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ScienceDirect

APCBEE Procedia 10 (2014) 229 – 234

Procedia APCBEE

www.elsevier.com/locate/procedia

ICESD 2014: February 19-21, Singapore

Combination of Chitosan and Bentonite as Coagulant Agents in Dissolved Air Flotation

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Abstract

The experiment was carried out to study the dissolved air flotation (DAF) process in a tank involving mainly velocity distribution and turbidity removal. Chitosan and Bentonite were known as coagulant agents thus were used in the study. Measurements were carried out on four cases with different inlet velocities of 0.3m/s, 0.6m/s, 0.9m/s and 1.2m/s. Laboratory tests were conducted to test the water quality based on turbidity values and basic drinking water parameters. From the test results, it was found that the inlet velocity gave impacts on the distribution of flow in the tank and thus affected the efficiency of the flotation process. Chitosan and Bentonite can be applied to the flotation tank resulting in an average of 97% turbidity removal. This study successfully proved the effectiveness of the combination of Chitosan and Bentonite as a coagulating agent in the DAF tank for raw water treatment process.

Selection and peer review under responsibility of Asia-Pacific Chemical, Biological & Environmental Engineering Society

Keywords: Chitosan, Bentonite, Dissolved air flotation (DAF)

1. Intoduction

In typical terms of particle size, shape and density as well as particle charge, all of them are controlled to some appropriate condition by the coagulation and the flocculation process [1]. The process is simple and that process is a vital stage in most water treatment systems. The agglomeration of fine particles or colloids

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Selection and peer review under responsibility of Asia-Pacific Chemical, Biological & Environmental Engineering Society
doi:10.1016/j.apcbee.2014.10.044

into large particles can be considered as a well-established approach for removing turbidity, natural organic matters and other soluble organic and inorganic pollutants [2]. In water treatment capacity, coagulation can be defined as the process whereby particles in water are destabilized by dosing the certain chemical additives i.e coagulant and causing rapid formation of small agglomerates or known as 'flocs'. Flocculation is then the process of destabilization of particles and small agglomerates, whereby, they are encouraged to collide with each other (agitated) to form flocs [1]. Actually, to eradicate these particles from water, it is required to neutralize the negative charge. In fact, there are quite numbers of mechanisms for destabilizing these particles, but most suitable for water treatment is through the addition of a chemical coagulant [1]. There are a number of coagulation mechanisms including double layer compression, charge neutralization, sweep flocculation and inter particle bridging, however the coagulant selected, its dose and water quality determine the mechanism. The coagulation process is generally optimized for a particular system in terms of coagulant dose and pH, achieved through a series of bench scale jar test [2].

2. Combination of Chitosan and Bentonite

The most favourable concentration weight ratio of the natural polymer to natural clay of bentonite is in between 1:5 to 1:20 [1]. In order to remove particles and colour from drinking water, natural cationic polymer coagulant and clay mineral in an adequate amount are believed to be effective to coagulate suspended particles in the raw water [1][3][4]. In order to to achieve a good removal, the effective or optimum dose needs to be investigated. The optimal dosage denotes to be a dose that is sufficient to produce the desired effect of removing particles in maximum while taking into consideration of cost and efficiency. The term 'primary coagulant' refers to the main coagulant which is typically a metal salt (conventionally alum) added alone or being added together with the secondary coagulant or 'coagulant aid'. The term 'coagulant aid' referring to a polymer substance typically a cationic, synthetic organic polymer, when added with a primary coagulant, will enhance the adherence of the particles [1]. In fact, an anionic or nonionic polymer which generally consists of high molecular weight is added after flocculation is initiated. The polymer will act as a flocculent aid by the mean of aggregation of the flocs [3].

Anionic particles of Bentonite are electrostatically attracted by the protonated amino groups of Chitosan [5]. This reaction facilitates the neutralization of the anionic charges which can bind together and settle rapidly by the effect of gravity. The total turbidity reduction is reached, when the number of protonated amino groups neutralizes all anionic charges [6]. Murcott et al., (1996) [3] in their experiment use Chitosan as a primary coagulant in combination with Bentonite as coagulant aids. As a result particles had removed from raw water as well or better than either Chitosan alone. It is reported that the combination of both natural coagulants, is better than the conventional chemical coagulant typically the metal salts (aluminum sulfate with or without a synthetic polymer). The natural coagulant currently is very famous and being used in most water treatment plants worldwide. It is proven that low doses of the natural polymer of Chitosan together with the coagulant aid of Bentonite are able to perform better than alum with a synthetic polymer in the removal of particulate matter and color from raw water [3].

3. Jar Test

The purpose of the jar tests was to determine the effectiveness of the combination of Chitosan with coagulant aid Bentonite as an alternate coagulant in terms of dose, coagulant mixture ratio, pH and mixing time [3]. A jar test is vital in most water treatment plant systems. The minimal coagulant dosage and concentration to optimally remove the residual turbidity of the water are determined by the jar test technique [4]. It can be said that many factors will influence coagulation beside there are complex reactions involved, it