires higher maintenance expertise.

3. LITERATURE REVIEW

J. P. Canler, J. M. Perret (1994) [1] presented biological aerated filtration which is a common and intensive process. The technology based on biological processes has certain advantages like the absence of secondary clarifiers, the wide variety of treatment applications & the modular nature.. The result shows that at applied loads of less than 7 kg of COD, the effluent is of satisfactory quality (< 90 mg / 1 of COD) & that the removal of suspended solids is highly efficient. Many other aspects have been studied & the data gathered prove the potential of this process, which neither requires a careful & regular system operation procedure. H.W. Pearson, et al. (2003) [2] presented guidelines for the
minimum evaluation of the performance of existing waste stabilization ponds. It is recommended that 24-h flow-weighted composite samples of the raw wastewater and pond effluents be taken over a 5 week period at the hottest & coldest periods of the year & analyzed for COD, BOD, SS, NO\textsubscript{3}-N, NH\textsubscript{3}-N and total P; fecal coli form numbers should be determined on grab samples, & algal biomass approximate by measuring chlorophyll concentrations in samples of the pond water column. Pond mid-depth mean daily temperatures & pond sludge depths should also be measured, & local meteorological data obtained. The diurnal variation of pond effluent quality and of dissolved oxygen & temperature with depth should be measured at least once during each sampling season. Recommendations are also given for a more basic estimate of pond performance in areas where the lack of skilled manpower, materials and equipment preclude the complete minimum evaluation procedure. Jafrudeen, et al. (2012) [3] reported that hospital waste water may have an adverse impact on human health and environments as it may contain different likely hazardous materials. Consequently, proper treatment of hospital waste water with suitable treatment technology is essential. Hospital waste water discharge standards should conform to EPA 1986 (source: GSR 7 dated Dec. 22, 1998). In accordance with WHO guidelines, for irrigation purpose treated waste water should not hold no more than one helminths egg per liter and no more than 1000 Fecal Coli forms per 100 mL. The comparison of broadly used treatment technologies will assist engineers, designers, architects in selection of treatment technologies in terms of their energy, operation, efficiency, land requirement, performance, cost etc. The results shows that the effluent discharge after suitable treatment protects public health and environment, integrated waste water management approach should be adapted by the government. Musharrafie A. et al. (2010) [4] presented a social evaluation approach and environmental study of two waste water treatment plants; Stabilization Ponds and Activated Sludge System. Life Cycle Assessment (LCA) technique is used for social and environmental assessment of these WWTPs (Waste Water Treatment Plants). The results illustrate that a larger number of environmental impacts are produced by the activated sludge; though from a social approach the impacts related with this technology have improved performance. Abdel Shafi et al. (2000) [5] studied that the wastewater treatment in the Egyptian rural areas lags far behind potable water supply. The vast majority of the Egyptian population receives piped potable water, however only urban areas and some larger rural villages possess wastewater treatment facilities. Untreated wastewater is typically discharged in water bodies. This practice has contributed to widespread degradation of water quality and affects the policy reuse of drainage water plans in Egypt. Based on the past experiences and learned lessons in the municipal wastewater treatment, the anaerobic technology proved a very good performance and efficiencies due to its positive advantages against aerobic ones. El Nadi El Hosseiny Dr.Mohamed [6] reviewed that the average waste water characteristics and the performance of the low cost wastewater treatment plants which proved to vary greatly in rural areas and depend mainly on the behavior of the society. It is recommended to have aside specific data for the design of low cost wastewater treatments plants for water quality protection.

4. CASE STUDY

Three towns located in Bathinda & Mansa districts where Sewage treatment plants based on different technologies are working at present were selected for the present study. The cities and towns included are Mansa, Sardulgarh, Bhikhi, Budhlada in Mansa district and Bathinda, Talwandi Sabo, Maur in Bathinda district. The steps included for the work done are:

- Quantity of waste water generated in a town is already calculated before designing the Sewage treatment plant, so the waste water generated is obtained from PWSSB department who is running the STP's at present.
- All other data like Construction cost, maintenance cost, Power cost, Construction area, working hours, Average daily flow, Peak flow of STP etc is collected from the records of STP's at site.
- Samples are are collected at a particular time and place and they represent only the composition of source at that time and place. Samples were collected according to the procedure mentioned in “Standard Methods for the examination of water and wastewater (2005)”. A
summary of the handling requirements followed in the present study is given in table 1. Point samples of wastewater were collected from entrance point & outlet of the STP in the selected cities and towns.

- Characterization was carried out by collecting the wastewater samples from the inlet & outlet of the STP and then analyzing the sample for the parameters like pH, COD, BOD₅, Alkanity, Total Suspended Solids, Total Dissolved Solids, Total Coli forms and Fecal Coli forms.

Table 1: Summary of handling requirements

<table>
<thead>
<tr>
<th>S. no</th>
<th>Determination</th>
<th>Container</th>
<th>Volume (ml)</th>
<th>Preservation</th>
<th>Maximum Storage Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>pH</td>
<td>P,G</td>
<td>50</td>
<td>Analyze immediately</td>
<td>2 h/stag</td>
</tr>
<tr>
<td>2.</td>
<td>BOD</td>
<td>P,G</td>
<td>1000</td>
<td>Refrigerate</td>
<td>6 h/48 h</td>
</tr>
<tr>
<td>3.</td>
<td>COD</td>
<td>P,G</td>
<td>100</td>
<td>Analyze, or add H₂SO₄ to pH&lt;2</td>
<td>7 d/28 d</td>
</tr>
<tr>
<td>4.</td>
<td>Solid s</td>
<td>P,G</td>
<td>200</td>
<td>Refrigerate</td>
<td>7 d/ 2-7 d</td>
</tr>
</tbody>
</table>

P: Plastic (Polyethylene or equivalent), G: Glass,

5. EXPERIMENTAL ANALYSIS

The study is conducted in the Malwa region of Punjab. The results of parameters analyzed in different cities or towns are shown in the following graphs:

Table 2: Average Treated effluent Result

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sardugalh</th>
<th>Bhi Kh i</th>
<th>Mansa</th>
<th>Bhudhla</th>
<th>Maur Mandi</th>
<th>Bathinda</th>
<th>Talwandi Sabo</th>
<th>PPCB Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.2</td>
<td>7.3</td>
<td>7.3</td>
<td>7.2</td>
<td>7.5</td>
<td>7.2</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>TSS mg/l</td>
<td>27</td>
<td>29</td>
<td>18</td>
<td>17</td>
<td>19</td>
<td>7</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>BOD mg/l</td>
<td>28</td>
<td>28</td>
<td>18</td>
<td>18</td>
<td>14</td>
<td>5</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>COD mg/l</td>
<td>74</td>
<td>81</td>
<td>71</td>
<td>68</td>
<td>67</td>
<td>65</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>Fecal Coliform/100m MPN</td>
<td>2900</td>
<td>280</td>
<td>800</td>
<td>700</td>
<td>600</td>
<td>500</td>
<td>800</td>
<td>1000</td>
</tr>
</tbody>
</table>

The results of wastewater samples tested & computed in the tables and comparison in the tabular form along with Bar chart is as below:

Figure 1: pH level of different cities

Figure 2: Total Suspended Solids of different cities

Figure 3: Biolchemical Oxygen Demand (BOD₅) of different cities
Table 3: Average results of different technologies

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Average Treated effluent Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WSP</td>
</tr>
<tr>
<td>pH</td>
<td>7.3</td>
</tr>
<tr>
<td>TSS (mg/l)</td>
<td>27</td>
</tr>
<tr>
<td>BOD₅ (mg/l)</td>
<td>29</td>
</tr>
<tr>
<td>COD (mg/l)</td>
<td>78</td>
</tr>
<tr>
<td>Fecal Coliform/100ml (MPN)</td>
<td>2900</td>
</tr>
</tbody>
</table>

6. CONCLUSION

Following conclusions are made from this study:

- pH of effluent of the selected Towns of different STP based on different technologies is alkaline in nature. It varies from 7.2 to 7.3 after treatment which means that all technologies meet the standards and are equally efficient.
- TSS after treatment of WSP plants reaches the maximum value of 27 mg/l which is extremely high and is above the permissible limit. Whereas in MBBR & SBR the value is quite low as less than 20. TSS after treatment of wastewater is satisfactory for MBBR and SBR technologies.
- The BOD₅ is the indicators of the organic load in municipal and industrial wastewaters. In the studied areas, BOD₅ of effluent for WSP based technology plants reaches to 30 mg/l. In plants based on MBBR technology the maximum value of effluent found is 20mg/l whereas in case of SBR based plants the maximum value after treatment doesn't exceed 10mg/l. This shows the SBR is most effective for BOD treatment when compared to others. The PPCB norm for BOD in the wastewater to be disposed of was 30mg/l before 2/5/2012. But later the BOD limit for the effluent was fixed as 10mg/l. It was also found that SBR is the only technology which is satisfying the present required standards of PPCB whereas the other technologies studied doesn't meet the present fixed standards.
- COD values observed in all the technologies are less than 90mg/l. The accuracy of SBR is found much higher than WSP & SBR.
• Microbiological analysis of the wastewater indicates the presence of Fecal Coliforms in the effluent samples is less than 1000MPN per 100ml for MBBR and SBR technologies, which is within the permissible limit fixed.

• It is found that WSP requires maximum area for construction, least capital cost, least power consumption and least maintenance cost. It is suitable where the maintaining authority is not able to cope up with the higher maintenance cost but has large low value land available like in new developed towns. The efficiency is quite lower as compared to other technologies. MBBR and SBR technology are very common & most constructed plants in Punjab by PWSSB. MBBR plants are bit cheaper in capital cost, maintenance cost & less land required for construction due to low Sludge retention time needed as compared to SBR whereas SBR plants are suitable where very efficiency is needed & all other land & cost factors are given least importance.

• It is seen that as the permissible standards of PPCB/CPCB have been lowered so the department have to modify old constructed plants to meet the new standards. However the to meet the requirements of PPCB the department has made new projects at WSP based plants to distribute the treated effluent to nearby fields for irrigation by laying RCC pipe in the adjoining fields. Most of these projects are running at present and farmers nearby are taking the advantage for irrigating their fields.

7.0 REFERENCES


