

## Hybrid Solutions in Physicochemical Processes for the Removal of Turbidity in Andean Reservoirs

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**Abstract :** Sediment removal is very important in the purification of water, not only for reasons of visual perception but also because of its association with odor and taste problems. The Cuchoquesera reservoir, which is in the Andean region of Ayacucho (Peru) at an altitude of 3,740 meters above sea level, visually presents suspended particles and organic impurities indicating that it contains water of dubious quality to deduce that it is suitable for direct consumption of human beings. In order to quantitatively know the degree of impurities, water quality monitoring was carried out from February to August 2018, in which four sampling stations were established in the reservoir. The selected measured parameters were electrical conductivity, total dissolved solids, pH, color, turbidity, and sludge volume. The indicators of the studied parameters exceed the permissible limits except for electrical conductivity (190  $\mu\text{S}/\text{cm}$ ) and total dissolved solids (255 mg/L). In this investigation, the best combination and the optimal doses of reagents were determined that allowed the removal of sediments from the waters of the Cuchoquesera reservoir, through the physicochemical process of coagulation-flocculation. In order to improve this process during the rainy season, six combinations of reagents were evaluated, made up of three coagulants (ferric chloride, ferrous sulfate, and aluminum sulfate) and two natural flocculants: prickly pear powder (*Opuntia ficus-indica*) and tara gum (*Caesalpinia spinoza*). For each combination of reagents, jar tests were developed following the central composite experimental design (CCED), where the design factors were the doses of coagulant and flocculant and the initial turbidity. The results of the jar tests were adjusted to mathematical models, obtaining that to treat the water from the Cuchoquesera reservoir, with a turbidity of 150 UTN and a color of 137 U Pt-Co, 27.9 mg/L of the coagulant aluminum sulfate with 3 mg/L of the natural tara gum flocculant to produce a purified water quality of 1.7 UTN of turbidity and 3.2 U Pt-Co of apparent color. The estimated cost of the dose of coagulant and flocculant found was 0.22 USD/m<sup>3</sup>. This is how "grey-green" technologies can be used as a combination in nature-based solutions in water treatment, in this case, to achieve potability, making it more sustainable, especially economically, if green technology is available at the site of application of the nature-based hybrid solution. This research is a demonstration of the compatibility of natural coagulants/flocculants with other treatment technologies in the integrated/hybrid treatment process, such as the possibility of hybridizing natural coagulants with other types of coagulants.

**Keywords :** prickly pear powder, tara gum, nature-based solutions, aluminum sulfate, jar test, turbidity, coagulation, flocculation

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