Chapter 11

Characteristics of Polyaluminum Chloride (PAC) Coagulant Prepared by Baking Process

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11.1. Abstract

One new technique was introduced preparing high-efficiency flocculation: polyaluminium chloride (PAC) with the materials of $AlCl_3 \cdot 6H_2O$. Effect of preparing conditions on quality and separation of PAC was tested. The optimal preparing method was: baking temperature 290℃; baking time 30 min; maturation time 18 h; liquids laying aside time 12 h. The crystal type and appearance of PAC was studied by scanning electron microscope (SEM), and Al_{13} was detected by ^{27}Al-NMR. And the flocculating efficiency of PAC was also preliminarily examined by jar test.

11.2. Introduction

In water treatment, coagulation is an essential process for the removal of fine particulate matter (Gao, *et al.*, 2002). Polyaluminum chloride (PAC) coagulant has been proven to be an effective coagulant for the removal of certain contaminants, turbidity and color. PAC coagulant has been developed and used in water and wastewater treatment since the 1980s throughout the world (Pasrthasarathy *et al.*, 1985). PAC is made by partial hydrolysis of acid aluminum chloride solution using a specific reactor, an empirical formula of $Al(OH)_nCl_{3-n}$ (with n from 1.0 to 2.5) is achieved. A variety of species can be formed when stock solutions of PAC are added to raw water.

Much attention has been paid to PAC in recent years because of its higher efficiency and relatively low costs compared with the traditional flocculation (Boisvert *et al.*, 1999; Wang *et al.*, 2004). Preparation (Shen, 1998) is one of the important parts to decide whether PAC products industrial production, large-scale application. In recent years many countries in the world of the researchers have done a lot of work on the PAC of the methods and process. But so far, synthesis of PAC largely based on liquid. Fluid methods of preparing PAC have been well-rounded, but, there are many limits: complex process, high energy cost, high impurity, etc. (Kyun *et al.*, 2000). These factors have restricted the application of the product. To overcome these shortcomings, use the dry method to make the liquid products into solid products. However, in enrichment, the process of drying need to consume a large amount of heat, and HCl gas has a strong corrosive on the equipment. In this way, the cost of production inputs and equipment are very high. So how we can adopt a more simple production method to directly product the high performance PAC solid-state is the people have always been highly concerned about.

Baking process has been had a small number of examples of industrial production. But there are so few reports of its basic research. Particularly on the reports of production influence factors, stability, morphological distribution, flocculation characteristics and mechanism of flocculation of the solid-state PAC by direct thermal decomposition method. And that impacts to the development to be the low power consumption, less pollution, high quality products. In addition, many theories of PAC rally-flocculation process still remain in the speculation stage, and the basic theoretical research has lagged far behind the applied research, so that inorganic polymer flocculation (IPF) application process failed to give full play to the effect of efficient flocculation in the actual production, thereby constraining the further development of such pharmaceutical and applications (Li *et al.*, 2003). Especially for preparing the solid-state PAC by baking process directly has not yet conducted, such as studies the impact of factors, stability, pool flocculation characteristics and flocculation mechanism.

Thus, the development of new highly efficient production of inorganic polymer flocculation PAC so as to improve the quality, thereby enhancing coagulation ability is important significance.

Therefore, the present chapter deals with prepare PAC by baking process. Research on the best conditions to synthesize the solid-state PAC, and its stability, structure and the effect of coagulation and promoting flocculation characteristics, provide the basis for the application.

Base on extensive review of literature and the formers' studies, this study introduced a new method to make PAC. Made the research scheme first, then had a careful research on characteristics of PAC by baking process. Morphological distribution of PAC was measured using timed colorimetric speciation techniques as the ferron test. Crystal type and appearance of PAC was studied by scanning electron mi-

croscope (SEM), Al_{13} was detected by ^{27}Al-NMR (Wang *et al.*, 1999). The flocculating efficiency of PAC was also preliminarily examined by jar test. And remained Al was tested using AAS.

11.3. The Status of Water Quality Control

With the acceleration of the global process of industrialization and population growth, water has increasingly become one of the important factors for sustainable development of human society. The demand for water has led to continuous growth in both quantity and quality of contradictions. While water is the basis to meet demand, but poor water quality deterioration or actually has reduced water consumption, water quality improvement or recovery of the corresponding increase in water resources, to reach into the water quality can be repeated use is particularly important in the circumstances of water shortage. In China, most cities which seriously short water have caused serious economic losses and social environment, which will inevitably have a serious impact on China's implementation of the strategy of sustainable development. How will the quality of the natural conditions under artificial strengthen the trans- formation process, the full and effective use of limited resources such as water treatment research on the important subject.

Coagulation process is the basic method to remove the suspension things and colloidal particles from water, and it's the important field of scientific research in water treatment project. Nearly a century, domestic and foreign researchers on the optimization of water quality issues a lot of fruitful exploration, from the coagulation theory on the development of the semi-qualitative or quantitative models and quantitative models, and the establishment of a variety of chemical particles from under the conditions of stability and transmission mathematical model. However, with the rapid industrial and economic development, water resources and water increasingly serious environmental problems, the traditional coagulation technology faces enormous challenges.

Coagulation is the key technology application; it can be used to reduce the turbidity of raw water, sense of color and other indicators. Inorganic coagulant which is non-toxic (or low toxicity), cheap and easy for raw materials, and many other advantages, in the coagulation technology occupy an extremely important position, has been widely used. In the traditional aluminum, iron salt coagulant on the basis of the 1960s and the new inorganic polymer flocculation (IPF) on behalf of inorganic coagulants the dominant trend of development, has become a widely used special chemicals in the water treatment. Compared with the traditional coagulant, it can significantly improve the effectiveness of purification, and the amount of a settlement performance, and it is widely used and rapid development in the field of water treatment. As science and technology development and wider application of IPF, people began to shape the polymerization of IPF and coagulation of a lot of research in the early 1980s, and found that the PAC (Poly Aluminum Chloride, PAC) both in shape structural features, flocculation mechanism, or flocculation with the performance aspects of the traditional aluminum rally there the distinction between the nature and form of proposed. $A1_{13}$ is the best form of cohesion flocculation of PAC (Hu *et al.*, 2006), the number of its products to reflect the performance of the flocculation.

Polyaluminium chloride (PAC) is an important flocculation in water treatment. O'Melia and Dempsey (1982), in a review of work done using a wide variety of PAC coagulants, proposed that some PAC formulations may contain aluminum precipitates. The positively changed precipitates of $Al(OH)_3$ (s) may improve flocculation kinetics in turbidity removal and adsorb humic substances. O'Melia *et al.* (1989) concluded that PAC coagulants are effective at lower dosages than other aluminum preparations for the coagulation of high turbidity water, particularly at low temperature or acidic pH, also that PAC is an effective filter aid for low turbidity waters, providing for destabilization and subsequent filtration of particles at acidic and neutral pH.

PAC has good performance coagulation, with high efficiency, rapid precipitation, suitable for a wide range of advantages. PAC has been gradually replacing the traditional flocculation trend. At present, the PAC domestic demand has shown a growth trend, this PAC to expand production and development of a broad market space, coupled with the PAC's extensive source of raw materials, the use of advanced production technology development and production of PAC's bright future (He *et al*., 2003).