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Dısınfectants In Potabılızatıon Systems: Aspects For Choice And Application İn İnvestment Plans İn Tropical Countries

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Abstract

This article considers aspects and elements for the selection of the appropriate technology for the application of integrated disinfectants to water treatment systems in tropical countries, where the vast majority of these are developing countries and the economic resources for investment are scarce. Given the above, the criteria of maximum flow rate per unit, contact time of the disinfectant, applied dose, application pH within the contact tank, area occupied by the unit, investment, operation and maintenance costs, are some explicit indicators in the choice of the appropriate technology, to guarantee the reliability, complexity and flexibility of disinfectants to eliminate pathogenic microorganisms, more convenient and implicitly in the drinking water treatment system, which adapts to climatic variability in tropical countries

Keywords: *purification, disinfectants, tropical countries*

1 Introduction:

In water treatment plants, for the treatment of raw surface or ground water, the use of disinfection for the elimination of pathogenic microorganisms is essential to deliver water suitable for human consumption and other activities. However, several factors implicitly influence the disinfection operation, which can be: the reaction contact time, the dose and the applied pH, the treatment flow rate, the amount of pathogenic microorganisms, the by-products derived from disinfection and other characteristics of previously filtered raw water. (Hoque, 1995; Petterson, 2015; Solis, 2020; Nawrocki, 2006; McDermott, 2019; Durmish, 2015).

Currently, there are several types of disinfectants, which can be physical or chemical, which can be selected according to economic and technical conditions, in the context of the drinking water treatment system, which must guarantee the total elimination of pathogenic microorganisms, with extensive areas or with adequate investment, operation and maintenance costs, not to mention technical aspects of the application of disinfectants, which influence appropriate technologies in tropical countries. Due to the above, this article considers some elements for the selection of disinfectants applied in the purification of water, according to characteristics of the filtered raw water, the reaction contact time, the dose and the applied pH, the treatment flow rate, the number of pathogenic microorganisms, areas, costs, among other aspects. (Durmish, 2015; Hoque, 1995).

2 Developıng

In tropical countries, where there is only one season (summer) with bimodal events of the dry and rainy season , due to the influence of the intertropical convergence zone, with high humidity, with climatic phenomena such as Niño or La Niña, which are periodic, thus such as geographic and socio-economic overlapping conditions, which favors changing weather conditions on a time scale, that is, the fluctuating set of weather conditions, leads to integrating factors that determine and interact with the climate order in physical and geographic conditions that present a variation in time and space scales, thus, the modifications in the interaction between the components of the climate system are due to the temporal variations of the climate in short periods of time (years or months) or around its average state (high dependence on the amount and distribution of rainfall), known as climatic variability (Pabón, 1998; Montealegre, 2000; Izaguirre, 2010; García, 2007; Ruíz, 2016; Ortiz, 2017; Rodríguez e. a., 2017; Deago, 2020).

In accordance with the above, in tropical countries, where the majority are in the process of development, investments in drinking water treatment systems have reduced economic resources, therefore, it is significant to properly select treatment units and, in this case, disinfection. In general, disinfection can be carried out using physical agents such as ultraviolet radiation, ozone, heating to a boiling point, ultrasound or ultrasonic waves, among others; when a chemical is used, it can be from halogenated compounds as bromine, iodine, chlorine, and metal ions such as silver, copper and mercury, among others. Usually, the use of Chlorine can be through presentations of chlorine dioxide, chlorinated lime, sodium hypochlorite, calcium hypochlorite and chlorine gas. (AWWA, 1990; McGhee, 1999.)

Pre-chlorination can be mentioned in the disinfection of water through chlorination, which is the addition of chlorine to raw water, before any process or operation in purification, to reduce organic load, odor, taste and improve the coagulation process, however, it increases the generation of trihalomethanes (HTMs) and other halogenated organic compounds. Post chlorination is the dosage of chlorine after the filtration of particles in the water and is carried out in a chlorine contact tank, so the water is later distributed in the drinking water distribution of trihalomethanes (HTMs) and other halogenated organic compounds system. Superchlorination is the application of an additional dose of chlorine in the water distribution system to ensure the concentration of free residual chlorine throughout the system. Dechlorination is the decrease of chlorine through aeration, activated carbon, reducing agents (sulfur dioxide, bisulfites, sulfites or thiosulfites) among others. Hypochlorination is the application of compounds such as calcium or sodium hypochlorite. (Kiely G., 1999; McGhee, 1999.)

It is significant to consider the reliability, complexity and flexibility, in terms of raw water quality, capacity, process stability, and appropriate adaptability to the conditions of the purification system. Given the above, some elements for the selection of disinfectants are mentioned in Table 1. (Arboleda, 2000; Carrión, 1992; Richter, 1984; Droste, 1997; Pérez, 1997; Romero, 2000; McDermott, 2019).

Applied Disinfectant	**Flow (L/s)**	**Contact time (Min)**	**Dose (mg/L)**	**pH**	**Area**	**Investment Cost (USD $)**	**Operation and Maintenance Cost (USD $)**
Applications							
Prechlorination	≥ 0.1	1 - 5	0.1 - 1.0	6.0 - 7.5	LOW	AVERAGE	AVERAGE
Postchlorination	≥ 0.1	1 - 5	0.2 - 4.0	6.0 - 7.5	LOW	AVERAGE	AVERAGE
Superchlorination	≥ 0.1	1 - 5	0.2 -	6.0 -	LOW	AVERAGE	AVERAGE

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			0.5	7.5			
Physicists							
Ultraviolet	≥ 0.1	0.25	≥ 0.001	N/A	LOW	HIGH	HIGH
Ozone	≥ 0.1	4	≥ 0.1	N/A	LOW	HIGH	HIGH
Heating	≥ 0.1	≤ 60	≥ 0.1	N/A	HIGH	HIGH	HIGH
Ultrasound	≥ 0.1	≤ 60	≥ 0.1	N/A	LOW	HIGH	HIGH
Chemicals							
Bromine	≥ 0.1	20 - 30	≥ 0.5	6.0 - 8.5	LOW	AVERAGE	AVERAGE
Iodine	≥ 0.1	20 - 30	1.0 - 2.0	6.5 - 8.0	LOW	AVERAGE	AVERAGE
Silver	≥ 0.1	20 - 30	≥ 0.01	6.0 - 8.5	LOW	AVERAGE	AVERAGE
Copper and Mercury	≥ 0.1	≤ 20	≥ 0.001	6.0 - 8.0	LOW	AVERAGE	AVERAGE
Gaseous Chlorine	≥ 10	≤ 20	0.4 - 4.0	6.0 - 7.5	LOW	AVERAGE	HIGH
Chlorine dioxide	≤ 10	≤ 20	≤ 1.2	6.0 - 7.5	LOW	AVERAGE	AVERAGE
Chlorinated lime	≤ 10	≤ 20	≤ 1.0	6.0 - 7.5	LOW	LOW	LOW
Sodium hypochlorite	≤ 10	≤ 20	0.4 - 4.0	6.0 - 7.5	LOW	LOW	LOW
Calcium hypochlorite	≤ 10	≤ 20	0.4 - 4.0	6.0 - 7.5	LOW	LOW	LOW

Table 1. Disinfectant selection criteria. Source: Authors.

It is significant to mention that in the selection of the disinfectant in the drinking water treatment systems, aspects such as: consumption of electrical energy, available area per unit, variability in the quality of raw water, sensitivity analysis for flow rates, low investment, operation and maintenance cost, little environmental impact, industrial safety measures, generation of by-products, not very specialized personnel for the operation and coordination with the complete purification project, among other aspects must be taken into account. (Arboleda, 2000; Arceivala D.J,, 1981; Droste, 1997; Fair, 2006; Nawrocki, 2006; McDermott, 2019).

3 Conclusıons

The most convenient alternative in the selection of the disinfectant in the drinking water treatment systems is the one that adapts to the climatic variability in tropical countries, the instability of the supply source in terms of the quality of the filtered raw water and therefore the conditions of tractability, to the investment conditions by the government entity, to the threshold of operation and maintenance costs, to the possibility of inclusion in conventional or advanced purification systems, mobile or portable or fixed (≤ 10 L/s) or in modular masonry plants (≥ 10 L/s). Additionally, the appropriate technology selected of the disinfectants in drinking water treatment systems must take into account the electrical energy required, the degree of complexity, local participation in design, materials, reliability and flexibility in operation technique.

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