PRE-SEDIMENTATION TANK EFFECTS ON WATER TREATMENT UNIT OPERATION

Mehran Jahanshahi, Mohammad Mehdi Taghizadeh*

Department of Environmental Engineering,
Islamic Azad University, Estahban Branch, Fars, Iran

* Corresponding author E-mail: tgmehdi@yahoo.com

Abstract

Understanding the effect of any unit of Water Treatment Plant (WTP) on the performance of the other units is very important in optimal design of a WTP. In some of the WTP a Primary settling is done in the unit of Pre-Sedimentation Tank (PST) in entrance of raw water to the WTP. In some WTP, the unit of PST is used only in flood condition. Regarding the high-cast of equipment and maintenance of PST, more studies are needed for evaluation of the role and performance of the PST on the other units of the WTP .This study was done in Salman Farsi WTP. The removal efficiency of turbidity for PST, clarifier, filters and backwash interval time in filters in flood and non-flood conditions and use and non-use of PST were examined and evaluated. Coagulant and chlorine consumption were also compared in the presence and absence of pre-sedimentation basin during non-flood condition. The results showed that in non- flood condition and using from PST, the PST didn't play significant role in decreasing the turbidity and coagulant consumption increased compared to none use of PST. In this condition, consumption of gaseous chlorine of 900 kilograms in one month is more than in none-use of PST condition. In flood condition and non-use of PST filtration, efficiency is considerably reduced and filters backwash interval time is decreased more than 3 times and rate of water treatment is reduced by 20 percent. Overall, the results showed if PST is absent in low turbidity, Total costs will reduce; Instead, in the absence of PST in flood condition the rate of water production reduces, and quickly clogging of the filters is happened

Key words: *water treatment plant, pre-sedimentation tank, turbidity, settling, filter*

Introduction

Sedimentation is recommended as simple and low cost pre-treatment of water prior to application of other purification treatments such as filtration and disinfection methods. It removes undesirable small particulate suspended matters (sand, silt and clay) and some biological contaminants from water under the influence of gravity. It also improves the visual qualities of the water and increases its acceptance by consumers. The longer the water is sediment, the more the suspended solids and pathogens will settle to the bottom of the container. Sedimentation is a simple low

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cost pre-treatment technology to reduce settable solids and some microbes from water under the influence of gravity prior to application of other purification methods. It also improves the visual qualities of the water and increases its acceptance by consumers

For the treatment of highly turbid raw water during the rainy season, solids loadings including larger particles decreased substantially with the application of pre-sedimentation in the water treatment plant during the rainy season (Kwak et al., 2010). Contaminants from raw water could be removed step-by-step following sequential treatment processes. The selection and arrangement of different treatment processes are of great importance for achieving high contaminant removal efficiency. Pre-sedimentation has various effects on water treatment plant operation, and the produced water depends on raw water quality. Optimization is needed. For increasing the efficiency of produced water, optimization of conventional drinking water treatment plant means" to attain the most efficient or effective use" of water treatment plant regarding some principles. There are achievements of consistently high quality finished water on a continuous basis, and importance to focus on overall plant performance (Angreni, 2009). Researches have shown that Pre-Sedimentation Tanks (PST) cause some problems in the water treatment plants. Concentration and suspended particle characteristics could be influenced by performance and efficiency of sedimentation tank (Sammarraee et al.,2009) though the PST decreases the turbidity, low turbidity causes water to become "tough," and hardly can be tackled in subsequent units of water treatment plants (Al Rawi and Bilal, 2013) and not always increasing in raw water turbidity results in an increase in turbidity removal efficiency (Al Ani and Awaid, 2013). The re-sults of examining the impacts of filter backwash water and membrane backwash water recycles on water quality in coagulation–sedimentation processes showed a significantly higher removal of dissolved organic carbon from the raw water that was in blended with 5 and 10% by volume of filter backwash water as compared to control trials where backwash water was not added (Gottfried et. al., 2008). Pre-sedimentation also can cause some other problems as same as increasing fecal coli- form via sediments to water flow. Fecal coliform percent increases sometimes due to sediments in sedimentation tank (Al Hashemi et al., 2013). Problematic algae, species that do not settle or are not easily removed by water treatment processes, are common in many water treatment plants (Joh et al., 2011). As the PST in tropical climate is adequate place for growing algae, operators need to control algae in these tanks. Pre-chlorination is a common and effective method for the control of algal growth in conventional water treatment plants (Ibrahim et al., 2011). Amount of chlorine consumption is related to algae mass. Increase in consumption of chlorine can be one of the disadvantages of its use (PST) in inadequate conditions. Pre-chlorination produces harmful byproducts as same as Tri-halo Methane (THM) (Sadiq and Rodriguez, 2004; Sharp et al., 2006; Joh et al., 2011; Al Hashemi et al., 2013; Özdemir, 2014). The goal of this paper is evaluation of the role and performance of the PST on the other units of the WTP in flood and non-flood conditions.

Material and methods

Characteristics of water treatment plant

Salman Farsi water treatment plant in Fars province (near Ghir city) in Iran was chosen as a pilot study. The date of its startup was in 2007. Figure 1 shows the location on the map (Fig. 1) and the schematic (Fig. 2) of Salman Farsi water treatment plant (WTP) site. This treatment plant is equipped for a maximum 80 million liters of water in a day (MLD) from the Salman dam. Raw water is drawn to the treatment plant .The Salman Farsi WTP is equipped with conventional facilities. Units of this plant are contain pre-chlorination facilities, two PST, two accelerator units which do coagulation, flocculation and sedimentation in one tanks, rapid sand filters and gas chlorination. PSTs are constructed but not on line.

Figure 1
Map of WTP site location

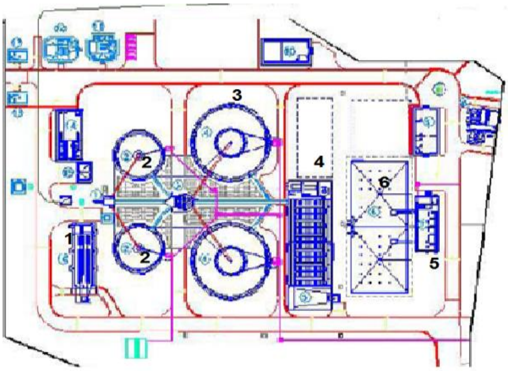

Figure 2
Schematic of Salman Farsi water treatment plant (WTP):
1- primary chlorination
2-PST
3- accelerator (coagulation; flocculation; sedimentation)
4- Rapid sand filter
5- final chlorination
6- Sludge sedimentation tanks filtration and secondary sedimentation.

Experimental Set-up and Operation

Influence of PST on performance of the other units was evaluated in flood and non-flood condition in Salman Farsi WTP. The absence of PST in flood condition was examined for 24 hours. In this condition the output water of the plant was precisely considered to control standards and prevent to social damage. Experiments included measurement of turbidity, chlorine residual and Jar test filters clogging time. Turbidity was examined by turbidity meter (model: hatch HTCH, 2100P) (APHA, 2005) and was tested in the input water to PST, the output from PST, the

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output after final sedimentation tank and in the output from filters were tested. 520 samples were examined for turbidity. The amount of free residual chlorine, after the initial chlorination and before final chlorination was sampled. Free chlorine was examined by portable free chlorine test kit. Model of the free chlorine test kit was HI3831F that is a chemical test kit that uses the DPD method to measure free chlorine.(APHA, 2005) Amount of chlorine present in non-flood condition and in presence and absence of PST in WTP was recorded in 340 days. The coagulant used in Salman Farsi WTP was ferric chloride (40%) which of required amount was daily determined by Jar Test ((Satterfield, 2005). The amount of coagulant used was also recorded in non- flood conditions in the presence and absence of PST. Backwashing automatically occurred in sand filters by increasing pressure drop. Filters operation time was recorded in flood conditions and in the absence of PST and were compared with non-flood condition.

Results and Discussion

The results showed the turbidity measurement of the input water to the plant in a non-flood river (between 15-8 unit NTU) that the water turbidity was in this range in most cases. The input water turbidity of river was between 105-35 unit NTU in the flood condition after heavy rainfall. Figure 3 showed input turbidity changes to the WTP, output turbidity from the clarifier and output from filtration in non -flood and in the absence of PST. It was considered that the output water turbidity of clarifier in non-flood condition doesn't has direct relationship to increase input water turbidity.

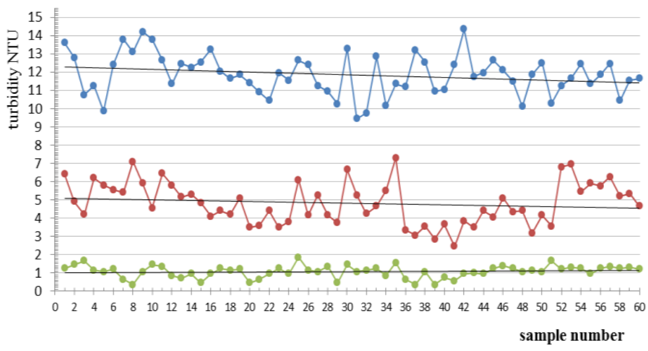

Figure 3
Evaluation of turbidity amount in non- flood condition and in the absence of pre sedimentation. Blue line input turbidity of water treatment plant, red line output turbidity of clarifier, green line output turbidity of water treatment plan.

Evaluation of water turbidity amount in non--flood and in the presence of sedimentation as shown in figure 3 and compared to figure 4 showed that output changes of the plant didn't have any relationship with the presence or absence of PST in non -flood conditions.

It was also observed that the output turbidity of clarifier and output turbidity of water treatment plant didn't have sensible difference when PST is active or non-active. Figure 5 shows the performance of pre sedimentation tank at the time of the flood. As it was seen, the role of pre-sedimentation tank caused to reduce the influence of the flood considerably and more uniform output with low turbidity go out from pre sedimentation tank. Figure 6 shows the evaluation of amount of turbidity in flood time and the absence of pre-sedimentation.

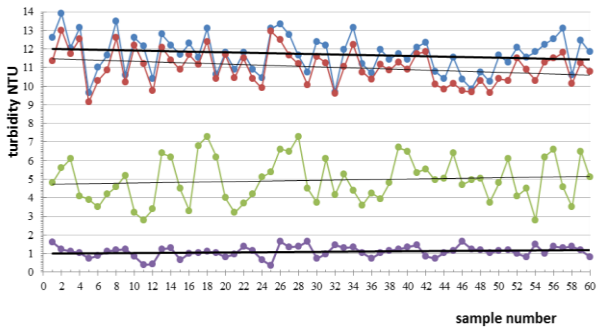

Figure 4
Evaluation of turbidity in non--flood time and active PST.
Blue line input turbidity of PST, red line output turbidity of PST, green line output turbidity of clarifier, purple line output turbidity of WTP.

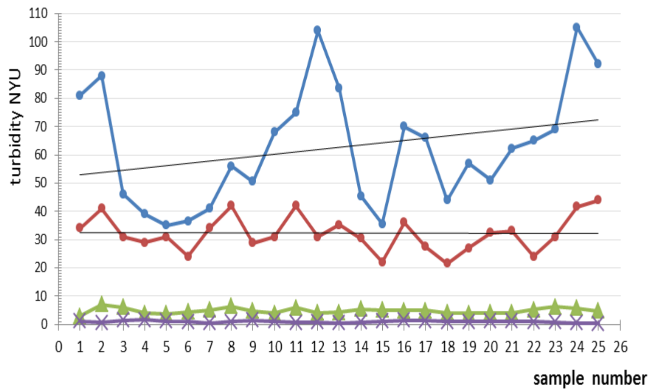

Figure 5
Evaluation of turbidity in flood time and active PST.
Blue line input turbidity of PST, green line output turbidity of final sedimentation tank, purple line output turtbidity of WTP.

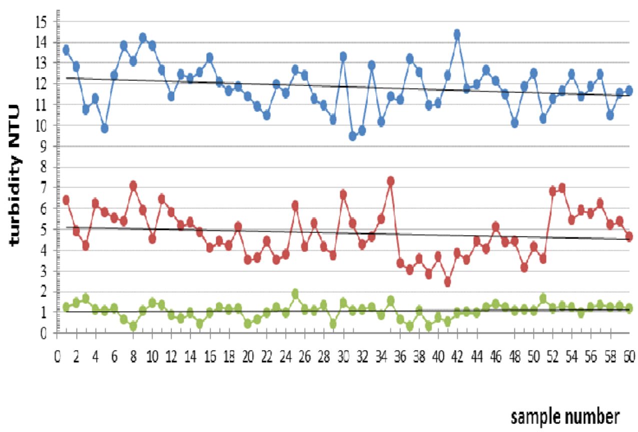

Figure 6
Evaluation of amount of turbidity in flood time and the absence of PST.
Blue line input PST turbidity, red line output PST turbidity, green line clarifier output turbidity.

Figure 7 shows that the water turbidity removal efficiency increases in pre-sedimentation tank with more NTU 35 turbidity.

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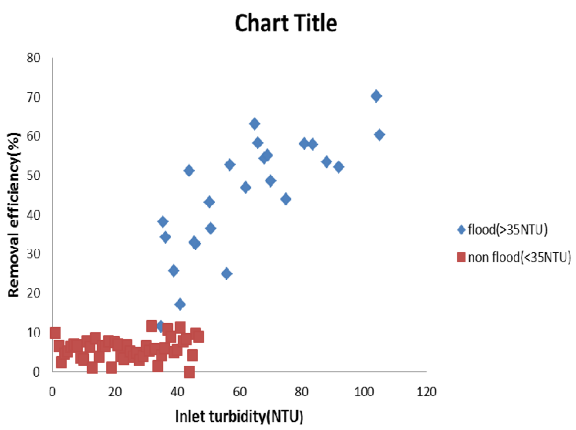

Figure 7
PST efficiency in various turbidity conditions

The amount of ferric chloride (40%) and chlorine used in water treatment plants and in active and not-active PST were compared. The results were shown in Table 1.

Table 1
Comparison of the amount of ferric chloride 40% and chlorine used in ter treatment plants and in active and not-active pre sedimentation tank in not- flood condition.

Average amount of ferric chloride(40%) consumption daily (kg)	Amount of chlorine gas consumption monthly (kg)	The state of PST
720	3420	Active PST and flood condition
585	2500	Inactive PST and non-flood condition

It was considered when PST is active,that due to the reduction of water turbidity the amount of ferric chloride increases. In fact, some previous studies have shown if input turbidity reduced the coagulation would be sometime more difficult (Sati et al., 2013; Al Ani and Awaid, 2013).

It can be seen if the PST was active, monthly about 900 kilograms of chlorine gas would be consumed more than with non-use of PST. This problem caused increase of common costs of the water treatment plant. Because of pre sedimentation, some algae were developed and residual chlorine was increased in the presence of light and heat.

Table 2 presents the results of influence of PST on the performance of rapid sand filters. By leaving PST on water treatment path in the flood condition, filtration efficiency was severely reduced and filters backwashing was increased more than 3 times and interval back wash time increased more than 25 minutes that caused faster clogging time of filters, so rate of water generation was reduced with 20% in WTP and in flood condition (45,000 cubic meters of water per day to about 36,000 cubic meters), while the output of the water turbidity in water treatment rose 5-4 NTU units.

In table 2 we compared the filters interval washing time in active with not-active PST.

Filters interval backwash time	States
One day and every wash 20 minutes	Inactive PST and not flood condition
One day and every wash 20 minutes	Active PST and not flood condition
One day and every wash 20 minutes	Active PST and flood condition
About 8 hours and every wash 20 minutes	Inactive PST and flood condition

Table 2 *Comparison of filters interval backwash time*

Conclusions

Since rain input water turbidity suddenly increases in rainfall time and is not predictable, it is necessary to service the tank in heavy fall rains. If PST is not used in flood condition, the water turbidity will increase, so, too much turbidity enters to filters. This problem causes to decrease interval backwash time (three times a day).
Meanwhile data analysis indicated that if the water turbidity was 30 NTU units, the PST-or basin would not require to be serviced due to the low efficiency of turbidity, so it could be prevented to consume additional energy and basin depreciation. Evaluation showed if PST was in service, about 30 kilograms of chlorine gas would be consumed more daily. So it is suggested that PST should be put inline only in flood time.

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