JOURNAL OF ADVANCED SCIENTIFIC RESEARCH

ISSN: 0976-9595

Journal of Advanced Scientific Research (ISSN: 0976-9595)

Vol.1. Issue 1 page 56

Editorial Team

C/O Advanced Scientific Research,
8/21 Thamotharan Street,
Arisipalayam, Salem

Journal of Advanced Scientific Research (ISSN: 0976-9595)
Vol.1. Issue 1 page 57

Theoretical foundations of the mixing process and mechanical mixers used in water purification technology

Abdialim Mirzayev., Shodiyor Jamankulov

https://www.doi.org/10.5281/zenodo.5770602

Samarkand State Institute of Architecture and Civil Engineering named after Mirzo Ulugbek, Candidate of Technical Sciences, Associate Professor.
e-mail: amirzaev@mail.ru,
tel.:(99890-213-86-84)

Annotation: The article provides an overview of domestic and foreign literature, which discusses methods for improving flocculation processes by creating optimal hydraulic conditions by mechanical mixing of the treated water with a coagulant, an analysis of the factors causing the low efficiency of hydraulic mixers is given, recommendations are given for solving the problem of the expediency of using mechanical mixers.

Keywords: mixing, reagent, water, coagulant, effect, clarification, dose, rate, intensity, colloid aluminum hydroxide, stirring, temperature, mechanical, mixer, processing.

INTRODUCTION

The development of science and technology should be even more subordinated to the solution of the most important problems of the further progress of our society, the accelerated transition of the economy to the path of intensive development [1]. The main directions of development of the national economy of the Republic of Uzbekistan, adopted by the decree of the Cabinet of Ministers of the Republic of Uzbekistan, envisage increasing the provision of cities and towns with centralized water supply and, at the same time, improving the protection of water sources from depletion and pollution [2]. This task should first of all be solved by intensifying the work of existing enterprises as a result of their reconstruction and technical re-equipment. In this regard, the use of mechanical mixers at water treatment plants represents a certain unused reserve.

One of the important stages in the technology for improving water quality is mixing reagents with the mass of treated water. This process must satisfy two main requirements: an even distribution of the reagent in the volume of treated water and a quick completion of the operation.

The need to fulfill the first requirement can be traced by the example of the coagulation curve shown in Fig. 1. Suppose that there was an uneven distribution of the coagulant in the mass of the treated water. In that part of the water where there is a lack of coagulant (the first zone to the point of fracture), the coagulation process is sluggish. In this case, the effect of clarification and discoloration of water by settling or filtering is insignificant. In the second zone, an increase in the dose of coagulant dramatically affects the effect of water clarification and discoloration. The boundary between the first and second zones is called the coagulation threshold. In the third zone, an increase in the dose of coagulant does not give a noticeable improvement in the effect of clarification and discoloration of water. The curve is practically parallel to the abscissa axis. The boundary between the second and third zones is called the optimal dose, and only there the process of coagulation of water impurities will proceed normally. Hence, it becomes obvious the need for uniform distribution of the reagent in the mass of the treated water, tk. only under this condition can the desired result be achieved. The process of coagulation of water impurities in time is divided into two stages: perikinetic and orthokinetic. The process of perikinetic coagulation occurs almost instantly, after the introduction of the coagulant into the water we treat. It ends with a violation of aggregate stability during carry, as a result of exchange adsorption of cations of the diffuse layer of ionic and aluminum cations (or aeation), and the formation of primary aggregates. This is followed by the process of orthoxhetic coagulation, characterized by the agglomeration of primary aggregates and individual impurities and ending with the formation of large flakes visible to the naked eye. The second stage of the process of coagulation of water impurities is much longer than the first. It lasts from 6-8 minutes to 1 hour or more, depending on the quality of the treated water [3,4].

Hence, it becomes obvious that the requirement for fast and shallow mixing of reagents with water follows from the need to prevent the destruction of the formed flocs in the flow of turbulent mode, which takes place in mixers and displace devices. Therefore, the mixing of the coagulant with water must be carried out extremely quickly, therefore the process taking place in the mixer is of decisive importance for the subsequent stages of water treatment. The importance of the process of instantaneous distribution of the coagulant in water is based on the theory of coagulation, according to which the role of intermediate dissolved aluminum complexes in the destabilization of suspended particles is very great. In this case, the required rate of solution of the coagulant with water depends on the rate of formation of compounds capable of destabilizing contaminant particles. Ineffective mixing can lead to overexpenditure of the coagulant and a low rate of particle aggregation at a given dose of coagulant [5].

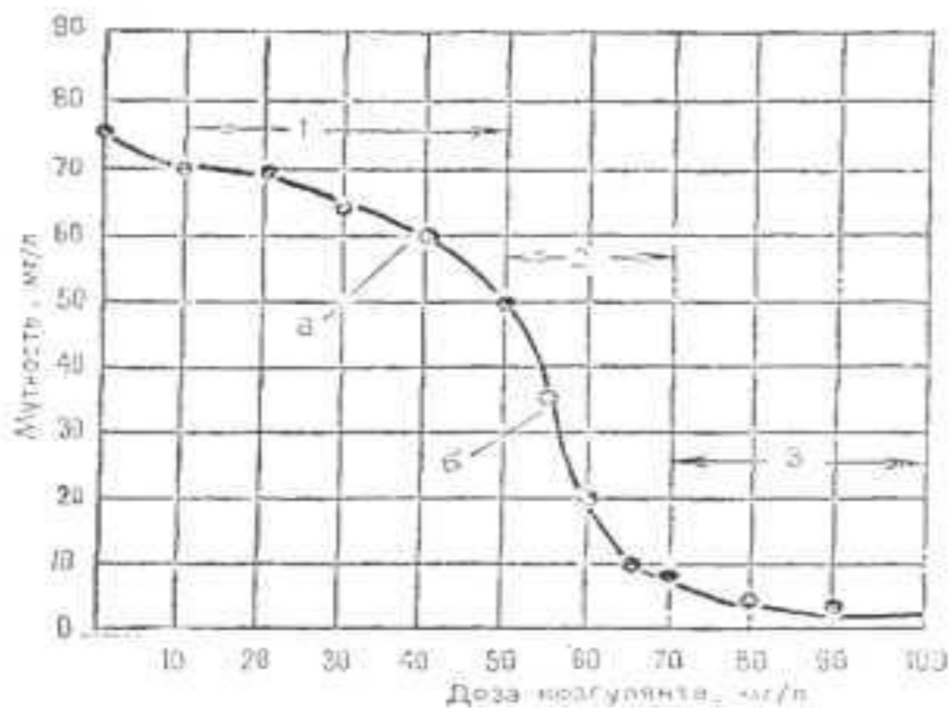

Fig. 1 Coagulation curve.
1 dose of coagulant is insufficient; 2- increasing the dose of the reagent improves the coagulation process; 3 - excess dose of coagulant, loose flakes are formed; a - coagulation threshold; b - optimal dosage for the coagulant.

Holland F., Chalman F., Aris R. et al. Define mixing as “contacting two or more dissimilar portions of a substance, leading to the achievement of the desired level of both physical and chemical homogeneity of the final product." in a container, are rapidly mixed due to molecular diffusion. In liquids, however, molecular diffusion usually proceeds very slowly. "To accelerate mixing inside liquids, the mechanical energy of a rotating stirrer is used. If the wrong type of mixing device is chosen to achieve the desired result, most of the mechanical energy can be wasted [5,6].

According to the definition of G.N. Abramovich mixing - "creating a state of activity, such as flow or turbulence, in systems that are not in perfect mixing conditions."

In order to study the effect of mixing reagents with the treated water and the influence of the size, shape and location of the mixers, as well as the speed of these mixers on the mixing and coagulation processes and on the subsequent water treatment, experimental work was carried out by the researchers: Kozlov V.I. ., Pechnikov V.G., Apeltsina E.I., Lysyakova T.N., Khailov E.G. and foreign researchers Keshum TR, Souchek T., Shndelazh R., Morrow.Ya., Raul K., Hudson H.E., Letterman RD, Kawamura and others. and Lysyakova T.M. the mechanical mixer was an apparatus with a capacity of 2.102m3 / h with the supply of water and reagent from the bottom and the discharge of the mixture through the outlet from the top. Turbine stirrer, eight-bladed. The measured values are the residence time of water in the mixer, the concentration of the reagent by the volume of the mixer, etc. Variables: the number of revolutions of the mixer, the flow rate of the reagent, the position of the outlet.

The results of processing the experimental data were the following values: the number of revolutions corresponding to the optimal mixing conditions, the degree of conversion of the reagent into a hydrolysis product, the number of compartments for the sequential introduction of various reagents; residence time of water in the chamber (10-30 s'1), stirrer rotation speed (300 s-1). Studied by V.I. Kozlov a mechanical paddle-type mixer was a chamber in the form of a square wooden well. The stirrer rotation speed was 0.4-0.42 m / s, the mixing time was 2-3 minutes. and the ratio of the area of the blades interfered with the volume of water in the mixer no more than 10 m3 per 1 m of the mixer blades. Iron vitriol and aluminum sulphate were taken as a coagulant. Doses of coagulants were taken: for iron - 175 mg / l and for alumina 125 mg / l. The research results have shown that the use of these mixers is advisable. The operation of mechanical and other types of mixers, as well as flocculators, in foreign literature is usually characterized by the value of the average velocity gradient (G). The value of (G) is recommended as a useful criterion when choosing the design ratios and setting power of the drive for mechanical flocculation and high-speed mixing, which makes it possible to better design the apparatus than when evaluating these characteristics from other dependencies.

If the value of the net power transmitted to the liquid is known, then assuming the homogeneity of the distribution of the mixing flows, the value (b) can be calculated using the formula given in Camp's work.

$$G = (\frac{W}{\mu})^{\frac{1}{2}}; C^{-1}$$

where: W is the net power dissipated in the length of the volume, W / m^3;

μ- is the absolute viscosity of the liquid at a given temperature, ns / m^2;

$$W = \frac{P}{V}, \text{Вт/м}^3$$

V - volume of treated water in the mixer, m^3; P is the power transmitted by the stirrer to the liquid flow, W.

Argaman I., Lettegman R.D., Morrow I.I. note that different mixing devices operating at the same mean velocity gradient, coagulant dose and mixing duration give slightly different results. Netto I.M. , Ann X. in their works note the influence of the chamber shape of a mechanical mixer on the effect of mixing and coagulation of water impurities. It was found that the different shape of the chamber causes the formation of turbulent vortices of different intensity and frequency. In the works of Camp T., devoted to the influence of the conditions of the initial mixing of iron sulfate with water on the properties of the resulting flakes, it is shown that the mixing intensity at a value of (G) of the order of 4000-12000 s-1 can delay the formation of flakes with subsequent slow stirring in a flocculator.

In the work of Morrow and Rausch it was established that the efficiency of cationic flocculants in the treatment of low-turbid and turbid waters increases with an increase in the mixing intensity in comparison with the intensity usually accepted for mechanical mixers, corresponding to G = 300 s^{-1}. Letterman et al. Demonstrated the effect of the Camp criterion on the coagulant dose. The (GT) values varied from 800 poros at a coagulant dose of 100 m / l to 15,000 at a dose of 10 mg / l. Souchek and Schendelage showed that insufficient mixing of coagulant with water also slows down the process of flocculation and water clarification. The presence of a connection between the intensity of mixing and the effect of coagulation purification prompted researchers to search for oval mixing modes.

The authors believe that in mixing devices, the values of the velocity gradient should be maintained usually in the range of 300: 350 s-1, and mixing should be carried out for 1-2 minutes. Increasing (G) up to 500: 1000 s-1 allows keeping the period of rapid stirring up to 10-30 s.

It should be noted that in works [4, 6, 7], a comparative analysis of the effectiveness of various devices for the rapid reduction of coagulant with water is given and factors affecting the rate of formation and sedimentation of a colloidal suspension during water treatment with a coagulant (salts A1 + 3 and Fe + 3).

It has been experimentally established that good coagulation is carried out at a coagulant concentration of 0.1% (according to A12O3), at a concentration of 0.05, there is already a significant decrease in the coagulation efficiency, since in this case the coagulant is hydrolyzed before it is introduced into the treated water.

It can be assumed that when using highly efficient mechanical mixers, the effect of the coagulant concentration will not be so noticeable.

Conclusions

Analysis of literature sources and completed research works, carried out in the research laboratory of SamGASI and other institutes, convincingly testifies to the technological and sometimes economic advantages of mechanical mixers over hydraulic mixers, namely:

1. When properly designed, mechanical mixers are compact and reliable in operation;
2. Mixers of this type make it possible to adjust the mixing speed in accordance with the changing flow rates and properties of the water;
3. The results of the performed analysis allow us to conclude that mechanical paddle type mixers should be considered the most effective and promising. They are simple in their structure, have the proper mixing effect, and are reliable in operation;
4. The level of development of domestic science and technology allows us to hope that there are all the prerequisites for the day of widespread use of mechanical mixers in water treatment complexes.

References

1. Decree of the president of the Republic of Uzbekistan "on measures for further improvement of drinking water supply and Sewerage Water System and increasing the efficiency of investment projects in the field" dated September 25, 2020 № PF-6074. Tashkent, 2020 year.
2. Decree of the Cabinet of Ministers of the Republic of Uzbekistan "on measures to improve the management of drinking water supply and Sewerage Water System" №854 of December 23, 2020. Tashkent 2020 year.
3. Sanatjon Khidirov, Zokhidjon Ishankulov, Jakhongir Kosimov, Durdona Tadjieva, Panji Nurmatov, and Boyburi Ashirov. Hydraulic regimes and hydrostatic pressure of the flow on the elements of fastenings of the downstream of water outlets. E3S Web of Conferences 264, 03053 (2021) https://doi.org/10.1051/e3sconf/202126403053 CONMECHYDRO - 2021.
4. Makhmudjon Mamajanov, Bakhtiyor Uralov, Marina Li, Eshmatboy Qalqonov, Panji Nurmatov and Abdulatif Gayur. Irrigation pumping stations according to the hydraulic and operational indicators of pumping units. e3s web of conferences 264, 03074 (2021) https://doi.org/10.1051/e3sconf/202126403074 CONMECHYDRO - 2021.
5. Abdialim Mirzaev. Investigation of hydrodynamic characteristics of mechanical mixers in water quality improvement technology. Monograph LAP LAMBERT Academic Publishing RU, ISBN: 978-620-2-91978-4, Samarkand, 2020, p.100.