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Study on Optimum Selection of Coagulant in Polluted Water Treatment with Low Temperature and Turbidity Based on Positive Osmosis

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ABSTRACT. *Low temperature and low turbidity water treatment is one of the difficult problems in water supply treatment. Coagulant plays an important role in low temperature and low turbidity water treatment. Its treatment effect will directly affect the operation complexity of subsequent processes. Positive osmosis separation technology is a membrane separation process driven by osmotic pressure difference of solution spontaneously. This process does not require additional operating pressure and has low energy consumption. Moreover, the positive osmosis membrane is lightly polluted and easy to clean after pollution. Therefore, the technology of positive osmosis membrane treatment has become a research hotspot in the field of water treatment. Positive osmosis technology has good application prospects due to its low energy consumption and light pollution. Its future development needs to be transformed from experimental research to practical application. The preparation of excellent FO membrane, the selection and separation of extraction liquid are still positive osmosis. Key core issues in technology research and application. On this basis, the challenges of forward osmosis technology are analyzed. In the future, the preparation of positively permeable membranes should focus on solving the problems of internal concentration polarization caused by membranes and reverse osmosis of the draw solution; the preparation and selection of the draw solution should focus on the draw solution which can reduce the polarization of internal concentration*

KEYWORDS: *Positive osmosis, Low temperature and turbidity, Water treatment; Coagulant*

1. Introduction

The treatment of low temperature and low turbidity water has always been one of the most concerned problems in water supply industry. At present, domestic low temperature and low turbidity water treatment technologies mainly include air flotation, sludge reflux, micro-flocculation and so on. It is one of the economical and effective ways to improve the coagulation effect by optimizing coagulant or compound coagulant suitable for low temperature and turbidity water quality [1]. Positive osmosis technology has the characteristics of low energy consumption, strong interception ability, low degree of membrane fouling and easy cleaning of membrane fouling [2]. However, because the mass transfer of water in the process of positive osmosis is in the direction of osmotic pressure difference, water molecules flow into the higher osmotic pressure absorbent through the positive osmosis membrane, which limits the application of positive osmosis technology as an independent process in water treatment [3]. The concentrated raw material liquid can be recycled as the draw liquid of the next forward osmosis process, and the diluted draw liquid can obtain pure water of the product by means of chemical sedimentation, cooling sedimentation, thermal decomposition, thermal evaporation and the like [4]. There is also a special case in the infiltration process: when an applied pressure smaller than the osmotic pressure difference is applied during the infiltration process, water still flows from the side of the raw material liquid to the side of the draw liquid during the infiltration process. At the same time, it is found that strengthening the coagulation and sedimentation process is the key to improving the efficiency of water treatment system. Therefore, considering the turbidity and decontamination effects of coagulant selection, and determining the optimal coagulation conditions, it will be meaningful to strengthen the conventional process of water treatment and solve the problem of decontamination of drinking water [5].

Choosing high quality and efficient coagulant suitable for water quality treatment is one of the important ways to improve coagulation efficiency. In previous studies, the main basis for evaluating and optimizing coagulants was turbidity removal ability, while the pollution removal efficiency of coagulants was neglected [6]. In recent years, some scholars have begun to study the technology of positive osmosis [7]. If pressure is applied in the opposite direction of osmotic pressure difference, and the pressure is less than osmotic pressure difference, water molecules still diffuse from the feed liquid to the extract liquid. This osmotic process is called pressure damped osmosis, which is an intermediate process between FO and RO processes [8]. At the same time, with the development of functional pumping liquid, forward osmosis technology is expected to be combined with functionalized draw liquid utilization technology. In this type of combined process, the draw solution does not need to be regenerated, and can be directly utilized for functionalization. Choosing a high-quality and efficient coagulant suitable for treating water quality and adding a suitable coagulant is a more cost-effective way to improve the coagulation effect [9]. Forward osmosis technology can also be used as a pretreatment process for advanced treatment to optimize the operating conditions of the advanced treatment process. The PAC and the dienyl quaternary ammonium salt polymer (cationic polymer flocculant, ST) were compounded into a coagulant for coagulation experiments. The turbidity of the selected coagulant to the raw water of low temperature and low turbidity reservoir was compared. The organic removal effect provides a reference for the treatment of this characteristic raw water [10].

1. Materials And Methods

The raw water of the experiment was taken from the lake water quality of a city. The water quality analysis is shown in Table 1. For low temperature and low turbidity water, there are few suspended particles in the water, and the collision probability between particles is very small. Moreover, due to the influence of low temperature, the water has a high viscosity, which is not conducive to the collision, coagulation and floc growth of micro-particles in the water. FO is a membrane separation process, which refers to the transfer of water from high hydrochemical potential region to low hydrochemical potential region through selective permeation membrane. The osmotic pressure difference between high hydrochemical potential (FS) and low hydrochemical potential (DS) separated by selective permeation membranes is the driving force of FO process. After repeated floc formation, crushing and re-flocculation, the floc size after each crushing is smaller than that before the crushing. have shown that when aluminium sulfate and polyacrylamide are used as coagulants, it is difficult to flocculate the crushed flocs after they are crushed at high shear rate. Promote the agglomeration and growth of particles. The low concentration of particulates in low turbidity water will inevitably affect the normal process of coagulation treatment. High water flux, fresh water recovery and desalination rate can be obtained by using high concentration ammonium salt DS, and the higher the ammonium carbamate concentration in DS, the greater the osmotic pressure difference between the two sides of the membrane. In DS, the concentration of ammonium carbamate is related to the mixing ratio of NH3 and CO2. When the seawater is desalinated by the extracting liquid prepared by the volatile gas, the diluted extracting liquid can remove the volatile gas by heating or gas purging.

Table 1 Raw water quality

Project	*Water sample 1*	*Water sample 2*
Turbidity	*16.8*	*17.3*
PH value	*6.920*	*7.125*
Water temperature	*2.61*	*3.35*
Permanganate Number (mg.L-1)	*5.35*	*5.60*

The colloid has strong hydrophilicity and hydration, and the alum generated at low temperature is loose and fine, and the coagulation is slow, so the coagulation effect is poor. Ferric chloride is hydrolyzed relatively fast, and the floc formed is denser than aluminum salt floc, with fast settling speed and wide applicable pH range. However, the quaternary ammonium ions in ST flocculant are positively charged and have strong electric neutralization ability. Therefore, through compounding with aluminum salt, it can play a good coagulant aid role in reservoir raw water with low temperature and turbidity. The high-concentration chemical fertilizer solution is taken as a drawing liquid to recover water in seawater or polluted water sources, in the process, the chemical fertilizer solution is diluted, pollutants in raw water are trapped by a positive permeable membrane, and the diluted chemical fertilizer solution can be directly used for agriculture. The advantage of using nano-particles as absorbing solution lies in the fact that the solute back-mixing phenomenon is relatively light and the recovery process is simple. The disadvantage is that nano-particles are prone to agglomeration in the recovery process. Although separation can be carried out by ultrasonic method, the particle magnetism and recovery rate will be affected [9]. The operation of FO membrane in OMBR equipment was checked by the established salt accumulation model. Studies have shown that the ratio of salt permeability to water permeability of the FO membrane, the ratio of hydraulic retention time to sludge residence time are two important optimization control parameters in the OMBR reactor. The morphology of aluminum ions and iron ions is obviously improved, the degree of polymerization is greatly improved, and the coagulation performance of polyaluminum chloride is improved; the adaptability is strong, the pH range of the coagulation process is wide, the treatment effect of low water temperature is good, and the sedimentation speed is good. Quick and other advantages.

In a group of beakers, 1000 mL water samples were added, coagulant was added in the rapid mixing stage, coagulation steps were set in combination with production as Table 2, and the final settling time was 25 minutes.

Table 2 Coagulation program

Paragraph number	*Branch*	*Second*	*Speed*	*Dosing*
01	*00*	*10*	*152*	*1*
02	*02*	*12*	*96*	*0*
03	*01*	*20*	*132*	*0*

The turbidity removal effect of AS is relatively poor, PAC, PFAS and PACS are basically maintained at similar levels, but due to the low temperature and low turbidity of water quality, the remaining turbidity is basically maintained at around 0.2 NTU when the dosage is 35 mg / L. The results of turbidity removal by coagulants with different dosages are shown in Figure 1.

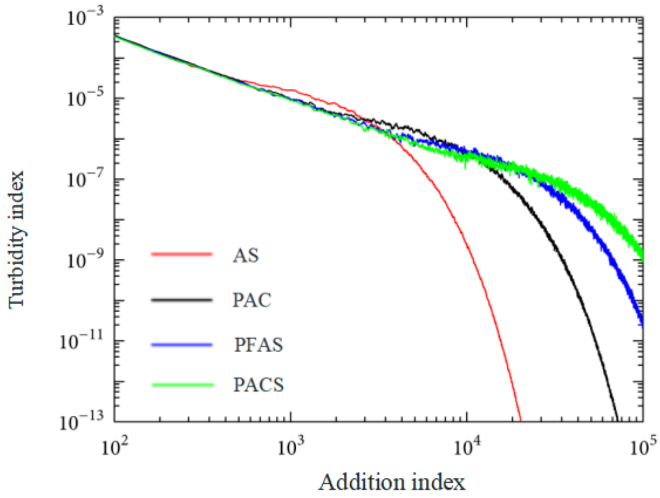

Fig. 1 Coagulation effect of different coagulants

In most of the applications of positive osmosis process, it is difficult to meet the process requirements alone. It is necessary to combine other separation processes or post-treatment processes, which not only improves the energy consumption of the combined process, but also increases the construction investment. Develop inorganic salt polymer flocculants to replace inorganic salt flocculants and study highly efficient and non-toxic organic synthetic polymer flocculants, optimize their synthesis process, reduce costs, and make use of natural macromolecule compounds to be non-toxic and non-polluting. By fully mixing the kinetic energy of water fall in water distribution wells with coagulant, coagulation is strengthened and the contact reaction time is prolonged. Aluminum sulfate has been gradually introduced into the selection field of DS. These DS have the advantages of producing high osmotic pressure and water flux, reducing internal concentration polarization and so on, but they also have some defects. For example, the particle coagulation of magnetic and hydrophilic nano-materials DS occurs in the process of magnetic separation and regeneration, which affects the regeneration of materials. With the increase of dosage, the formation of silk flower is accelerated, the flower is enlarged, and the sedimentation is accelerated. Within a certain range of dosage, the larger the dosage, the better the flowering situation. Therefore, for low temperature and low turbidity water, the coagulation effect of ferric chloride is better than that of aluminum sulfate. Through further research, found the important role of the support layer base film on the FO composite membrane, and found that the sponge-like pore structure is more serious than the internal concentration polarization of the finger-hole structure, so the basement membrane of the finger-like pore structure It is more advantageous to prepare a FO film excellent in performance.

2. Result Analysis and Discussion

Positive osmosis technology can also be used as pretreatment process for advanced treatment. Ferric chloride, aluminum sulfate and ferrous sulfate all have certain turbidity removal effect. With the increase of dosage, turbidity removal rate will gradually increase. The first two will reach a peak and then slightly decrease, indicating that it is meaningless to increase the dosage again. It can recycle the extracted liquid and produce high-quality reclaimed water at the same time. After the operation of osmotic pressure membrane bioreactor, it is found that the membrane pollution and energy consumption are greatly reduced compared with traditional MBR. After applying 2.3 MPa and 2.4 MPa pressure to FS side respectively, the water flux is obviously increased. This shows that the combination of FO and RO technologies (essentially PRO) is conducive to the increase of water flux, but the combination of technologies needs to find more suitable operating conditions. The more polysilicic acid is formed by polymerization. However, too much activated silicic acid will cause the polymerization rate to be too fast and cause the polysilicic acid to form a jelly prematurely and fail. On the contrary, the amount of activated silicic acid is insufficient, the concentration of free silicic acid is too low, the rate of polycondensation reaction is lowered, and the degree of polymerization is insufficient, which also directly affects the coagulating effect. Therefore, it is disadvantageous that the activated silicic acid is too high or too low. At low temperatures, the hydration of colloidal particles is enhanced, preventing colloidal flocculation. Moreover, the water in the hydration film is affected by the viscosity and the severity, which affects the adhesion strength between the particles and affects the formation of the flocs.

Positive osmosis process can be used as pretreatment process for advanced treatment process. In this process, the combined process of forward osmosis and reverse osmosis (FO-RO) is used to recover the water in the glucose solution, and the glucose solution is used as a drawing solution to draw clean water from the polluted water source. The key is to control the appropriate polymerization degree in the activation process, such as insufficient polymerization, short molecular chain and poor coagulation aid effect. If polymerization is excessive, the molecular weight is too large to form gel and lose coagulation aid effect. Pyrolytic substances or other substances which are easy to recover are used as the extraction liquid, driving force is provided by the osmotic pressure difference between seawater and the extraction liquid to generate pure water, and the diluted extraction liquid realizes fresh water regeneration by methods such as heating volatilization, adding medicament precipitation and the like. The internal concentration polarization of the membrane is minimized. There is not much research on the DS selection and synthesis that can reduce the intra-concentration polarization. To reduce the internal concentration polarization caused by DS, the DS diffusion coefficient should be increased, the viscosity should be reduced, and the ions or molecules should be reduced. Engineering and technical measures for sedimentation and filtration. On the basis of the original process, Qishui Plant has taken more effective measures such as increasing the dosage point and recycling water. If purified by a filter, the turbidity can be kept below 4.7 NTU.

When treating low-temperature and low-turbidity water, attention should be paid to the analysis of water quality characteristics, which includes not only water temperature and turbidity, but also the content of organic matters and colloidal substances. On this basis, the key is to select and develop coagulants and coagulants that are less affected by temperature and have excellent coagulation effect. At the same time, even if the salt content in fs is increased and ds with higher concentration is adopted, the membrane water flux still drops significantly, but increasing the cross-flow velocity on the membrane surface can eliminate the external concentration polarization and thus increase the water flux. the reason for the low water flux in the experiment may be the serious concentration polarization problem inside the ro membrane. The diluted driving liquid can volatilize NH3 and CO2 under the condition of about 40 DEG C, thereby separating fresh water. Since no additional driving pressure is required, seawater desalination using forward osmosis technology is more energy-saving than traditional desalination technology (such as RO, etc.), and the energy consumption is equivalent to 71% ~ 80% of the traditional desalination technology. Commonly used desalination technology, its raw water usually has high salinity, high temperature and high impurity characteristics. There is a serious fouling phenomenon during process operation. The deposition and accumulation of scale reduces the heat transfer efficiency of the heat exchanger, which in turn reduces Operating temperature and water recovery rate of the entire system. In the initial stage, as the dosage of coagulant increases, the coagulation effect is better, but the remaining turbidity will reach a low point. After that, the increase of coagulant dosage has little effect on turbidity removal. Excessive activation of silicic acid will cause the polymerization rate to be too fast, which will lead to the premature formation of the gelation of the polysilicic acid. On the contrary, the activated silicic acid is insufficient, the free silicic acid concentration is too low, and the polycondensation reaction rate is lowered. Not enough, it will directly affect the coagulation effect.

3. Conclusion

In this paper, the optimal selection of coagulants for low-temperature and low-turbidity polluted water treatment with positive osmosis is studied. The most convenient and effective way to improve the coagulation effect is to select the coagulant that is most suitable for the quality of raw water. It is an effective way to solve the problem of low-temperature and low-turbidity water treatment by selecting the coagulant that is less affected by water temperature and adding appropriate coagulant aids to improve the coagulation effect. Changing the low water temperature is not easy to implement in practice, and certain technical measures can be taken on the original coagulation, sedimentation and filtration treatment process equipment, such as increasing the concentration of raw water particles, improving coagulation conditions, etc. without major modification of the process equipment, but good results can be obtained. It will certainly attract more researchers' attention and in-depth study. At present, the preparation and selection of membrane materials which can reduce the problems of internal concentration polarization and reverse osmosis and the reduction of internal concentration polarization are the key to FO technology research. However, most of the research on forward osmosis technology is still in the laboratory stage. The only commercial membranes have the disadvantages of high cost, low pH tolerance and serious concentration polarization. These problems are all caused by the incomplete osmosis technology. The main obstacles to application. The forward osmosis combined process has been applied in the fields of seawater desalination, reclaimed water reuse, sewage treatment, material separation and drinking water production, and with forward osmosis membrane materials, extraction liquid, forward osmosis operation process and membrane pollution control, In-depth study of related directions.

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