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COAGULATION AS A METHOD OF IMPROVING WATER QUALITY, PURPOSE, ESSENCE, STEPS

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Abstract

Water coagulation is the process of enlargement, aggregation of colloidal and finely dispersed impurities of water due to their mutual adhesion under the influence of molecular attraction forces with the formation of flakes and their subsequent precipitation. In water treatment practice, two types of coagulation are known : coagulation in the depth of the granular filter load (contact coagulation) and coagulation occurring in the flocculation chambers (coagulation in the free volume). The coagulant must have a charge opposite to the charge of colloidal particles in the water; the coagulant itself forms a colloidal solution, which quickly coagulates to form flakes that precipitate. Neutralization of the charge of colloidal water particles on the surface of coagulant flakes is called neutralization coagulation, and their subsequent agglomeration into large flakes by adsorption or adhesion is called flocculation.

Key words: coagulation, water purification, water quality improvement, flocculation , sedimentation, chemical coagulants, turbidity removal, particle aggregation, filtration, disinfection.

Актуальность

Various coagulants are used for coagulation. The coagulant should not contain impurities that, if released into drinking water, could have a harmful effect on human health. The most widely used coagulant in water supply systems is aluminum sulfate (alumina sulfate) - $Al_2(SO_4)_3 \cdot 18H_2O$. To accelerate coagulation and intensify the operation of treatment facilities, flocculants are used - high-molecular synthetic compounds. Polyacrylamide is one of the synthetic flocculants used instead of mineral coagulants to neutralize the charge and flocculate colloidal impurities in water.[1.3]

The progress and success of coagulation is influenced not only by the alkalinity of the water, but also by the concentration of hydrogen ions (pH), temperature, humic substances of protective colloids, the nature of the suspension, the chemical properties of the coagulant and the conditions of

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the coagulation process. Therefore, theoretical calculations are not enough and experiments are carried out on each water supply to determine the optimal dose of the coagulant.

The organization of coagulation on water pipelines consists of the following operations:

1. dissolution of the coagulant;
2. dosing;
3. mixing with coagulated water;
4. creating favorable conditions for the formation of flocs and their sedimentation in settling tanks.

The supply and dissolution of the dry coagulant are mechanized. The coagulant can be used crushed in dry form, followed by passing through mechanical dispensers and dissolving directly in the coagulated water. After mixing, flocculation occurs, which requires 15-45 minutes to complete. The conditions for flocculation should facilitate the enlargement of flocs and prevent their settling before the end of this process. For this purpose, reaction chambers are used, in which water moves and mixes smoothly. If there is no reaction chamber, as happens on small water pipelines, flocculation occurs in the sump.

In addition to aluminum sulfate, ferric chloride ($FeCl_3$) can be used as a coagulant in water pipelines. The advantages of the latter are the speed of onset and progression of coagulation and low dependence on temperature and pH of the environment.

Coagulation only prepares water for further processing - clarification and bleaching - and in this sense is not an independent process. In some cases, coagulation may be absent in the water treatment scheme.

Stages of clarification of tap water (whether or not it has undergone coagulation):

1. Sedimentation of suspended solids in settling tanks.
2. Filtration through filters with granular loading.

The composition of water treatment facilities, or its design, is selected depending on the quality of the source water, the level of turbidity and color indicators and their ratio.

Coagulation is the process of enlargement, aggregation of colloidal and finely dispersed impurities of water due to their mutual adhesion under the influence of molecular attraction forces.

Coagulation of water impurities allows for faster lightening and discoloration . Coagulation occurs under the influence of chemical reagents - coagulants, which either disrupt the aggregative stability of water impurities or form colloids that absorb water impurities. Aluminum or iron salts are most often used as coagulants [2.5].

In water treatment practice, two types of coagulation are known: coagulation in the depth of the granular filter load (contact coagulation) and coagulation occurring in the flocculation chambers

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(coagulation in the free volume).

The mechanism of contact coagulation is a violation of aggregative stability of colloidal impurities of water as a result of elimination or reduction to very small values of the charge of the micelle. When a coagulant, such as aluminum sulfate, is added to the treated water, it hydrolyzes to form a trivalent aluminum ion:

A12(S04)3 + 6H20 = 2AF + 3S042 + 6H+ + 60H$^-$.

Aluminum ions neutralize the charge of colloidal particles of water impurities and thereby disrupt their aggregative stability. Colloidal particles lacking stability, passing with the water flow through the filter (contact clarifier), are adsorbed on the surface of the particles of the granular filter loading under the influence of intermolecular interaction forces. This leads to lightening and discoloration of the water.

The mechanism of coagulation in a free volume has a different character. As with contact coagulation, the introduction of aluminum sulfate into the treated water neutralizes the charge of natural water colloids and reduces their aggregative stability. This process proceeds very quickly and ends when equilibrium is established between the coagulant cations and micelles of natural colloids. After this, the formation of aluminum hydroxide begins as a result of hydrolysis:

A1 2(S04)3+ 6H20 = 2A1(OH) h + 3H2S04,

and by interaction of the coagulant with the carbonates and bicarbonates present in the water (reserve alkalinity of the water):

A12(S04) j + ZS a (HC03)2 = 2A1(OH) h + 3CaS04+ 6C02.

hydroxide has a colloidal structure (sol), as a result of which it has a developed surface that absorbs water impurities, including natural colloids that have lost aggregative stability.

Hydrolysis of the coagulant is a reversible reaction, and its completeness is affected by the active reaction of water. Lowering the pH suppresses the hydrolysis of salts of weak bases, such as aluminum sulfate. When pH increases a negatively charged aluminate ion [A 102] is formed, which does not lead to coagulation. Acceptable pH value for hydrolysis is 4.3-7.6, optimal - 5.5-6.5.

The efficiency of coagulation is also influenced by the amount of coarse suspension, the particles of which serve as a kind of “ coagulation nuclei ,” the intensity of mixing, and the water

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temperature.

It is obvious that waters of different composition require different doses of coagulant. A preliminary calculation of the optimal dose is made taking into account the alkalinity and color of the treated water. However, the complexity of the physicochemical processes leading to coagulation forces the pre-calculated dose to be clarified experimentally.

To accelerate coagulation and intensify the operation of treatment facilities, so-called flocculants are used - high-molecular synthetic compounds. There are flocculants anionic (polyacrylamide , K-4, K-6, activated silicic acid) and cationic (for example, VA-2) type. The use of anionic flocculants requires pre-treatment of water with a coagulant; the use of cationic flocculants - does not require prior introduction of a coagulant. Flocculants make it possible to accelerate coagulation, increase the speed of water movement in settling tanks, reduce settling time by increasing the rate of sedimentation of flakes, increase the filtration speed and duration of the filter cycle .

The range of substances with flocculating properties is constantly expanding. For use in centralized drinking water supplies , only flocculants that have passed hygienic testing and have standardized maximum permissible concentrations are allowed.

Facilities for coagulation in a free volume must include a dispenser, a mixer and a flocculation chamber. The purpose of the buildings is clear from their names. There are many designs that differ in material consumption, complexity of installation and operation, operational efficiency and productivity.

Coagulation only prepares water for further processing - clarification and bleaching and in this sense is not an independent process. In some cases, coagulation is not indicated in the drinking water preparation scheme.[2.4]

Sedimentation and coagulation as methods of water purification for centralized water supply, their hygienic characteristics.

The simplest and most accessible method for purifying drinking water is settling tap water. At the same time, residual free chlorine (Cl2), which is used in water intake systems for water disinfection, evaporates over a certain time. In addition, under the influence of gravitational forces, relatively large suspension and colloidal particles in suspension occur. In some cases, the sediment turns yellow.

hydroxides in the liquid phase with colloids of wastewater contaminants adsorbed on them and coprecipitated heavy metal hydroxides .[1.3]

During coagulation, special reagents are introduced into the treated wastewater, and when they interact with water, a new, poorly soluble, highly porous phase is formed, usually iron or

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aluminum hydroxides . Co-precipitation of heavy metals also occurs , with properties similar to the coagulant introduced into the solution. This method is widely used in water treatment. The resulting flakes, 0.5–3.0 mm in size, have a very large surface area with good sorption activity. During the process of its formation and sedimentation, suspended substances (silt, plankton cells, large microorganisms, plant remains, etc.), colloidal particles and that part of the pollutant ions that are associated on the surface of these particles are included in the structure.

Modern coagulants based on hydroxochloride - polyhydroxochloride , aluminum hydroxochlorosulfate , Aqua-Aurat , etc. - can significantly improve the quality and intensify the wastewater treatment process. To improve the efficiency of coagulation and reagent precipitation processes, polyacrylamide is widely used .

The so-called contact coagulation allows you to reduce the volume of equipment used and the consumption of reagents. It is implemented by introducing a coagulant solution in front of a mechanical water filter. In this case, the loading grains and the particles adsorbed on them serve as coagulation centers - “seeds”. At the same time, the process of growth of flakes, which are formed directly on the grains of the load, is sharply accelerated and, accordingly, there is no need for them to settle. The wastewater treatment process is accelerated tens of times. [4.5.7]

Filtration as a method of water purification for centralized water supply, hygienic characteristics.

Filtration - retention of insoluble solid particles (gels, suspensions) of a certain size (limited by the size of the holes) occurs in the pores of the microporous structure of a polymer or ceramic filter. Further cleaning consists of retaining the pores of the sorbent (most often activated carbon, prepared by special methods) of organic molecules (including washing powders), residual chlorine and other gases, some heavy metals, etc.

When operating such systems, it is necessary to ensure that the outlet parts of the filters do not become overgrown with bacterial films, which can cause secondary contamination of the purified water.[5.6.9]

Let's look at slow filters. These are containers filled with sand. Filtered water is discharged through a drain at the bottom of the tank. Such a filter must “mature”, i.e. an active biological film should form, consisting of adsorbed suspended particles, plankton and bacteria in the upper part of the sand layer.

The undoubted advantages of slow filters include uniform, close to natural, filtration, in which bacteria retention reaches 99%, as well as the simplicity of the device. But filtration in such filters occurs very slowly and amounts to only 10 cm of water. st /h.

This water purification system is currently used in our country only on small, most often rural,

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water supply systems.

Rapid filters are used for urban water supply. These are concrete tanks with a double bottom. The bottom bottom is solid, and the top is perforated, which ensures the drainage properties of the filter. Water for filtration is supplied from above and discharged from below through the drainage space. The productivity of conventional fast filters is approximately 50 times higher than slow ones, and reaches 5 m^3/h, which is a definite advantage. However, contamination of the filter layer occurs much faster in fast filters. Their ability to retain bacteria is somewhat lower, which is 95%.

Modernized high-speed filters with double-layer loading have even greater productivity. In them, the upper filter layer is represented by anthracite chips, and the lower one is quartz sand. Due to the formation of coagulation centers on large particles of anthracite chips, a significant amount of coarse suspension is retained in the upper layer. Filtration is carried out at a speed of 10 m water . with t./h. [2.3.4]

The Academy of Public Utilities has developed new AKH filters, which eliminate the disadvantage of one-way filtration of conventional filters. In AKH filters, water is supplied both from above and from below, and filtered water is removed from the middle part of the filter through a special drainage device. This filtration principle allows you to increase water purification productivity to 12-15 m^3/h.

The most convenient and effective model of fast filters is a contact clarifier (KO). The bottom layer of loading in it consists of gravel, and the top layer of quartz sand. QR process goes faster and more completely as a result of the formation of large flakes on the gravel and the retention of suspension on them. The dirt holding capacity of such filters is significantly increased . The filtration rate reaches 5-6 m^3/h, and the full water treatment cycle is about 8 hours.

It should be noted that although the adsorption of microorganisms during water clarification and filtration is very high, such a purification scheme does not provide a complete guarantee of epidemic safety. In this regard, after being purified using filters, the water undergoes disinfection.

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