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Design of a High-Loaded Clarifier and Its Application on the Treatment of Overflow Rainwater

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Abstract. Overflow rainwater is a serious environmental problem nowadays, which attracted the most researchers' attentions. Accordingly, effective and economic treatment of overflow rainwater is highly required. This study aimed to design a high-loaded clarifier equipment and developed an innovative overflow rainwater treatment. The high-loaded clarifier equipment was consisted of grid, pump, coagulant, reactor, and the most important part of lamella clarifier with serried metal plates. The removal of pollutants in overflow rainwater with the high-loaded clarifier equipment was evaluated. The pollutions removal rate of overflow rainwater was investigated with 65% COD and 90% SS, approximately.

Introduction

Surface water quality is negatively influenced by stormwater runoff. The overflow rainwater effect is the main impetus for pollutants transportations and increases pollutant loads to surface water especially [1]. Some relevant foreign scholars focus on the definition, causes, effects, as well as the regularity of the pollutant flush by runoff from small watershed and regional scale. Also many Chinese scholars pay attention to describing the overflow rainwater phenomenon accurately, the regularity of the pollutant flush, engineering practice guidance of treatment, and so on [2].

As Chinese urbanization developing, urban stormwater runoff pollution and emission characteristics have always been investigated intensively [3,4]. Hefei is a well-known city in the world for its rapid rhythm of development. But in recent years with the rapid economic and social development, the degradation of the Nanfei River quality is becoming increasingly serious. Urban storm runoff has been a serious pollution source of the river. It is important to find out the rule of pollutants removal from overflow rainwater.

High-loaded clarifier equipment was designed and set up near the Nanfei River. The efficiency of the high-loaded clarifier equipment in the treatment of overflow rainwater was investigated.

Experimental Facilities and Method

The High-Loaded clarifier Equipment. A lamella clarifier features a rack of inclined metal plates. Metal plates could cause flocculated material to precipitate from water. Gravity settlers are sized on the basis of upflow rate of the liquid and settling area. On a clarifier the settling area is the tank surface and on lamella settlers it is the total area of the inclined plates projected on a horizontal surface. This reduces the footprint of lamella settlers by about 90% as compared to clarifiers and consequently less land is required [5].

In our designed equipment, serried metal plates were adopted inside the high-loaded clarifier, which could promote the SS and COD removal rate of overflow rainwater. The high-loaded clarifier equipment was characterized as high removal rate of pollutions, hydraulics impact resistance, and stable effluent in terms of the results of experiments.

The high-loaded clarifier equipment was consisted of:

Ⅰ: 2 sewage pumps: flow rate of 50 m^3/h, delivery head of 15 m;

Ⅱ: 1 mechanical reactor: 6.0 × 2.0 × 2.6 m^3, the effective volume of 25 m^3, hydraulic retention time of 30min;

Ⅲ: 1 clarifier (Precipitator): 2.0 × 2.5 × 5.5 m^3. fixed 20 plate racks inside, the effective volume of 20 m^3, surface loading rates of 12.5 $m^3/(m^2 \cdot h)$, hydraulic retention time of 24 min;

Ⅳ: 2 mixers.

The site of clarifier equipment fixed and the schematic diagram of clarifier were shown in Fig. 1 and Fig. 2, respectively. Suspended Solid (SS) and Chemical Oxygen Demand (COD) were determined by national standard analysis method of China.

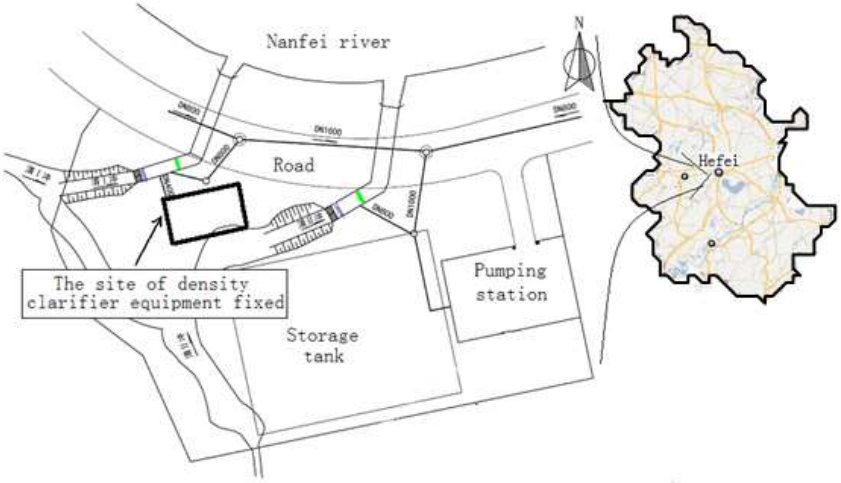

Figure 1. The site of the high-loaded clarifier equipment set up

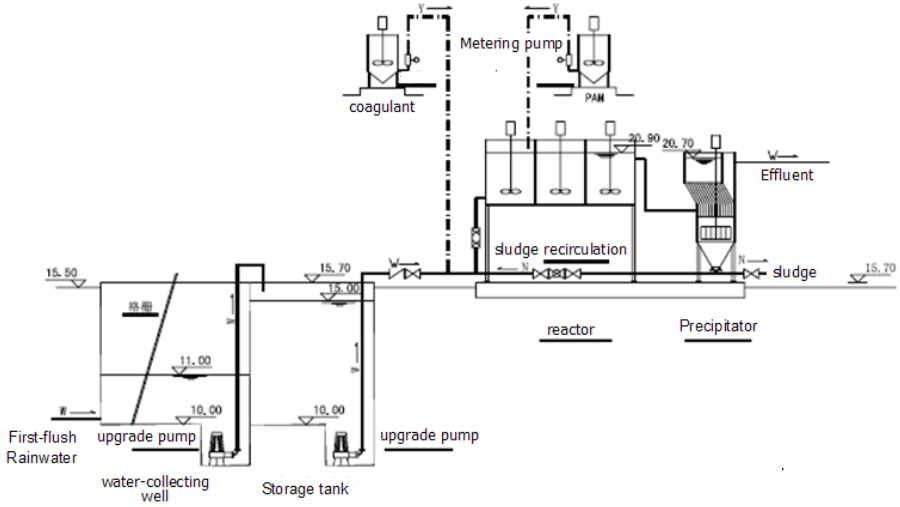

Figure 2. The schematic diagram of clarifier equipment

Result

The Effect of Flow. The raw water with pollution of 357~765 mg/L SS and 216~565 mg/L COD were treated by high-loaded clarifier at the condition of different flow rate. Table 1 given out the results of pollutions removal rate. As shown in table 1, it can be concluded that the COD removal rate increased with increasing flow rate, while as the SS removal rate was not good relation with the flow rate.

Table 1. The pollutions removal rate at the different flow rate

Sample No	Flow rate (m^3/h)	Raw water SS (mg/L)	Removal rate (%)	Raw water COD (mg/L)	Removal rate (%)
1	45	357	85.7	216	53.2
2	50	482	84.3	337	57.3
3	55	673	89.2	473	64.2
4	60	765	91.6	350	63.8
5	65	462	80.7	565	66.9
6	70	575	83.4	375	55.2

The Treatment Efficiency to Real Samples. The high-loaded clarifier equipment was run to remove the pollution of overflow rainwater between May 10, 2011 and July 20, 2011 in Hefei city. The quality of first-flush was determined with COD concentration ranging of 280~1900 mg/L, and SS concentration ranging of 600~2000 mg/L. Also the outlet of storage tank was checked with water quality of 158~565 mg/L COD and of 161~935 mg/L SS. Then the water was treated by coagulation and coagulation process further at flow rate of 60 m3/h. The results were shown in table 2. The concentration of 25 mg/L coagulant PAC was adopted. The approximately 65% removal rate of COD and 90% removal rate of SS were obtained in the experiments.

Table 2. The pollutions removal rate of real sample

Sample No	Data	Raw water SS (mg/L)	Removal rate (%)	Data	Raw water COD (mg/L)	Removal rate (%)
1	2011-6-14	161	68.3	2011-6-14	383	63.4
2	2011-7-17	462	80.7	2011-6-17	357	53.5
3	2011-6-24	318	78.6	2011-7-17	565	67.0
4	2011-6-10	213	82.2	2011-5-11	158	44.3
5	2011-7-4	935	88.9	2011-6-24	282	44.1
6	2011-7-4	765	91.6	2011-7-4	350	63.8
7	2011-6-24	432	89.6	2011-6-10	387	36.1
8	2011-6-10	315	74.9			

Summary

A high-loaded clarifier equipment was designed, which was consisted of grid, pump, coagulant, reactor, and the most important part of lamella clarifier with serried metal plates. When the high-loaded clarifier equipment was adopted to treatment the overflow rainwater, the COD removal rate increased with increasing flow rate, while the SS removal rate was not good relation with the flow rate. The pollutions removal rate of overflow rainwater was investigated with 65% COD and 90% SS, approximately.

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