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# Floculators In Potabılızatıon Systems: Elements For Selection And Application İn İnvestment Projects İn Tropical Countries

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***Abstract***

*This manuscript considers aspects and elements for the selection of the appropriate technology for integrated flocculators into purification systems in tropical countries, where the vast majority of these are developing countries, and in which the economic resources for investment are scarce. Given the above, the criteria of maximum flow per unit, retention time, water velocity and speed gradient within the tank, area occupied by the unit, investment, operation and maintenance costs, are some explicit indicators in the choice of adequate technology, to guarantee the reliability, complexity and flexibility of the most convenient flocculator implicitly in the purification system, which adapts to climatic variability in tropical countries*

***Keywords:*** *purification, flocculators, tropical countries*

## 1 Introduction:

In water treatment plants, for the treatment of raw surface or ground water, the uses of flocculation units are essential for the formation of artificial flocs initially generated in coagulation, which are later decanted in the settlers and filtered in filtration units. However, several factors implicitly influence the operation of the flow, which can be: the retention time, mixing or speed gradient, the variations in the inlet flow rate, the composition of the turbidity, color, pH and other characteristics of raw water and in a lesser extent, the number of flocculator compartments. (Bharti, 2019; Govorova, 2020; Shi, 2019).

Currently, there are several technologies of flocculation units, mechanical and hydraulic, depending on the type of raw water, integrated into the purification systems, which contribute to the improvement of the agglomeration of suspended particles, under conditions of slow mixing and preset contact time, with large areas or with adequate investment, operation and maintenance costs, such as appropriate technologies in tropical countries (Choque, 2020; Li, 2020). Due to the above, this manuscript considers some elements for the selection of flocculator technologies according to characteristics of raw water, retention time, speed gradient, areas, costs, among other aspects.

## 2 Developıng

In tropical countries, where there is only one season (summer) with bimodal events of 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, 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. 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).

According to 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 select appropriately the treatment units and in this case, the flocculators. In general, the flocculators included in the treatment of drinking water can be mechanical (rotary and reciprocating), hydraulic (horizontal, vertical flow, forced passage, Alabama, porous bed) and hydromechanical; also they can be of solid contact and dissipation of energy or power. (Richter, 1984; Arceivala D.J,, 1981; Arboleda, 2000).

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

| **Flocculators Technology** | **Flow (L / s)** | **Retention time (Min)** | **Water speed (m/s)** | **Gradient ($s^{-1}$)** | **Area** | **Investment Cost (USD $)** | **Operation and Maintenance Cost (USD $)** |
|---|---|---|---|---|---|---|---|
| *Hydraulic* | | | | | | | |
| Horizontal flow | ≤ 100 | 15 - 40 | 0.1 - 0.6 | 20 - 90 | HIGH | LOW | LOW |
| Vertical flow | ≤ 250 | 10 - 30 | 0.1 - 0.6 | 20 - 70 | LOW | LOW | LOW |
| Porous bed | ≤ 50 | 3 - 10 | ≥ 0.1 | 10 - 100 | MIDDLE | AVERAGE | AVERAGE |
| Forced Pass | ≤ 100 | 15 - 40 | ≥ 0.1 | 20 - 70 | MIDDLE | LOW | LOW |
| Mesh | ≤ 50 | 10 - 25 | 0.03 - 0.16 | 20 - 90 | LOW | AVERAGE | AVERAGE |
| Helical or Cox | ≤ 100 | 20 - 40 | 0.1 - 0.7 | 10 - 100 | LOW | LOW | LOW |
| Alabama | ≤ 50 | 20 - 40 | 0.4 - 0.6 | 30 - 60 | LOW | LOW | LOW |
| *Mechanics* | | | | | | | |
| Rotary | ≥ 250 | 20 - 60 | 0.3 - 0.9 | 30 - 80 | LOW | HIGH | HIGH |
| Reciprocating | ≥ 250 | 20 - 60 | 0.15 - 0.6 | 20 - 75 | LOW | HIGH | HIGH |
| *Hydromechanical* | | | | | | | |
| Horizontal flow | ≥ 150 | 10 - 30 | 0.3 - 0.9 | 10 - 100 | LOW | AVERAGE | AVERAGE |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Ballasted* | | | | | | | |
| Weighted with micro-sand | ≤ 50 | 7 - 15 | 0.1 - 0.3 | 10 - 100 | LOW | AVERAGE | AVERAGE |

**Table 1.** Selection criteria for flocculators. Source:Authors.

It is significant to mention that in the selection of the flocculator, aspects such as: electrical energy consumption, available area per unit, variability in raw water quality, sensitivity analysis for flow rates, low investment cost, operation and maintenance, little environmental impact, low energy loss, not very specialized personnel for the operation and the articulation with the complete purification project, among other aspects must be taken into account. (Arboleda, 2000; Arceivala D.J,, 1981; Droste, 1997; Fair, 2006).

## 3 Conclusıons

The most convenient alternative to flocculator technology is the one that adapts to climatic variability in tropical countries, to the instability of the supply source in terms of the quality of the raw water and therefore the treatable conditions, the conditions investment by the government entity, at the threshold of operation and maintenance costs, 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 in flocculators must take into account the required electrical energy, the degree of complexity, the local participation in the project, the materials, the reliability and flexibility in the operation of the technique.

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