

Research Article

Research of Diatomite's Purification Capacity to Organic Pollutants in Water

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Abstract: The experimental study is conducted for diatomite's purification capacity to and effects on organic pollutants. In the aspects of different dosage of diatomite, different adsorption time, etc., explore diatomite's removal capacity to COD and nitrogen oxide in water. When 500 g diatomite and 2 L water are mixed into the precoating liquid, the pH value of the wastewater is 7, the mixed adsorption time of the wastewater and diatomite is 30 min and the dosage of aluminum chloride flocculant in 1 L wastewater is 300, diatomite's removal capacity to the organic pollutants and nitrides in landfill leachate is the strongest. Diatomite can effectively adsorb the organic pollutants in water, so it is suitable to be used as industrial water purifier.

Keywords: Diatomite, organic pollutants, water treatment

INTRODUCTION

Diatomite is also known as Diatomaceous Earth, Kieselguhr, Kieselgur and Celite. It is a naturally occurring, soft, chalk-like, sedimentary rock and is primarily composed of the fossilized remains of unicellular fresh water plants, Diatoms. It can be easily crumbled into a fine white to off-white powder. The powder has abrasive feeling which is similar to pumice powder. It is very light-weight because of its porosity.

For millennia, the diatoms have been compressed and created one of the most effective growing mediums available. Approximately 90% of diatomite is silicon dioxide and the remainder is elemental minerals that are essential for plant growth.

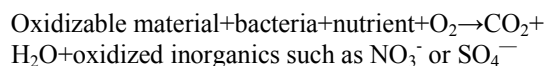
Diatomaceous earth, also known as diatomite, kieselguhr, kieselgur and Celite, is a naturally occurring, soft, chalk-like, sedimentary rock mineral that is easily crumbled into a fine white to off-white powder. This powder has an abrasive feeling similar to pumice powder and is very light-weight due to its high porosity (Gómez *et al.*, 2014). It is made primarily of silica and consists of fossilized remains of diatoms, a type of hard-shelled algae. It is used as a filtration aid, as a mild abrasive, as a mechanical insecticide, as an adsorbent for liquids, as cat litter and as a component of dynamite.

Diatomite is very resourceful all over the world and distributes widely in each continent except the South Pole. The reserve volume of diatomite that has been discovered is about 2 billion tons and the possible ore is 3.573 billion tons, among them, Asia's reserve is the most, which can reach to about 1 million tons; the

second is Europe, which can be 500 million tons; and the summation of America, Africa and Oceania can be about 500 million tons.

Diatomite mineral resource of China is relatively abundant and its volume dose can be above 2 billion tons (Xiao-Jiang *et al.*, 2013). Diatomite of China that has been discovered is about 390 million tons, which stands in front of the world and ranks only second to America. Moreover, in the field of city wastewater comprehensive treatment and industrial waste water treatment, China already has nearly 20 years of research history of diatomite processing technology. At present, the application of diatomite in aspect of water treatment only covers a few percents with low use ratio. While, diatomite possesses lots of superiorities when being used in waste water treatment, such as that the sludge volume is small, be easy to separate, the settling velocity is fast, secondary pollution is small and decrease the composite cost of water treatment. So, more and more personages in water treatment field begin to pay attention to diatomite (Xin-Dong and Wan-Fu, 2013).

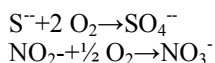
Any oxidizable material present in a natural waterway or in an industrial wastewater will be oxidized both by biochemical (bacterial) or chemical processes. The result is that the oxygen content of the water will be decreased. Basically, the reaction for biochemical oxidation may be written as:



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Oxygen consumption by reducing chemicals such as sulfides and nitrites is typified as follows:



Since all natural waterways contain bacteria and nutrients, almost any waste compounds introduced into such waterways will initiate biochemical reactions (such as shown above). Those biochemical reactions create what is measured in the laboratory as the Biochemical Oxygen Demand (BOD). Such chemicals are also liable to be broken down using strong oxidizing agents and these chemical reactions create what is measured in the laboratory as the Chemical Oxygen Demand (COD) (Zamorska and Papciak, 2008). Both the BOD and COD tests are a measure of the relative oxygen-depletion effect of a waste contaminant. Both have been widely adopted as a measure of pollution effect. The BOD test measures the oxygen demand of biodegradable pollutants whereas the COD test measures the oxygen demand of oxidizable pollutants (Ikeda *et al.*, 2007).

The so-called 5-day BOD measures the amount of oxygen consumed by biochemical oxidation of waste contaminants in a 5-day period. The total amount of oxygen consumed when the biochemical reaction is allowed to proceed to completion is called the Ultimate BOD. Because the Ultimate BOD is so time consuming, the 5-day BOD has been almost universally adopted as a measure of relative pollution effect.

There are also many different COD tests of which the 4-h COD is probably the most common.

There is no generalized correlation between the 5-day BOD and the ultimate BOD. Similarly there is no generalized correlation between BOD and COD. It is possible to develop such correlations for specific waste contaminants in a specific wastewater stream but such correlations cannot be generalized for use with any other waste contaminants or wastewater streams (Zhengrong and Xin, 2013). This is because the composition of any wastewater stream is different. As an example an effluent consisting of a solution of simple sugars that might discharge from a confectionery factory is likely to have organic components that degrade very quickly. In such a case, the 5 day BOD and the ultimate BOD would be very similar since there would be very little organic material left after 5 days. However a final effluent of a sewage treatment works serving a large industrialised area might have a discharge where the ultimate BOD was much greater than the 5 day BOD because much of the easily degraded material would have been removed in the sewage treatment process and many industrial processes discharge difficult to degrade organic molecules (Khraisheh *et al.*, 2005).

The laboratory test procedures for the determining the above oxygen demands are detailed in many standard texts. American versions include the "Standard Methods for the Examination of Water and Wastewater."

With the development of the industry and the human life level, organic pollutants have become the substantial harmful substances in the natural water body. Through the method of adsorption filtration and from diatomite dosage, pH, adsorption time, flocculant dosage and other aspects, this research has observed and studied diatomite's removal capacity to the organic pollutants and nitrides in landfill leachate so as to further provide a certain basis to diatomite's treatment of high concentration of organic pollutants and nitrides.

MATERIALS AND METHODS

Experimental materials:

Diatomite: Wuxi Daxin Environmental Protection Material Co., Ltd., model: DA-1, SiO₂ content: 90 (%) or higher, water content: 0.1 (%) or less, PH value: 10.

Simulated waste water: Simulated waste water is made by glucose, urea, NH₄Cl and carbon ink and NaHO3 is added into it as pH buffer at the same time, in which the concentrations of COD, TN and ammonia nitrogen are, respectively about 4000, 2000 and 1500 mg/L, respectively.

Experimental method: Under stirring, firstly, add water purifier into waste water for flocculation and sedimentation and to obtain lignin by filtering separation; then under stirring, add lime milk into the processed water for desilication and the adjustment of pH value, after the sedimentation of calcium metasilicate, filter it and recycle or discharge clean water (Peilong *et al.*, 2013). The technological process is as follows: waste water-adding water purifier-flocculation and sedimentation-siphon water-adding lime milk, removing silica and adjusting pH value-siphon water, filtering and subsiding calcium silicon-clean water-using or discharging it. Then, take 100 g precoated layer made by diatomite. Respectively add 100, 200, 300, 400 and 500 mL, respectively aluminum chloride flocculant (10%) as well as 20 min flocculation. Make filtration treatment to the mixture, take the filtering medium for detection and determine the best flocculant dosage.

RESULTS AND DISCUSSION

The relationship between the adsorption time and the removal rate: Diatomite's adsorption effects on the pollutants in waste water are mainly in the form of physical adsorption and chemical adsorption. Physical adsorption is to reach adsorption equilibrium in a relatively short period through electrostatic interactions. Chemical adsorption is to make full use of the active groups on the surface of diatomite to react with pollutants. As chemisorption capacity is large, the speed is slow, there's no sufficient adsorption time and it is easy to cause the waste of the adsorption capacity of diatomite, therefore, adsorption time has great influence on the effects of removing pollutants by diatomite.

Table 1: The relationship between the adsorption time and the removal rate

Adsorption time (min)	Pollutant removal rate (%)		
	COD	TN	Ammonia nitrogen
5	39.4	41.8	12.5
10	48.3	49.7	31.2
15	52.7	54.3	34.4
20	69.4	56.8	41.7
25	69.6	60.0	41.9
30	70.1	63.5	42.2
35	70.2	63.8	42.7
40	70.2	63.8	43.3

Table 2: The relationship between the amount of flocculant and the removal rate

The amount of flocculant (/mL)	Pollutant removal rate (%)		
	COD	TN	Ammonia nitrogen
100	39.7	42.2	30.2
200	42.1	44.1	33.9
300	44.9	46.3	35.2
400	42.7	43.5	35.9
500	40.1	39.8	34.4

The relationship between the adsorption time and the removal rate is shown in Table 1. Diatomite can't achieve the best removal of pollutants in a relatively short period. With the increase of adsorption time, the adsorption effect enhances unceasingly. When the adsorption capacity of diatomite reaches saturation, even if adsorption time is added more, the adsorption effects will not change too much.

The relationship between the flocculant dosage and the removal rate: The surface and the interior surface of the holes of diatomite are covered by a large number of hydroxyl silicon, which can dissociate H⁺ in aqueous solution to make the diatomite particles electronegative. This electro negativity can make diatomite realize electric neutralization to the colloidal substances with positive charge, but there are limitations to the adsorption of the organic substances with negative charge. Add flocculants to modify diatomite and the obtained modified diatomite can make the flocculating setting of pollutants in waste water after the pollutants are adsorbed to form pie sediments and strengthen the effect of adsorption removal. The relation curve between the flocculant dosage and the removal rate is shown in Table 2.

With the increase of the dosage of the flocculant aluminum chloride, the removal rates of COD, TN, ammonia nitrogen, etc., have been increased and a peak value occurs when the dosage is 300 mL; continue to add flocculant, the removal rates of COD and TN will be reduced gradually and that of ammonia nitrogen basically remains unchanged. When adding 300 mL flocculant, the removal effects of COD, TN and ammonia nitrogen are the best with the respective removal rate of 46, 47 and 36%, respectively. This is mainly because when the dosage of flocculant is too large, the acidity of itself and the acidness produced by

aluminum hydrolysis will make pH value of the solution rapidly reduced and exceed the best pH of wastewater treatment.

CONCLUSION

The experiment proves that diatomite has a stronger purification effect on organic pollutants in water. As the manufacturing cost of the composite water purifier made of diatomite is low, the production cost is reduced and the emissions of waste (especially acid pickle) are avoided, the pollution of the environment has been released. The waste water treatment by the water purifier has a simple craft and low processing cost and it is a good method of waste water treatment.

Diatomite shall have a good development prospect in water treatment in China, for the reason that the resource of diatomite in China is rich, it can be widely obtained widely, its price is low, as well as its good adsorption property. However, most of diatomite in China is low grade, so it is necessary to make modification and improve its adsorbing capacity. In order to achieve the objective of effective recycling, it needs to make researches on diatomite's regeneration methods and conditions.

In addition, diatomite can also combine with bioprocess technology to form effective combination treatment process. Applying diatomite into the field of water treatment can not only carve out a wide new market for China's abundant diatomite resource, but also help to relieve the secondary pollution problem confronted by China in aspect of pollution regulation at present. Besides, due to that diatomite is a kind of natural mineral, so the reclamation space of diatomite sludge is large and its stability is good, such that, it can be recycled to be applied in fields of agriculture, building materials and waste water treatment after proper disposition. Make researches on these aspects, for example, after purification and modification, diatomite can be used to be a kind of effective adsorbing materials to dispose urban sanitary waste water and industrial waste water, which can be of great significance to worldwide abundant diatomite resources and also shall be the main development trends in the future.

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