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Promotion of Polyferric Sulphate on Dewatering of Blue-Green Algae from Taihu Lake

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Abstract. Through we ourselves prepare polyferric sulphate in the lab to flocculate and dewater blue-green algae.The result showed that the best condition of polyferric sulphate flocculating and dehydrating blue algae in the different condition (temperature is 35℃ and pH is 2), and research both polyferric sulphate and other medicament flocculate and dehydrate blue algae.It provided an operational base for removal for blue- algae with polyferric sulphate theoretically and practically both.

1. Introduction

Taihu Lake is one of the five major freshwater lakes in China. It is one of the river basins under the key renovation of "three rivers and three lakes" designated by the state council during the ninth five-year plan period. Nearly tenyears to twenty years, because of the industrial development, most of the excess emissions of industrial wastewater, the vast majority of urban domestic wastewater without any treatment has been discharged into the Taihu Lake, taihu lake eutrophication has been increasing [1]. Eutrophication is occurred in the whole lake, and organic pollution and heavy eutrophication is appeared in some areas.The blue-green algae outbreak in Taihu Lake in June 2007 resulted in the formation of thick algae accumulation layer in the coastal waters and the foul smell of water quality, which caused serious harm to local water use [2], it captured national attention.Because blue-green algae is a microorganism, algae cells are rich in nutrients.In order to prevent "secondary pollution" caused by salvaged blue-green algae, reduce the volume of salvaged blue-green algae and facilitate transportation, and composting needs, the salvaged blue-green algae need to be flocculated and dehydrated [3-5]. However, only Ping Ning has applied research on the algal removal in Dianchi by cyanobacteria at present [3], there is no report on blue-green algae dehydration in China.In this experiment, a new inorganic macromolecule flocculant, polyferric sulfate, was mainly selected to study the feasibility of dehydration of blue-green algae.

2. Materials and methods

2.1. Experimental materials

The blue-green algae used in the experiment was taken from the lake of mashan,in wuxi on September 12, 2007, with an average water content of 97.03% (w/v) and a pH of 5.12.

The polymeric ferric sulphate used in the test is formulated according to the ratio of Table 1 to material, and is formulated according to the method described in reference [6].

Table 1. Material ratio of PFS prepared by using HNO_3 as oxidant

Serial number	material	Quality or volume
1	$FeSO_4 \cdot 7H_2O$ (AR)	50g
2	H_2SO_4 (98%)	4.5ml
3	H_2O	200ml
4	NaOH solution (5%)	10ml
5	HNO_3 (70%)	10ml

2.2. Flocculation centrifugal dewatering experiment
Polymeric ferric sulfate solution prepared in Laboratory of 4, 8, 12, 16, 20 and 24 mL was added to 90 mL protoalgae respectively. The final Polyferric content was 7 nm/l, 14 nm/l, 21nm/l, 28nm/l, 35nm/l and 42nm/l respectively. After centrifugation, the water content of the mud cake after centrifugation was 91.86%, 91.10%, 90.61% and 89.79% respectively. 89.32% and 89.12%.

The results showed that the greater the amount of polymerized ferric sulfate, the lower the moisture content after flocculation. However, when the content of Polyferric is more than 35 ml, the water content of cyanobacteria residue after flocculation and dehydration is not significantly affected by increasing the amount of polysulfuric acid.

3. Results and analysis

3.1. Effect of different dosage of ferric sulfate on centrifugal dewatering of blue-green algae
The raw algae is mixed with water to make algal liquor of various concentrations required.Take 90ml of algal solution of various concentrations, and add different amounts of polyferric sulfate to it, and add water to 100mL.The effect of different concentration of ferric sulfate on flocculation and dehydration of cyanobacteria was compared. The result is shown in Figure 1.

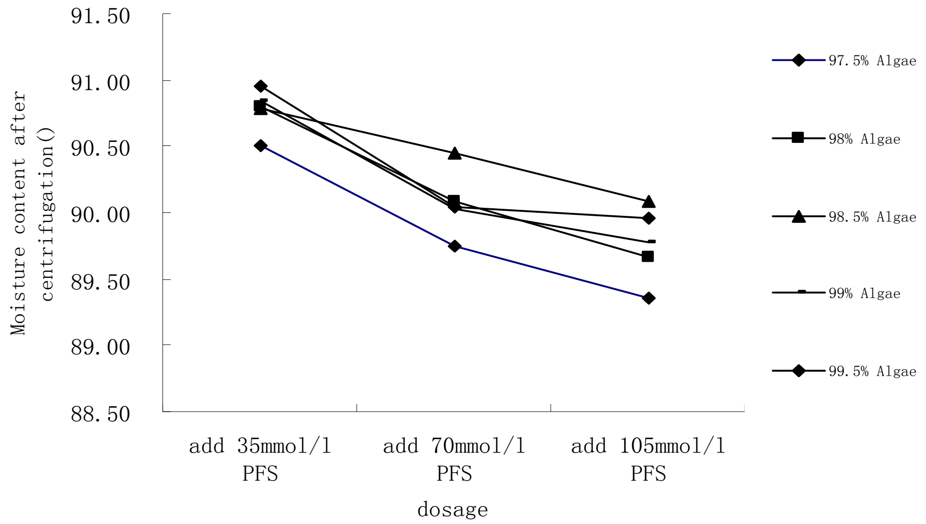

Figure 1. Water content of cyanobacteria with different moisture content and different amount of PFS after centrifugation

Fig. 1 shows that for algae with the same algae concentration, with the increase of flocculation dosage, the better the flocculation dehydration effect, the lower the moisture content of the centrifuged algae cake.After centrifugation, the water content of the mud cake showed a downward trend. When the water content of the algae was high (99.5%), the polyferric sulfate had a better effect on the flocculation and dehydration of the algae.The water content was the lowest when the algae liquid was added to the medicine and centrifuged.When the moisture content of algae was low (97.5%), the flocculation and dehydration effect of different dosage of polymeric ferric sulfate was poor, and the moisture content of algae was the highest after centrifugal drying.Moreover, when the dosage of Polyferric iron was small (adding 5 ml polyferric), the water content of the lowest and highest water content algae did not differ significantly after centrifugal drying.but the water content of the lowest and the highest water content algae dried by centrifugal drying was significantly different when the dosage of Polyferric iron was 15 ml.

3.2. Effect of pH and temperature on flocculation and dehydration of cyanobacteria

In pH test [7,8], cyanobacteria with water content of 98.5% 100ml and 5 ml polymerized ferric sulfate were used to prepare different terminal pH values with 5 mol/L hydrochloric acid and 5 mol/L sodium hydroxide solution respectively, and then centrifuged after 1 hour.

In the temperature test, cyanobacteria with 98.5% water content 100 ml and 5 ml polymeric ferric sulfate were added. The pH value of the flocculation system was natural. The flocculation system was placed in 25, 30, 35, 40, and 45 C constant temperature water bath, and centrifuged after one hour.The result is shown in Figure 2.

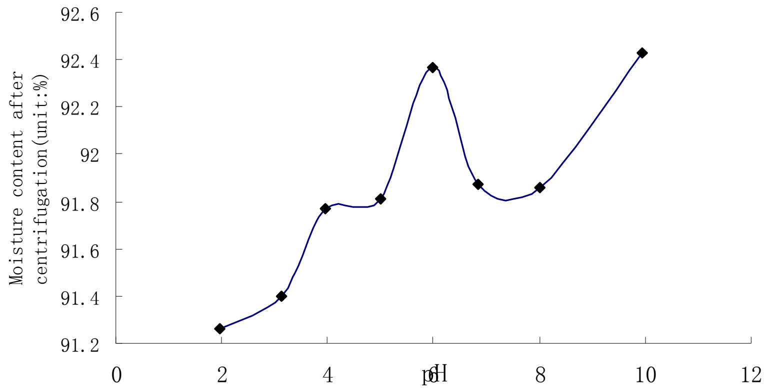

Figure 2. Effect of Polyferric Sulphate on Dewatering of Blue-green Algae under different pH conditions

It can be seen from Fig. 2 that pH has a significant effect on the moisture content of cyanobacterial flocs after centrifugation.The lower the pH, the lower the moisture content of mud cake.The effect of flocculation and centrifugation at pH 6.0 was close to the worst, which was inconsistent with the coagulation effect of FeCl3 with the increase of pH in algae water at pH 6-9.The rule and mechanism of the flocculation effect of polyferric chloride on cyanobacteria with pH remain to be further studied.

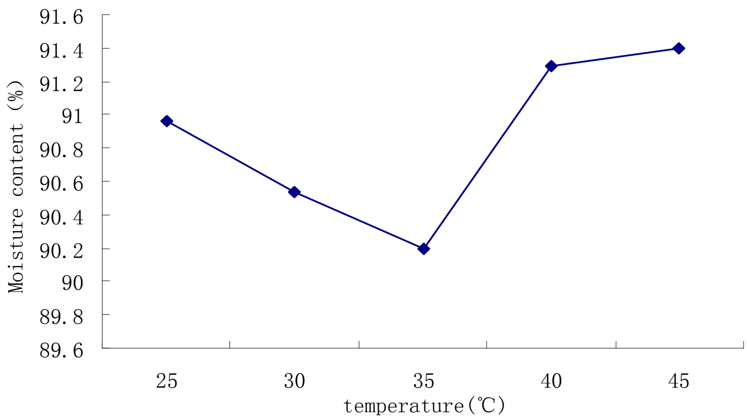

Figure 3. Effect of Polyferric Sulphate on Dewatering of Blue-green Algae under different temperatures

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From the figure 3, it can be seen that the water content of cyanobacteria centrifugal mud cake decreases firstly and then increases significantly with the increase of temperature in the range of 25-45℃, that is, the flocculation and dewatering effect of cyanobacteria centrifugal mud cake increases first and then decreases.Polyferric sulfate had the lowest water content after centrifugal flocculation and dehydration of cyanobacteria at 35℃, which indicated that polyferric sulfate had the best effect on centrifugal dehydration of cyanobacteria after flocculation and dehydration.This is consistent with the optimum flocculation temperature of general flocculants, because the temperature is too low, the viscosity of water is too high, the shear force of water flow increases, and the flocculent growth is hindered.Therefore, the coagulation effect is poor when the water temperature is low.However, if the temperature is too high, it is easy to make the polymer flocculant aging into insoluble substances, and on the contrary, the flocculation effect will be reduced [9] [10].

3.3. Synergistic effect orthogonal test

In order to improve the synergistic effect of polymeric ferric sulfate flocculation, KMnO4 and polyacrylamide were selected as the synergistic agents of polymeric ferric sulfate flocculation. According to the test method 1.2, the effect of two compounds was determined by orthogonal test [11 and 12].

Table 2. $L_9 3^3$Orthogonal test results table

		Factor		index
Test column number	Polymeric ferric sulphate (ml)	$KMnO_4$ (mg/l)	Polyacrylamide (g/l)	Water content (%)
	A	B	C	
1	1	0	0.5	92.54
2	1	0.8	1	92.63
3	1	1.6	1.5	92.57
4	5	0	1	91.58
5	5	0.8	1.5	91.62
6	5	1.6	0.5	91.57
7	10	0	1.5	91.26
8	10	0.8	0.5	91.32
9	10	1.6	1	91.03
Ⅰ	277.74	275.38	275.38	Ⅰ+Ⅱ+Ⅲ=The sum
Ⅱ	274.77	275.57	275.57	
Ⅲ	273.61	275.17	275.17	
Ⅰ/3	92.58	91.79	91.81	
Ⅱ/3	91.59	91.86	91.74	
Ⅲ/3	91.2	91.72	91.82	
Extreme difference R	1.38	0.14	0.08	

The three value of the factor A1 level is the first set.The three value of the factor A2 level is second groups, including the three times of the factor A3 level is third groups.The analysis factors were tested in three levels.When the water content of each group was added up, I = 277.74 (%), II = 274.77 (%) and III = 273.61 (%) were obtained, and the extreme difference R of the average water content and the average result of each level were calculated.The larger the extreme difference R, the greater the impact of the factor on the index.By analogy, we can analyze the influence of factors B and C, such as table 1: From the extreme difference R analysis in Table 2, A > B > C.That is, factor A (Polyferric sulphate) has great influence on flocculation and dehydration.From table 1, we can see that the best level combination is A3B3C2.

It can be seen from the above that the effect of polyacrylamide and Potassium Permanganate on the synergistic dehydration of polyiron is not as obvious as that of poly iron.However, the addition of polyacrylamide has a significant effect on reducing the COD content of effluent. It can increase the

COD removal rate of algae by 4.67%.At the same time, it has a synergistic effect on the removal of nitrogen and phosphorus from polyiron.

4. Conclusion

1) Polyferric sulfate can promote the centrifugal dehydration of cyanobacteria to a certain extent, and reduce the moisture content of mud cake after centrifugal dehydration of cyanobacteria.With the addition of polymeric ferric sulfate content increases gradually, the dewatering effect on cyanobacteria increased gradually,However, when the amount of polyferric sulfate exceeds a certain amount, the effect of polyferric sulfate on the flocculation and dehydration of cyanobacteria is not obvious.

2) when pH was added to polymerized ferric sulfate, the effect of flocculation and dehydration on cyanobacteria was best when the pH was about 2.When pH was adjusted, the flocculation and dehydration effect of PFS decreased with the increase of pH.The dehydration efficiency of polyferric sulfate to cyanobacteria increased first and then decreased at 25-45 ℃ .The flocculation and dehydration effect is best at 35℃.

3) In the orthogonal experiment of dehydration of cyanobacteria by potassium permanganate, polyacrylamide and polyferric sulfate, the amount of polyferric sulfate was the most important factor.

Acknowledgments
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