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Evaluation and assessment of performance of Al-Hussein bin Talal University (AHU) wastewater treatment plants

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ABSTRACT

Two hundreds wastewater samples were collected from inlet and outlet water of AHU wastewater treatment plant and analyzed for biochemical oxygen demand (BOD), chemical oxygen demand (COD) and total suspended solids (TSS) to evaluate performance of AHU wastewater treatment plant. $BOD_5$was almost reduced to very low level and the reduction percentage is 95% while COD less than BOD_5 84%and TSS is 83%.These percentages of reduction of BOD_5, COD and TSS explained the fulfilling overall efficiency of the plant. On this research, the biodegradability indexes (B.I) of wastewater treatment plants were observed. The average of B.I were shown that the highest biodegradability index was in June (0.95) and the lowest was in July (0.6). The correlation between BOD_5 and COD will support in evaluating the treatment approaches. This shows that probably AHU wastewater is relatively biodegradable. A correlation is established between the inlet and outlet parameters, especially when it comes to the BOD_5 parameter confirmed that the process is very efficient in reduction the biological matter.

1. Introduction

It is important to characterize the structures and describe the source of wastewater (Abdallaa and Hammam, 2014). The organic compounds are derived from living organisms and during the wastewater treatment processes these organic compounds are changed into other organic compounds under circumstance conditions (Khalil et al., 2006; Singh et al., 2011; Pandey and Tiwari, 2009). First of all, wastewater need to be characterized before handled to know the compositions that are important for powerful design and operation of wastewater treatment plant (Sahota and Pandove, 2010). The impact of the effect of wastewater discharge on the receiving water is expected by its oxygen demand (George et al., 2010).

The biochemical oxygen demand (BOD), the chemical oxygen demand (COD) and total suspended solids (TSS) are the most important parameters used to identify the structures of wastewater. BOD_5 is a measure of how much dissolved oxygen is consumed by aerobic microorganism in 5 days at 20°C. The normal range of BOD_5 in domestic wastewater range from 100 to 300 mg/L. COD is chemical oxygen demand and is measured chemically by digestion with acid (Vaish and Vaish, 2000) and there is a particular correlation between the COD and BOD under specific conditions (George et al., 2010; Vaish and Vaish, 2000; Siddiqui and Sharma, 2009). Although, the BOD_5 experiment has been in use for more than a century, and therefore stays deeply settled in the follow of biological wastewater treatment (Kavitha and Elangovan, 2010). The COD evaluation estimates the quantity of organic matters in wastewater in most effective three to four hours, instead than the five days required by using the BOD_5 scan, and may also be used instead. COD outcome are generally better than BOD_5 values, and the ratio between them will vary relying on the characteristics of the wastewater. This ratio has been commonly used as an indicator for biodegradation ability (Abdallaa and Hammam, 2014). It's known as "Biodegradability index" (B.I.). It is mainly regarded the cut-off point between biodegradable and non-biodegradable waste (Abdallaa and Hammam, 2014; Singh et al., 2010). Once an average B.I. has been founded for the plant wastewater circulation, COD scan can be used to tell about BOD_5. The BOD_5-to-COD ratio is 0.5:1 for raw domestic's wastewater, and may drop to be as little

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as 0.1: 1 for a well-stabilized secondary effluent. There are no standard values for BOD_5/ COD biodegradability index for unique types of wastewater (Sukumar and Sankar, 2011). Nevertheless, stated values for biodegradability index vary from 0.4 to 0.8, for municipal untreated wastewater. The ratio can exceed 10 for industrial wastewater (Gupta et al., 2009; Aiyuk et al., 2006).

The present study aims to evaluate performance of AHU wastewater treatment plant on field data. The removal efficiencies of BOD, COD and TSS in the influent and effluent treatment plant depends on satisfactory performance and if the effluent suitable agricultural irrigation and go with the Jordanian and international standards.

2. Materials and methods

The two hundreds water samples (both inlet and outlet) were collected from AHU wastewater treatment plant monthly for three years, under closely controlled and maintaining similar conditions. Wastewater samples before (inlet) biological treatment and after (outlet) biological treatment were analyzed for biochemical oxygen demand (BOD), chemical oxygen demand (COD) and total suspended solids (TSS). All the analyses were carried out according to the (APHA, 1995).

All statistical analyses of data were done using Microsoft Excel spreadsheets. The confidence levels were set at 95%.

3. Results and discussion

3.1. Organic compound degradation

3.1.1. BOD5 analysis

The results of this study indicate that the mean (for three years) of the BOD_5 values before the biological treatment (inlet) and after the biological treatment (outlet) were shown in Fig. 1. The BOD values ranged from 230.7 to 328.5 mg/l inlet and from 10.7 to 18.9 mg/l in outlet. Compere those values with the standard wastewater BOD before the biological treatment in the range 180 to 220 mg/l (Johal et al., 2014).

3.1.2. COD analysis

In the AUH plant samples the COD values ranged from 315.1 to 365.6 mg/l inlet and from 51.2 to 56.0 mg/l in outlet as shown in Fig. 2 that are lower than the standard wastewater COD which is ranged from 500 to 600 mg/l.

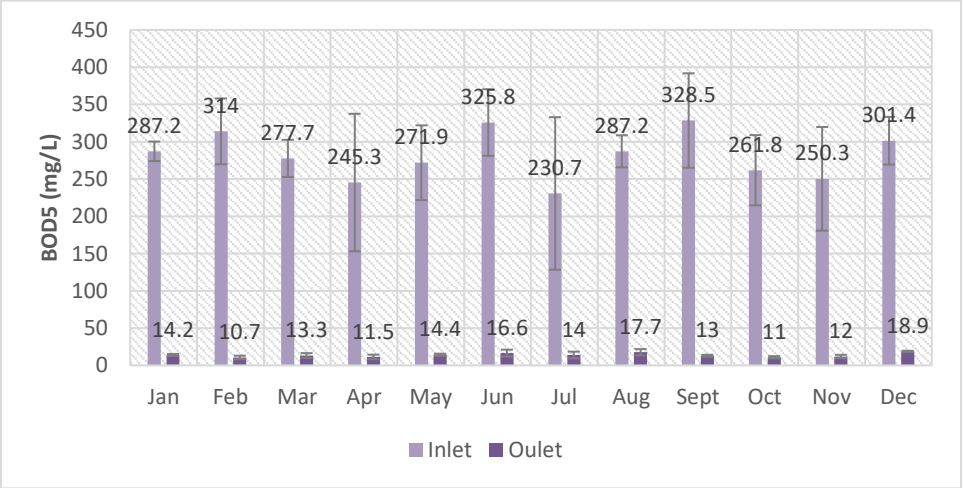

Fig. 1: BOD_5 values of inlet and outlet

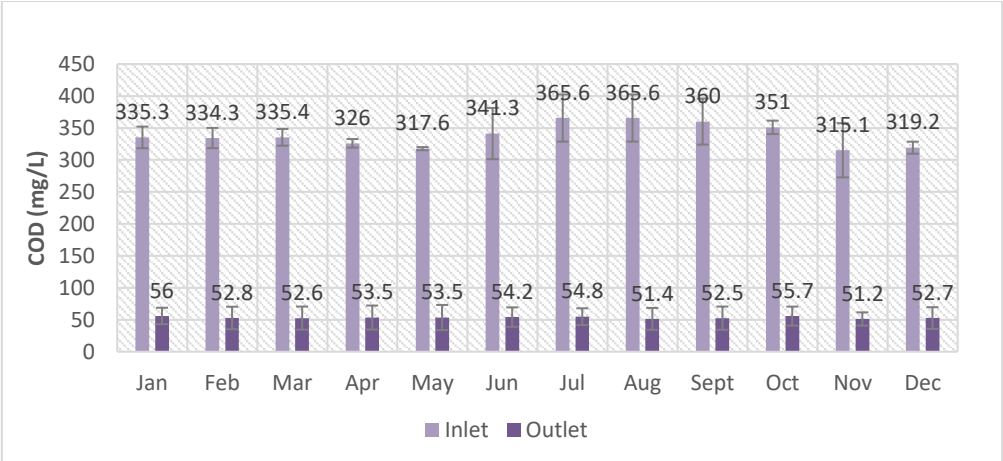

Fig. 2: COD values of inlet and outlet

3.2. TSS

The TSS measurement was estimated the free particle distribution in the wastewater that give an indicator of the clarity of the wastewater. The results show that TSS values ranged from 201.3 to 264.8 mg/l inlet and from 32.2 to 54.6 mg/l in outlet (Fig. 3). These results come with the standard municipal wastewaters which ranged between180 to 220 mg/L effluent (Johal et al., 2014).

3.3. Relationship between TSS and BOD

The relationship between the TSS-inlet and BOD-inlet is shown in Fig. 4. There was proportionate relation in the BOD-inlet concentration and TSS-inlet concentration levels with R^2 = 0.0912. The high concentrations of TSS come from the flushing of particles from land.

3.4. Relationship between TSS-outlet and BOD-outlet

Fig. 5 shows the relationship between the TSS-outlet and BOD-outlet of all samples during. There is a limited relation between the BOD-outlet concentration and TSS-outlet concentration levels with R^2 = 0.018. This means there was no a significant relationship with less than 2% correlation.

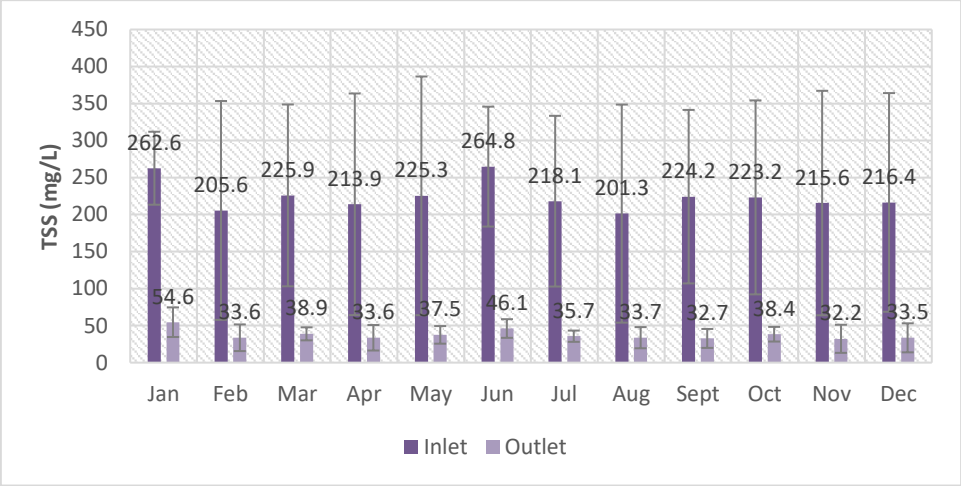

Fig. 3: TSS values of inlet and outlet

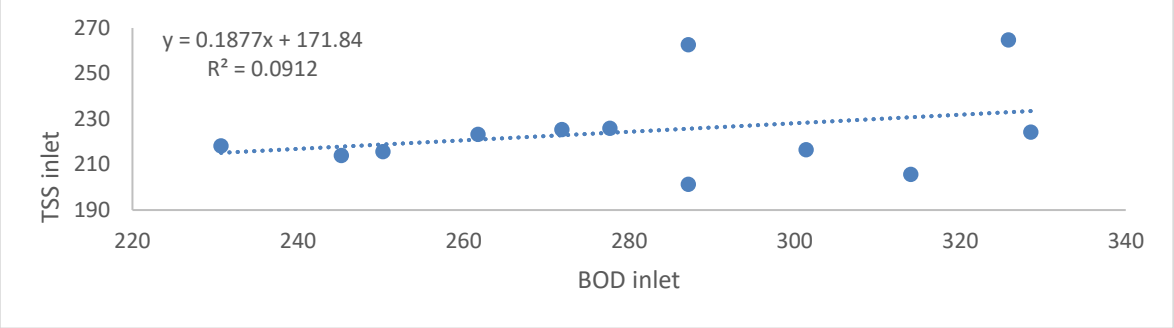

Fig. 4: The relationship between the TSS-inlet and BOD-inlet

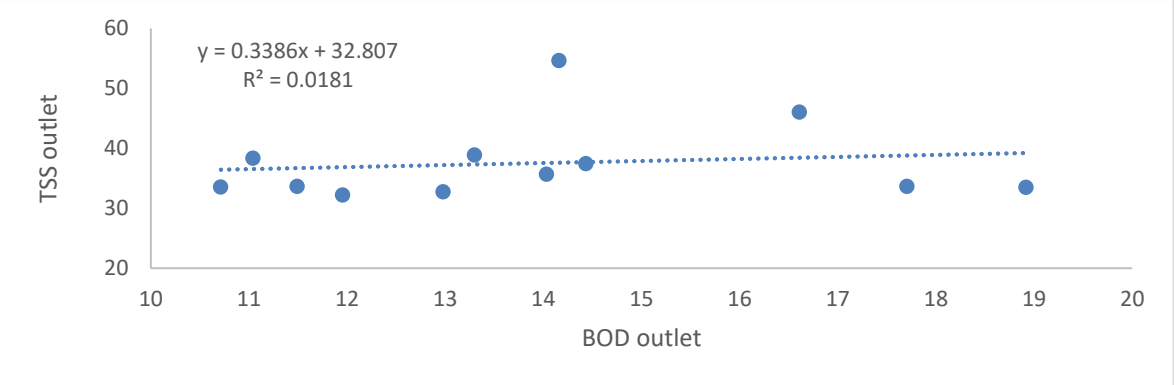

Fig. 5: The relationship between the TSS-outlet and BOD-outlet

3.5. Correlation between BOD and COD

BOD-inlet and COD-inlet concentrations for the whole untreated samples were in the range from 230.7 to 328.5 mg/L and ranged from 315.1 to 365.6 mg/L, respectively (Table 1). There was no significant correlation between the inlet BOD the inlet COD (Fig. 6). Since, the COD denotes typically all organic matters, either in completely biodegradable or no biodegradable and BOD the whole oxygen demand, it is necessary to improve correlation between BOD and COD. For the reason that BOD is a measure of the biodegradability of the wastewater, the ratio of BOD-inlet to COD-inlet can support more consider of the category of biological treatment that is suitable (Eckenfelder, 1989). Return be taught retains a prior BOD-inlet to COD-inlet ratio within the range of 0.6 – 1.0 as mentioned in Table 1. This shows that biological process was efficient more than that at the French Creek, Duke Point and Jalandhar sewage treatment plant (Johal et al., 2014).

Table 1: Bod inlet and cod inlet concentrations

Period	BOD5 (mg/l) inlet A	COD (mg/l) inlet A	BOD/COD
Jan	287.2	335.3	0.86
Feb	314.0	334.3	0.94
Mar	277.7	335.4	0.83
Apr	245.3	326.0	0.75
May	271.9	317.6	0.86
Jun	325.8	341.3	0.95
Jul	230.7	365.6	0.63
Aug	287.2	365.6	0.79
Sept	328.5	360.0	0.91
Oct	261.8	351.0	0.75
Nov	250.3	315.1	0.79
Dec	301.4	319.2	0.94
MIN	230.7	315.1	0.6
MAX	328.5	365.6	1.0

A: Average, S: Standard Deviation

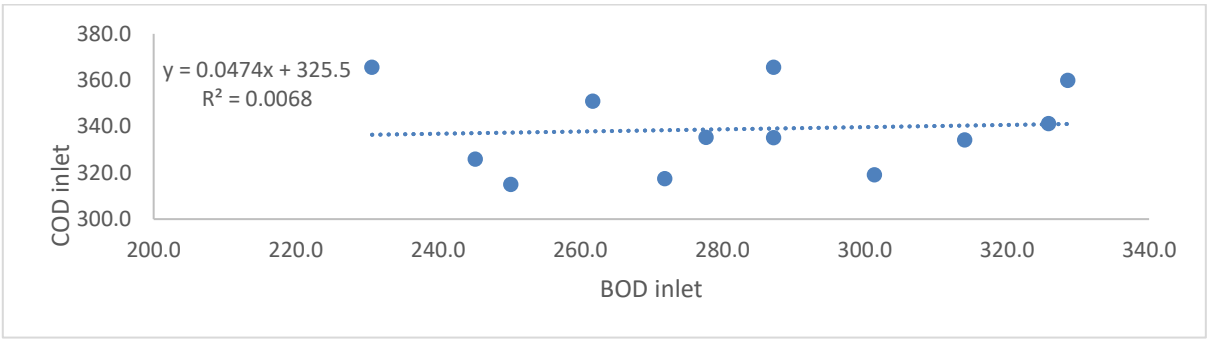

Fig. 6: Correlation between BOD inlet and COD inlet

3.6. Biodegradability index

The variances in the average of biodegradability index were shown in the Fig. 7 in the different months of year. These data shows that the highest biodegradability index was in June (0.95) and the lowest was in July (0.6). This data were similar to data collected from some wastewater treatment plants in Egypt (Abdallaa and Hammam, 2014).

Evaluation of biodegradability index (B.I.) values periodically and comparing it to the average of B.I. for the specified wastewater treatment plant can assist in monitoring the presence of toxic and non-biodegradable complexes; and improve in applying the correct protective actions. It is principal to know the biodegradability index of the untreated influent wastewater before choosing the biological wastewater treatment plant technology, as this choice would significantly influence the plant effluent quality. If BOD/ COD is >0.6 then the waste is quite biodegradable, and can also be without struggle controlled biologically. If BOD/COD ratio is between 0.3 and 0.6, then seeding is obligatory to treat it biologically, as the method will be temperately slow, as the adaptation of the microorganisms that support in the degradation process takes time. If BOD/COD < 0.3, biodegradation will not carry on, therefore it can't be treated biologically, seeing that the wastewater produced from these unchanging inhibits the metabolic effort of bacterial seed because of their toxicity or refractory houses (Abdallaa and Hammam, 2014).

The overall percentage of reduction of COD, TSS and BOD in the effluent treatment Plant has been shown in the Fig. 8 that shows COD, BOD and TSS meet the discharge requirements during the study of AHU's wastewater treatment plant, it has been observed that total removing competences of BOD, COD and TSS are detected as 93.7- 96.6 %, 83.3-85 % and 79- 85.6 % respectively which is most of the time due to massive reduction of pollution. This data

were going with the date collected from similar studies in different places.

The organic matter content of the wastewater is a very important issue. The BOD_5meaning the amount of oxygen required for oxidation organic matter by microorganisms after five days of incubation at room temperature. The average percent removal of BOD_5, COD and TSS indicates that the outlets were agree with the Jordanian standards for recollected wastewater that discharge to rivers, ground water and irrigation of vegetable and trees (Mayyas et al., 2014).

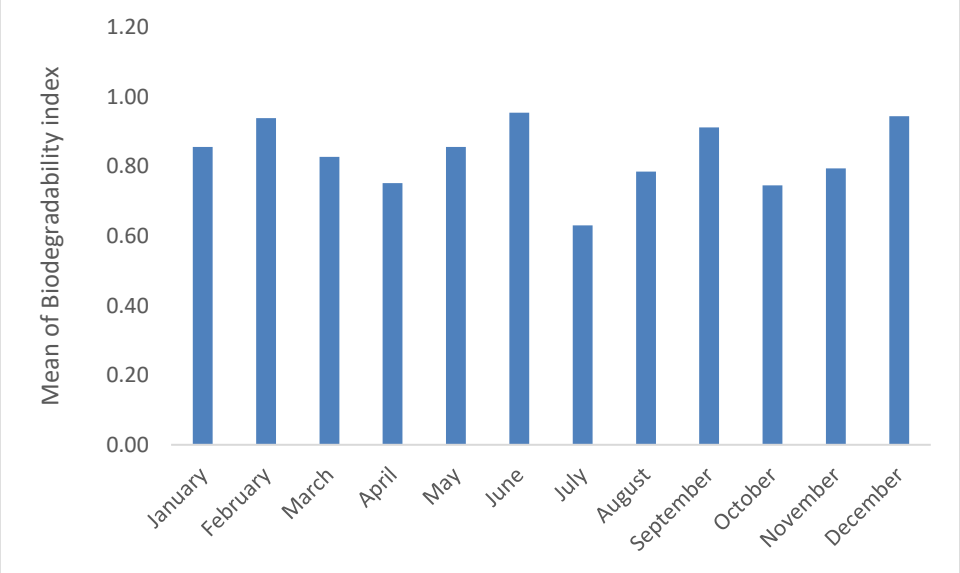

Fig. 7: The average of biodegradability index

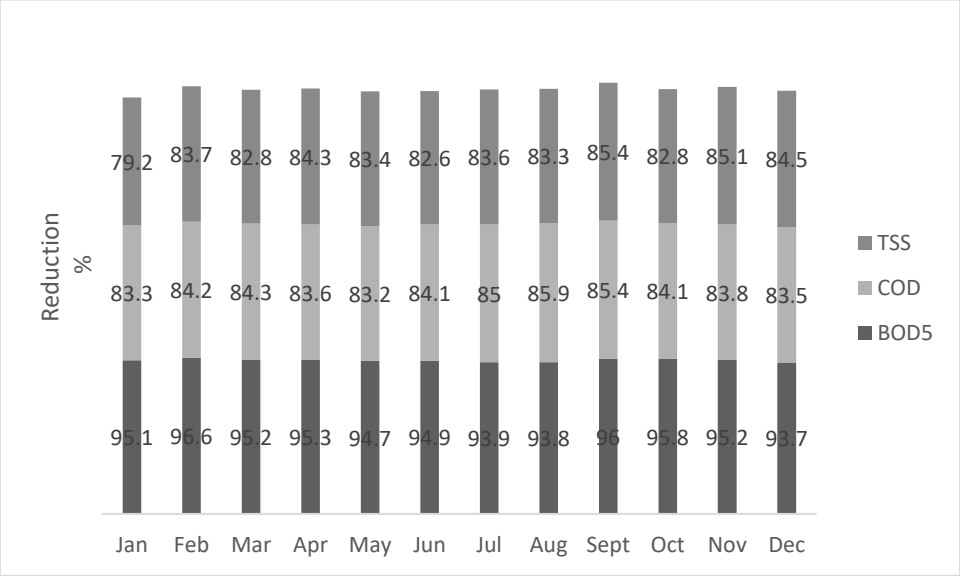

Fig. 8: Overall reduction of BOD, COD, and TSS

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