The experiment research on flocs based on the micro eddy flocculation technology

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Abstract: The purpose of the paper was to test the floc performance in the process of flocculation by applying to the micro eddy water purification technology and machine vision floc-line detection methods. During the tests, the experiment consisted of detecting the flocs equivalent characteristics such as the size and the quantity, inspecting the influence of the water flow and dosage to the equivalent size and the number of the flocs, exploring the relationship between the particle size and quantity of the flocs and the settled sewage quality.

Introduction

The conventional water purification process was the most widely used water treatment technology at home and abroad, mainly including coagulation, sedimentation, filtration and disinfection^[1-3]. The coagulation process was an important part of water treatment and it played a major role in the removal of organic matters^[4-6], increasing micro vortex will promote the collision probability of the destabilization particles, therefore, people formed a tiny vortex by setting various mixing equipment, so as to improve the effect of cohesion. The method of forming the micro vortex contained the small mesh grid flocculation pool or micro vortex coagulation new technology and so on^[7]. In this paper, the new micro-vortex coagulation process^[8-9] was adopted, the floc performance was discussed on different flows and dosage.

Materials and methods

Test reagents and water samples

During the test, the raw water taken in hole mesh lake of East China Jiaotong University, the raw water quality were shown in Table 1.

Table 1 the raw water quality during the test

Serial	number	Water quality index	range
	1	water temperature	20~22 [°C]
	2	pH	6.8~7.2
	3	ξ electric potential	-25.69~-24.72[mv]
	4	turbidity	3.984~6.074[NTU]

Test equipment

The design processing water of the micro eddy flocculation tank was 5m³/h, the pond size was 1000mm × 750mm and divided into 12 (3 × 4) square cells, the first nine cells were equipped with 20 HJTM1 type of vortex reactor^[10] and the last three each cells with 12 HJTM2 type of vortex

reactor, Those two vortex reactors' diameter was $\Phi 200\text{mm}$, with 25mm and 35mm surface holes of 50% and 65% opening rate. The micro eddy flocculation plan were shown in Figure 1.

Fig. 1 The cross section of inclined tube sedimentation

The inclined pipe diameter of the Sedimentation tank was 30mm, the installation angle is 60° with 900mm length. The length, width and height of the sedimentation tank were 1.75m、1.0m and 2.3m. The eddy grid flocculation connected with the inclined tube sedimentation tank via the DN150mm connecting pipe. The cross section of inclined tube sedimentation tank was shown in Figure 2, the micro eddy flocculation and Sedimentation kind was shown in Figure 3.

Fig. 2 The cross section of inclined tube sedimentation

Fig. 3 The micro eddy flocculation and Sedimentation kind

The flocs image processing and parameters determining

Using the live of machine vision systems^[11] to acquisite and handle the floc particles image formed during flocculation process, and the high-quality image acquisition should be with denoising pretreatment^[12].After preprocessing, floc recognition processing, morphological analysis, the floc image became clearer and stronger contrast, then scanned and marked the communication unit to the reprocessing floc image^[13].The purpose was to get the number、the area and the equivalent particle size or other parameters through the communication field recognition algorithm^[14].

Results and analysis

The effect of different influent flows on floc equivalent size and the numbers

Under the condition of certain PAC coagulant dosage (18 mg/L), CCD camera had taken the floc pictures after the completion of the transition section flocculation at different water flows as shown below figure. 4 (a ~ i).

(a) $Q=2.0 \text{ m}^3/\text{h}$

(b) $Q=2.5 \text{ m}^3/\text{h}$

(c) $Q=3.0 \text{ m}^3/\text{h}$

Fig. 4 The flocs images under different water flows

Fig. 5 the Equivalent sizes and the numbers of flocs under different water flows

Figure 5 showed that the floc equivalent diameter generated after flocculation increased gradually from small to large and the numbers were rapidly increasing along with the flows addition; When the water flow changed to $4.5\text{ m}^3/\text{h}$, the flocculation time reduced to 19 min, the hydraulic loading rised to $72\text{ m}^3/\text{m}^2\cdot\text{h}$, equivalent diameter reached the maximum 0.872 mm , and the numbers were reduced and was 77 every window. Thereafter, with the increase of water flows, the floc equivalent particle size no longer increased, but the number of flocs increased again.

The effect of different dosage D to the floc equivalent size and number

In certain water flows ($Q=4.5\text{ m}^3/\text{h}$), the floc images photoed at the transition after flocculation with different PAC dosages by CCD camera were listed below figure 6(a~i).

Fig. 6 The Floc images under different PAC dosages

Fig. 7 The effects between different dosages and the floc equivalent diagram and numbers

As seen in Figure 7, As the dosages increased, the floc equivalent particle size will likely grow with also the number; When the dosage was increased to 17.64mg/L , the resulting flocs equivalent diameter reached to the maximum 0.869mm , the flocs numbers were 82 every window with a small amplitude; Continue to add the dosage, the resulting flocs equivalent particle size decreased, the numbers went up rapidly conversely.

The effect caused by different dosages to the relationship between the effluent water quality and the floc equivalent size and quantities

Fig. 8 The relationship between the effluent turbidity and the flocs equivalent diameters and amounts on the case of different dosages

The figure 8 showed that after flocculation, sedimentation with adding PAC coagulants, the effluent turbidity rebounded when reduced to the lowest with the increase of the dosages, when the dosages continued to increase, the trend of the water turbidity and the flocculation floc equivalent particle size was contrary.

Conclusion

1) As the water flow increase, the flocs equivalent particle size first added, then reduced, the floc numbers decreases a bit after significantly increased and then increase with large amplitude.

2) Equivalent diameter of flocs was gradually increasing with the increase of dosage first then decreases, the floc number increased sharply first, and then after the magnitude smaller bigger.

3) The floc equivalent diameter generated after flocculation reaction and the water turbidity was negatively correlated, with water potential was positively correlated. Adding an appropriate amount of coagulant (PAC dosage of this test was 17.64 mg/L), water and colloidal flocculated up quickly, the formed floc equivalent particle size was large and not easily broken, the numbers grew slowly and water turbidity was low, the water ξ potential tended to zero but still negative.

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