

Preparation and Application of Non-toxic Kaolin Mineral Materials Flocculant

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Abstract

There are many kinds of inorganic mineral materials in the nature, and the flocculants can be made into efficient flocculants which must be related to the elements and components of their composition. In this research, the mineral materials of Kaolin with high aluminium content are selected as the raw materials, and the characteristics of mineral materials of Kaolin will be changed by chemical means, which can be studied and investigated the flocculation effect and flocculation mechanism of mineral materials of Kaolin. The research mainly make sure the optimum conditions, application conditions, flocculation mechanism and the safety of flocculant preparation from Kaolin mineral materials.

Keywords

Inorganic mineral material; flocculant; Kaolin.

1. Introduction

Colloidal river water and surface runoff water will be purified by contacting with the inorganic mineral materials, such as sand, clay and so on. And they will gradually become clear spring water (mineral water) which containing mineral ions[1]. Under the guidance of this concept of natural science, we make the flocculants which are produced directly by inorganic mineral materials. Although there are many advantages have been found in the preliminary experiments, its just a surface phenomenon, we need to look at the essence through the phenomenon. We should deeply research their chemical composition, mechanism of electroneutralization, adsorption, netting and compression in flocculation process, safety of treated water and floc sediments, the best operating conditions for preparation and the structure of flocs[2]. Therefore, this topic will carry out a detailed research from the following aspects: modification of Kaolin mineral materials, flocculation mechanism, safety and purification effect of the water quality[3].

2. Materials and methods

2.1 Preparation of flocculant

In this topic, Kaolin mineral materials are selected as the raw materials, because the unmodified mineral materials do not have flocculating effect. Firstly, the minerals are modified with different types and concentrations of acids, and then the effects of room temperature and high temperature on the preparation of flocculants will be compared. Finally, the properties of different flocculants are characterized. The particle size and specific surface area are measured by particle size analyzer, and the internal structure is studied by scanning electron microscopy (SEM), crystal morphology is studied by X-ray diffraction (XRD), and the chemical bond is studied by infrared spectroscopy (FTIR).

The large pieces of Kaolin are crushed into powders, then the powdered Kaolin is batched into the crusher to crush the Kaolin according to the required grinding time. After crushing, the Kaolin is sieving according to the required number of sieves, the Kaolin is put aside after sieving. Then the acid solution are prepared according to the required concentration strength, after the solution is prepared, the certain quality of Kaolin is put into the acid solution and stirred evenly, then it is sealed with fresh-keeping film, and activated for 8 hours at room temperature. After activation, put it in an oven at 98 °C for 4 hours to remove the moisture, and then dried at 105 °C for 8 hours. After drying, removed the Kaolin to put it into the crusher for 30 seconds, then the inorganic mineral flocculant is prepared.

2.2 Preparation of milk organic colloidal solution

Add a certain amount of milk purchased in pure water which is not easy to produce colloid. It is necessary to modify the milk by adding the necessary ionic aqueous solution to promote the formation of colloidal solution in milk simulated wastewater, and it can be quantified and equipped with a certain turbidity solution. Take 5000 mL tap water in a large number of barrels and measure the electrical conductivity of tap water by conductivity meter, the electrical conductivity of clean water must be 325. Normally the electrical conductivity of rigidly connected with tap water is usually higher than 325. Therefore, it is necessary to mix ultra-pure water to reduce the electrical conductivity of water until the electrical conductivity reaches to 325, after the excess water is poured out to make the volume of water reach to 5000 mL, then measured 9 mL pure milk and pour it into the fresh water, stir them with glass rod. At the moment to measure the turbidity of the liquid, the turbidity should be 211 NTU, if the turbidity is not reached, add 0.1 mL milk to the liquid and measure the turbidity every time until the turbidity reaches 211 NTU. At this time, the preparation of milk organic colloid solution is completed.

2.3 Environmental safety of Kaolin mineral flocculant

The soluble heavy metals such as iron and aluminium may exist in the effluent of inorganic mineral flocculation reaction. Therefore, inductive coupled plasma-mass spectrometry (ICP-MS) is used to determine the speciation and content of heavy metals. Compare with the relevant standards, at the same time the toxicity tests of microorganisms, aquatic animals and plants are carried out by using biotoxicity detection techniques such as luminescent bacterial toxicity test, to evaluate the environmental safety of inorganic mineral flocculants.

2.4 Comparison of flocculation effects

Take the milk as the simulated organic colloid in water, take the clay as the simulated inorganic colloids in water to prepare simulated wastewater, culture wastewater and fermentation wastewater respectively. The comparison of the flocculation effect of Kaolin mineral flocculant and PAC or PFS, to measure the water's turbidity of effluent, zeta potential, pH value, sedimentation velocity of floc and floc volume.

2.5 Flocculation mechanism

Compare with the inorganic mineral flocculant and PAC or PFS, the zeta potential and turbidity are used to judge the primary and secondary order of 4 flocculation mechanisms in flocculation process by electroneutralization, adsorption, netting and precipitation compression, light scattering technique is used to analyze the flocculent changes from time to time in the whole flocculation process by flocculation detector PDA. In addition, the soluble and granular components of Kaolin mineral flocculants are separated, to research their contribution to flocculation and the main active components will be determined.

3. Results and discussions

3.1 Influence of dosage of inorganic mineral material on flocculation efficiency

In order to investigate the influence of dosage on the flocculation effect of Kaolin inorganic mineral flocculants, 0.1 g, 0.2 g, 0.3 g, 0.4 g, 0.5 g and 0.6 g are added respectively. The Kaolin is crushed and sifted 200 orders of powders, according to the mass ratio of acid to inorganic mineral material 1:3, to react in the beaker. After 4 hours static activation, it is placed in a pre-set 98 °C oven for 4 hours. When the moisture is almost evaporated, the oven temperature is adjusted to 105 °C and dried for 12 hours. Then the samples should be crushed for 30 seconds and preserved as samples for the next experiment. The turbidity of inorganic colloidal river water is 8.6 NTU. Take 500 mL of river water, put it in the prepared beaker, and place it on a six-unit flocculation stirring device, add different dosage of Kaolin flocculant under the rapid stirring, and turn to slow stirring after 30 seconds, stop stirring after 3 minutes, measure the turbidity of each solution after 1 hour.

According to Table 1 and Figure 1, the dosage of inorganic mineral materials will affect the flocculation effect, consider 6 values, 0.2 g has the better flocculation effect.

Table 1: Comparison of flocculation effect of different flocculants

Dosage (g)	Turbidity	pH	SS(mg/l)	TP(mg/l)	NH3-N(mg/l)	COD(mg/l)
Original water	50.12	6.89	25	5.88	40.41	188.60
0.1g	18.83	7.23	17	0.33	36.85	89.32
0.2g	13.52	7.11	13	0.21	36.3	55.96
0.3g	12.31	7.07	12	0.15	35.95	53.82
0.4g	12.13	7.05	11	0.13	35.35	51.46
0.5g	11.95	7.03	11	0.11	34.42	52.25
0.6g	11.56	7.01	11	0.12	34.11	53.25

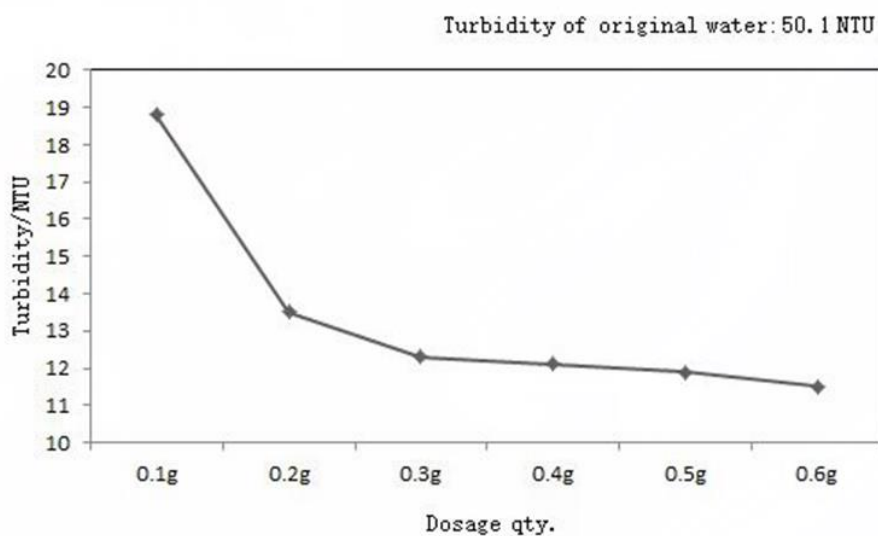


Figure 1 Effects of dosage on turbidity removal

3.2 Influence of crushing time of inorganic mineral flocculant

The inorganic mineral material Kaolin is used to prepare different samples according to the different crushing time of powder, then these samples are modified with sulfuric acid to make different

flocculants, then the milk simulated wastewater is carried out to investigate the change of turbidity. The volume of simulated milk wastewater is 500 mL, and the dosage of inorganic mineral flocculant is 0.15 g. Fast stirring for 30 seconds, added the flocculant, then slow down the stirring speed, change to a slow stirring, after 3 minutes change into the static stage, after 30 minutes to determined the turbidity of its supernatant, the results are shown in Figure 4. As is shown in Fig. 4, the crushing time has a certain influence on flocculation effect, with the increase of crushing time, the turbidity after flocculation is high to low, and then increases again, it shows that the best crushing time is 2 minutes, the turbidity decreases from 211 NTU to 18 NTU of the original milk simulated wastewater at this time. The turbidity of the flocculated mixed liquor will decrease significantly after 24 hours, and finally it can be reduced to less than 2 NTU.

According to Figure 2, the crushing time of inorganic mineral material Kaolin flocculation also affected by the change of particle diameter, 2 minutes crushing time has the better performance.

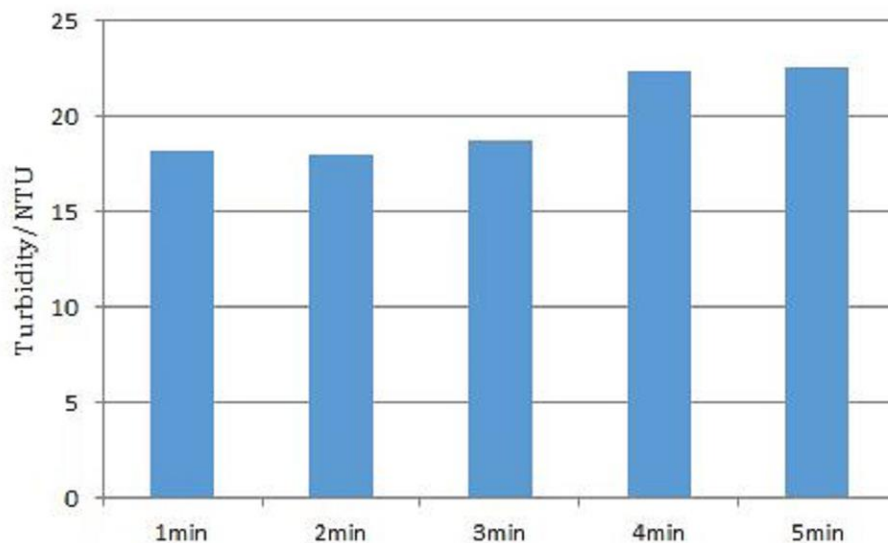


Figure 2 Effects of crushing time on turbidity removal

4. Conclusion

The topic group has been engaged in the preparation and characteristics of Kaolin flocculant, and part of the research content has completed. It is important is to understand the preparation method of flocculant, and the simple detection method of flocculant flocculation effect. More research contents depend on the existing basis, which give a good plan. From the current research, the following conclusions can be drawn:

The dosage of inorganic mineral materials will affect the flocculation effect, consider 6 values, 0.2 g has the better flocculation effect.

The crushing time of inorganic mineral material Kaolin flocculation also affected by the change of particle diameter, 2 minutes crushing time has the better performance.

Acid treatments is an important means of modification of inorganic mineral material of Kaolin, sulfuric acid has the best effect. Because the phosphoric acid and oxalic acid are weak acids, the ionization strength of inorganic mineral material is not enough. As the result, the flocculation effect of modified Kaolin is very poor.

Acknowledgements

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