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The Survey of Removal of Suspended Solids from River At Flooding Period by Plain Sedimentation Process

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ABSTRACT

The most important of surface sources of water in the large city are rivers. The turbidity and flow rate of rivers is a constantly changing phenomenon in the seasons from year. During rainy period, the run off carries with it silt, clay and sand which make a severe increasing in turbidity to over 1000NTU. The increasing of turbidity causes which the water plant treatment receives the more solides.However; in order to protection of plant units must apply pretreatment processes. In this research, the effectiveness of settling process in order to removal of TSS from raw water was studied. The beginning of the work, lab-scale pilot designed which consisted of a raw water preparation container; the settling column was made of Plexiglas with 2m height, 20cm diameter and the six of sampling ports. The settling column filled with the raw water associated with sediments of river. At defined time steps (30-60-90-120-150-180 min) samples were taken out from the bottom of the column (180cm under water surface). The temperature of water was in the range of 15 to 18oC during experiments. The results showed that between the increasing of TSS removal and settling time, a direct and significant relative ($p<0/01$) was obtained by Pearson, s correlation coefficient. Also with increasing the depth, the removal efficiency of TSS and turbidity decreased. In the settling time of 30min, 2640mg/L of TSS concentration, the depths of 30 and 180cm, systematically, the TSS removal 92.42% and 80.47% was obtained. when the initial TSS concentration increase to 27640mg/L (the most concentration of TSS), with increasing SOR from 25m/d to 60m/d, the total removal efficiency decreased from 99.2% to 92.2%, and with the TSS of concentration equals to 2640mg/L, the rate of total removal efficiency decreased from 97.2% to 95.7%. The results showed that the rising of SOR and TSS concentration, decreased the total removal efficiency. Also, these are an opposite and significant relative ($p<0/05$) between the removal of TSS and initial concentration of TSS.

Key words: River, Flood water, Settling column, TSS removal.

Introduction

Drinking water should preferably be obtained from a source free from pollution or contaminants. The raw water normally available from surface water sources is, however, not directly suitable for drinking [11]. The country of Iran located on dry and semidry region and the water sources is limit. However, the design of a proper strategy for planning on the development of sources water is necessary [2]. The chemical, agricultural, industrial pollutants of different sources arrived to rivers and the water quality in rivers changed. During rainy period, the run off carries with it silt, clay and sand which make a severe increasing in turbidity to over 1000NTU. Developing a systematic procedure that integrates the above mentioned design requirements of settling tanks will yield Settling tanks that are better adapted to particle removal. Improved particle removal will help control the release of clay-bound metals including iron, aluminum, manganese and phosphate [5]. The increasing of turbidity causes which the water plant treatment receives the more solids. However; in order to protection of plant units must apply pretreatment processes [8,4]. The problems of flooding are important for many countries. However, the control and prevention of flooding is very serious [12]. The one of pretreatment units is sedimentation unit. This unit is use to settling of suspended solids from water before entrance to plant treatment units

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and called presedimentation unit. Sedimentation process is a physical treatment processes that solid-liquid separation using gravitational settling to remove suspended solids. The design of a sedimentation basin is dependent upon the concentration, size and behavior of the solid suspension. In general, there are four types or classes of sedimentation. The aim of this research is to apply type 1, or free settling, known as discrete settling for removal of total suspended solids from rivers [9]. The discrete settling process is used in water treatment in order to removal sand, gravel, and other discrete particles from raw water sources (rivers) that there are high rates of suspended solids. Particles settle as separate units, and there is no apparent flocculation or interaction between the particles. Total removal is based on summation of % removal of individual mass fractions in a mixture. in this study, The total removal efficiency can be determined by a batch settling test or a sieve analysis [3]. The aim of this research is the survey of suspended solids removal efficiency from river by settling process at flooding period. Swell, the effect of parameters such as settling time, settling velocity, surface overflow rate on TSS removal have investigated.

Materials and Methods

Preparation Of The Pilot:

The beginning of the work, lab-scale pilot designed which included of a raw water preparation container with $2m^3$ volume, settling column was made of Plexiglas with 2m height, 20cm diameter, and the six sampling ports at intervales. The volume of column was 56.5L. The sediment was obtained from the bed of Zayandehrood in Isfahan. Before examination, some of sediment was added to water sample in settling column and mixed together and an initially uniform suspension of sediment in a significant volume of water prepared. In this way, the type of different turbidities was obtained. Finally, seven different types of turbidity (1058NTU- 3872NTU- 6570NTU- 8550NTU- 11940NTU- 14500NTU- 22960NTU) were considered to do the research.

Sampling:

At defined time steps (30-60-90-120-150-180 min) water samples were taken from the bottom of the column (180cm under water surface in settling column), and afterwards the samples was analyzed. The volume of samples varied. The volume of sample in high turbidity was 25mL, and in low turbidity was 100mL [1]. The temperatures of water was a range of 15 to 18^{o}C constantly.

Experimental Procedure:

The first step, after providing the column, the six of sample were taken from the depth of 0-180cm and mixed. It was known the primary sample. Then, after passing 30-60-90-120-150-180min; the six of sample from the depth of 180cm were taken. The samples were analyzed in laboratory in order to measuring primary and secondary of TSS and turbidity. In this research 7 concentration of primary TSS (2640-4880-8320-12875-16040-18120-27620mg/L) has been considered for studying the effect of suspended solids concentration, detention time, SOR on sedimentation process efficiency. The rate of SOR or settling velocity was in range of 1.74×10^{-2}m/min (25m/d) and 4.16×10^{-2} m/min (60m/d).To measure the total suspended solids performance according to the procedure outlined in standard method or 2540-D method [1]. Turbidity determined by a class of HACH-2100P Turbidity meter instrument.

The overall removal efficiency for all particle size was calculated using the Richards and Reynolds equation:

Fraction removed = $(1\text{-}f_0) + 1/V_0 \int vdf$

Where $(1\text{-}F_0)$ is Fraction of particles with velocities $Vs > V_0$ and $1/V_0 \int vdf$

Is Fraction of particles removed with $V_s<V_0$ [3].

Statistical Analysis:

All data were analyzed using of SPSS statistical analysis. The comparisons among data were made using the least significant difference test calculated at P-value by Pearson' s correlation.

Results:

In the investigation, in order to determine TSS removal efficiency by settling column, the reactor was operated at 3 hours in each step of different turbidities. Table 1 shows the TSS removal efficiency with settling velocity equal to 1.74×10^{-2}m/min and Table 2 shows the TSS removal efficiency with settling velocity of 4.17×10^{-2}m/min. To estimate of removal efficiency was based on the theory of type 1 settling. According to Table 1and Fig. 1, the highest removal efficiency of TSS with velocity settling 1.74×10^{-2}m/min, was % 99.2 and the least removal efficiency of TSS was % 97.2. According to Table 2 and Fig. 2, at velocity settling 4.17×10^{-2}m/min, the highest removal efficiency of TSS was % 97.1 and the least removal efficiency of TSS was % 92.2. Also, increasing the detention time to 180min increased the TSS total removal efficiency. The statistical analysis showed that the depth can't effect on the removal.

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Table 1: The total removal efficiency of discrete particles at settling type 1(SOR=25m/d).

TSS in (mg/L)	(F_0) Fraction of particles with velocities $V_s < V_0$	($1-F_0$) Fraction of particles with $V_s > V_0$ velocities	$\int_0^{F_0} VdF$	$\frac{1}{V_0}\int_0^{F_0} VdF$ Fraction of particles removed with $V_s<V_0$	Total fraction of particles removed (%)
2640	0.047	0.953	0.066	0.019	97.2
4880	0.027	0.973	0.049	0.014	98.7
8320	0.019	0.981	0.033	0.009	99
12875	0.024	0.976	0.043	0.012	98.8
16040	0.025	0.975	0.046	0.013	98.8
18120	0.015	0.985	0.021	0.006	99.1
27620	0.015	0.985	0.024	0.007	99.2

Table 2: The total removal efficiency of discrete particles at settling type 1(SOR=60m/d).

TSS in (mg/L)	(F_0) Fraction of particles with velocities $V_s <$ V_0	($1-F_0$) Fraction of particles $V_s >$ with velocities V_0	$\int_0^{F_0} VdF$	$\frac{1}{V_0}\int_0^{F_0} VdF$ Fraction of particles removed with $V_s<V_0$	Total fraction of particles removed (%)
2640	0.07	0.93	0.224	0.026	95.7
4880	0.049	0.951	0.17	0.02	97.1
8320	0.13	0.87	0.798	0.095	96.5
12875	0.2	0.8	1.14	0.137	93.7
16040	0.3	0.7	1.89	0.227	92.7
18120	0.32	0.68	2.19	0.263	94.3
27620	*0.39*	*0.61*	*2.59*	*0.312*	*92.2*

Discussion:

The results obtained from this study are summarized in Table 1 and 2 and the summarized removal efficiency showed at Fig. 1 and Fig. 2. According to Fig. 1, for SOR equal to 25m/d, the highest TSS removal efficiency was obtained at the highest concentration and the least TSS removal efficiency was obtained at the least concentration. In fact, increasing of suspended solids load has increased total removal efficiency. Therefore, the rate of particles effects on the removal of particles respectively. The study of water plant treatment in urmia at floating period showed that the increasing of turbidity during the severe precipitation had caused the plant treatment stopped in 1382 and 1383 at several times [10]. In the present study, the change of initially concentration from 2640mg/L to 27620mg/L increased the removal efficiency equal to %2. Statistical analysis indicated between the concentration and removal efficiency had not any significant difference. The reason is that when the detention time is high, discrete particles have enough time for settling and no interaction settled. Fig. 2 illustrates TSS removal efficiency based on SOR 60m/d. As shown in Table 2 and Fig. 2, the highest TSS removal efficiency was obtained in the least concentration (%95.7) and the least TSS removal efficiency was obtained in the highest concentration. In fact, the results are the opposite with each other. The results showed that increasing of SOR decreased the TSS removal efficiency at high concentration water. The statistical analysis showed that the increasing of SOR effect on TSS removal ($p<0.01$). Totally, in order to TSS removal from surface waters (rivers) in type 1 suspension (discrete settling) must select the optimum detention time and SOR. In this study, for receiving to the particles removal above %90, suggests that the detention time has not the under than 60 min. In Germany, the study of settling process showed that the settable particles removed during 2 hours the rate of above %80 [6,7]. It is very clear that the basin has effectively removed all large-size particles.

Conclusion:

Results show that the inlet concentrations and surface overflow rate (SOR) are efficient in reducing the particles in terms of settling. In addition overflow rate can be used as a design basis of settling tanks, to achieve a desired particle removal to identify the associated basin surface area and volume.

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