Kaolin suspension compound processed by biological flocculant and ferric salt

Z. Zhang[1] & L.N. Zheng[1,2*], X.Ai[1], X. R. Jiang[1] ,W. N. Wu[3]

1 College of Marine Technology and Environmental , Dalian Ocean University ,Dalian 116023, China

2 Key Laboratory of Nearshore Marine Environmental Research, Dalian 116023, China

3 Liaoning provincial solid waste management center, Shenyang, 110000, China

*8601375@qq.com

Keywords: Biological flocculants; $FeCl_3$; compound processed; fractal dimension

Abstract. By using kaolin suspension as the research object and the coagulation test as the basis, the optimum dosage and the fractal floc characteristics of high turbidity and low turbidity water processed by the biological flocculant (BFs) and $FeCl_3$ were investigated. The results demonstrated that the optimum dosage of the biological flocculants and $FeCl_3$ was 10.5mL/L and 5.25mL/L, respectively. The flock fractal dimension with optimal treatment effect and stability was between 1.4-1.6.

Introduction

Microbial flocculants are natural biopolymer flocculants and metabolites with flocculation activity produced by microorganism which contains glycoprotein, mucopolysaccharide, protein, cellulose and DNA. Microbial flocculants are high efficient, safe, without secondary pollution flocculants with biodegradable.

The growth process of flocks determined the flocks could have self similarity and scale invariance in a certain range, which is the two important characteristics of the fractal, namely the formation of flocks has the characteristics of fractal. The irregular degree of flocks was described by the flocks "fractal dimension" and the process of formation and "grow up" rules of flocks was described by the flocks "fractal dimension". The change of factors of flocks fractal dimension was related to the turbidity of raw water and flocculants dosage.

Better purification effect could be obtained by microbial flocculants and chemical flocculants used together and the total dosage of flocculants could be greatly reduced. The optimum dosage and fractal characteristics of flocks with the use of compound microbial flocculants and inorganic flocculants were investigated.

Materials and methods

Test instruments

Industrial control computer, 721 visible spectrophotometer, electronic balance, intelligent coagulation test stirrer.

Test water

The dispersion of kaolin powder was quantitative into deionizer water and stirred with high speed to prepare the synthetic raw water for the test. NaHCO3 and NaNO3 was added for each 0.5mol/L into the raw water to adjust the alkalinity and conductivity of the solution. The turbidity of high turbidity water and low turbidity water was 1000NTU and 100 NTU, respectively. The initial pH of kaolin raw water solution was 7.8.

Test insecticide

Bioflocculant was separated from the aerobic activated sludge in strain F6 and aerobic sludge

was obtained by oily wastewater in the aeration tank station (from Daqing). By the way, the strain F6 had been identified as the Bacillus sp. and the concentration of FeCl3 was 10%.

Table 1. Dosage of $FeCl_3$ under different water quality (unit: mL/L)

number	dosage of $FeCl_3$ under high turbidity water	dosage of $FeCl_3$ under low turbidity water
1	0.3	0.10
2	0.4	0.15
3	0.5	0.25
4	0.6	0.4
5	0.7	0.5
6	1.0	0.6

Test conditions

Six couplet beaker test were carried out by using the mixture of BFs and FeCl3. The experimental conditions were: BFs (dosage treatment of high turbidity water with low turbidity water: 10mL/L and 5mL/L respectively) with different amounts of FeCl3 compound, pH8.5, hydraulic conditions for two section type stirring (first section of stirring speed was 160r/min, stirring time was 40s, second section of stirring speed was 40r/min, stirring time was140s), the absorbance was measured after static settling for 20min, pictures were taken after the slow stirring, the fractal dimension was calculated and analyzed by using flocculation morphology and the average value of six linked beaker experiments was used as the experimental index.

Calculation of fractal dimension

Calculated of flocks by using the function relationship between the projection area of flocks and the maximum length of the fractal dimension was proposed by J. Gregory (Gregorian) which is the famous British scholar. The function relationship between the projection area of flocks and the maximum length was:

$$A = aL^{D_f} \quad (1)$$

In this type:

A : the flock particle projected area,

L :the maximum length of projection,

a :the proportionality constant,

Df : the fractal dimension of floc in two-dimensional space.

For the natural logarithm of the formula, there is:

ln A＝Dfln L＋ln a. (2)

Te slope of the line could be obtained according to the linear relationship between the mapping of lnA and lnL and the fractal dimension Df could be carried out.

Results and discussion

The compound treatment of high turbidity water by BFs and FeCl3

Dosage and water absorbance value of high turbidity water compound treatment by BFs and FeCl3 and fractal dimension are shown in Figure 1:

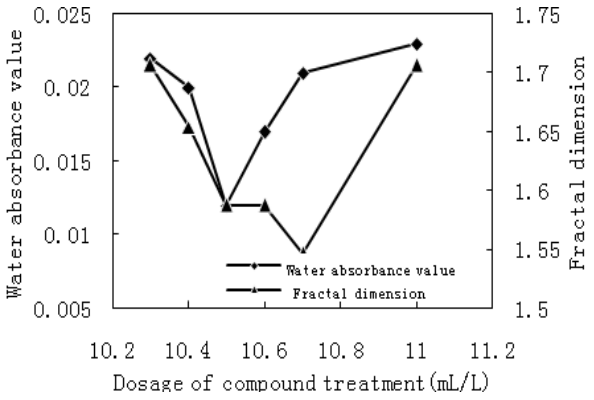

Figure 1. Water absorbance value and fractal dimension of high turbidity compound processed by BFs and $FeCl_3$

It is demonstrated in Figure 1 that the minimum effluent absorbance value and the best treatment effect and minimum mean square difference could be obtained when the dosage of BFs and FeCl3 were 10mL/L and 0.5mL/L, respectively. It is also demonstrated that the optimal stability and effect of experiments could be obtained by optimal dosage of BFs and FeCl3 was 10.5mL/L. The fractal dimension decreased after rising with the increasing of dosage and the fractal dimension was 1.588, when the effect of effluent and the stability were best.

The compound treatment of low turbidity water by BFs and FeCl3

Dosage and water absorbance value of low turbidity water compound treatment by BFs and FeCl3 and

fractal dimension are shown in Figure 2.

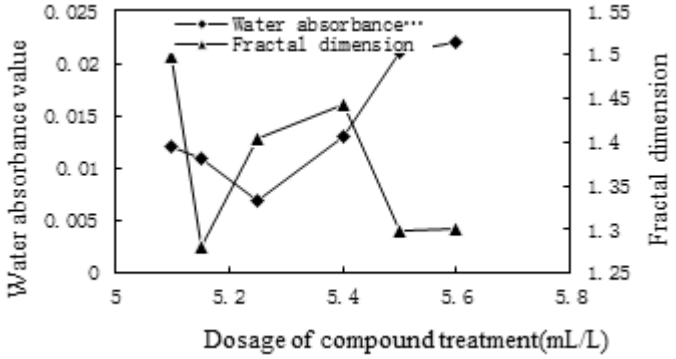

Figure 2. Water absorbance value and fractal dimension of low turbidity compound processed by BFs and FeCl3

It is demonstrated in Figure 2 that the minimum effluent absorbance value, the best treatment effect and minimum mean square difference could be obtained by the dosage of the BFs and FeCl3 was 5mL/L and 0.25mL/L, respectively, and the treatment effect was stable. It is also demonstrated that the optimal stability and effect of experiments could be obtained by optimal dosage of BFs and FeCl3 was 5.25mL/L. The fractal dimension varied significantly with the increasing of dosage and the fractal dimension was 1.412 when the effect of effluent and the stability were best.

Conclusion

The optimum dosage was 10.5mL/L and 5.25mL/L, respectively; when processed with the high turbidity water and low turbidity water by the mixture of BFs and FeCl3. It is demonstrated by calculating the fractal dimension that both in the treatment of high turbidity water and low turbidity water, fractal dimension and stability of the optimal treatment effect was 1.4~1.6.

Acknowledgements

This research was financially supported by the Liaoning Province Education Science Research Project (L2013275), Liaoning Province Finance Research Foundation (13C019), Liaoning province university student innovation training project(2014) and Dalian Ocean University Students' innovation and entrepreneurship program plan project(2013).

References

1. 2000. SALEHIZADEH H,VOSSOUGHI M,ALEMZADEH I. Some investigations on bioflocculant producing bacteria[J].Bio—them Eng, ,*5(1):39-44*.
2. Guo. J. W, Chai. T & Wang. M. 2010.A strain of microbial flocculant producing bacteria screening and flocculating activity research [J]. Industrial water treatment, *30(11): 37-40.*
3. Liu. C, Han. X & Wang. Y. X. 2011.High yield flocculant strain screening and its properties of G - 203 [J]. Journal of jinan university (natural science edition), *25 (1): 59-63.*
4. Zhang. D , Xiang. Y. L & Peng. Q. A. 2011 .Microbial flocculant producing bacteria screening, identification and flocculation experiment [J]. Hubei province agricultural science.*50 (1):66-69.*
5. Zhu. Y. B, 2006. The characteristics of biological flocculating agent flocculant producing bacteria and the process analysis of flocculation. Ph.D. Thesis, Harbin institute of technology.
6. Zhang. Y. J, Zhang. Z. Q & Dai. X. Q. 2011. Research progress of the preparation of microbial flocculant cheap [J]. Anhui agricultural science, *39(1):434-436*.