

NATURAL COAGULANTS FOR SPECIFIC WASTEWATER TREATMENT. PILOT PLANT IMPLEMENTATION

J. Beltrán de Heredia*, J. Sánchez Martín¹

University of Extremadura. Department of Chemical Engineering and Physical Chemistry. Avda. de Elvas, s/n.
06071. Badajoz (Spain)

* jbelther@unex.es; 1jsanmar@unex.es

Abstract

Although tannin-based coagulants are already well-known agents in removing special pollutants such as dyes or surfactants, pilot plant trials should be carried out in order to confirm the feasibility of this kind of coagulants. Simulated textile and laundry wastewater (100 mg·L⁻¹ and 50 mg·L⁻¹ respectively) were conducted through a pilot plant installation with a coagulant treatment of ca. 100 mg·L⁻¹ of commercially-available tannin-based product (Tanfloc). The efficacy of the whole purification process was high: 95% of dye removal, 80% surfactant removal and a reasonably stability of the system.

Introduction

Given the need to implement water treatment technologies that are appropriate for specific wastewater effluents and adapted to the constraints of developing countries and small communities, the potential of natural coagulants as sustainable and readily available options is increasingly being recognized and studied at laboratory level (Beltrán-Heredia and Sánchez-Martín, 2009). These agents are typically easy for unskilled personnel to handle and maintain.

Studies of plant products as potential water treatment agents have a long history. In particular, wood derivatives are considered to be highly effective adsorbents (Geay et al., 2000). In this view, tannins covers many families of chemical compounds. Their natural origin is as secondary metabolites of plants (Schofield et al, 2001), occurring in the bark, fruit, leaves, etc. While Acacia and Schinopsis bark constitute the principal source of tannins for the leather industry, the bark of other non-tropical trees such as *Quercus ilex*, *suber* or *robur* can also be tannin rich.

The product Tanfloc is a trademark of the TANAC company (Brazil). It is a tannin-based product, modified by a physicochemical process, with a high flocculant power. It is obtained from *Acacia mearnsii* de Wild bark. The tree is very common in Brazil and has a high concentration of tannins. The industrial

production process of Tanfloc is protected by intellectual patents (US patent 6,478,986 B1), but similar procedures are referred to as Mannich base reactions (Tramontini and Angiolini, 1994). It involves tannin polymerization through the addition of formaldehyde (37%), ammonium chloride and commercial hydrochloric acid. The resulting product, obtained under specific temperature conditions, has a viscous appearance and contains 36% active material.

The flocculant activity of Tanfloc as a laundry and textile wastewater treatment agent in a small scale pilot plant has been fully characterized in this contribution.

Methods

Buffered solution – Trials were carried out with pH-stable media. To this end, a pH-7 buffer solution was prepared of 1.2 g of NaH_2PO_4 and 0.85 g of Na_2HPO_4 in 1 L of water. The pH was then adjusted to 7 with HCl 1 M or NaOH 1 M. All reagents were analytical grade from Panreac.

Simulated wastewater – Textile industry effluent wastewater was simulated with an aqueous solution of a dye. In particular, stock solution of ca. 100 $\text{mg}\cdot\text{L}^{-1}$ of Alizarin Violet 3R (Aldrich) was prepared by mixing appropriate amounts of this anthraquinonic dye into the buffered solution. Laundry wastewater, on the other hand, was simulated by a surfactant solution. Stock solution of ca. 50 $\text{mg}\cdot\text{L}^{-1}$ of sodium dodecylbenzene sulfonate (SDBS, Chem Service Inc.) was prepared by dissolving the corresponding amount of this surfactant in the buffered solution.

The pilot plant – The pilot plant consists of coagulation–flocculation, sedimentation and slow sand filtration sections. Table 1 lists the design parameters and figure 1 is a schematic diagram of the installation. The water inflow was 77 $\text{mL}\cdot\text{min}^{-1}$. A period of 20 min was fixed for coagulation and mixing, followed by 1 h of sedimentation of the flocs.

Table 1. Experimental conditions in pilot plant trials

Parameter	Value
Experimental temperature	20°C
Experimental pH	7
Coagulant dosage	92.2 $\text{mg}\cdot\text{L}^{-1}$
Residence time in slow mixer	20 min
Residence time in sedimenter	60 min
Raw water flow	77.1 $\text{mL}\cdot\text{min}^{-1}$

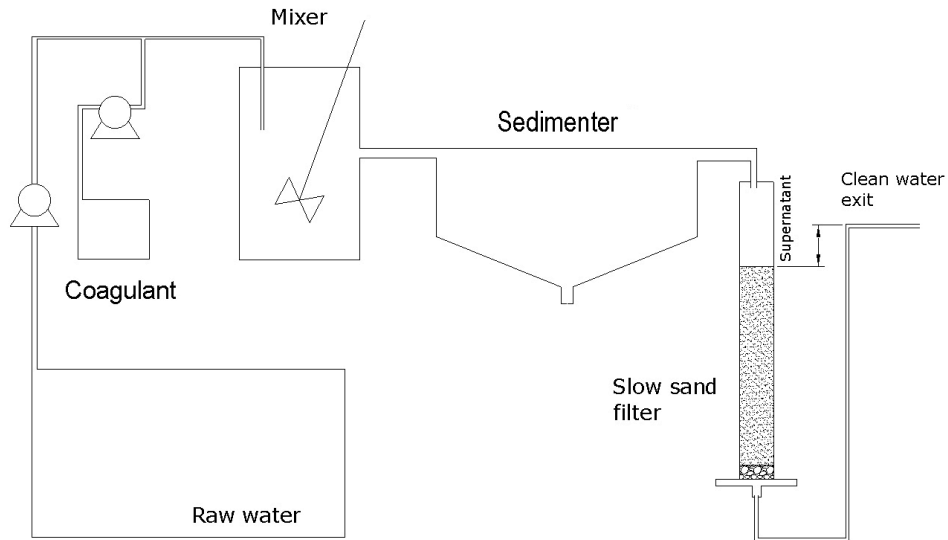


Figure 1. Pilot plant installation

Results and discussion

Figures 2 and 3 present the resulting percentage removal of dye and surfactant. The steady state was reached almost at once, and the percentage removal was high at the end of the process (after the sand filtration). This behaviour is similar in the case of surfactant and dye removal.

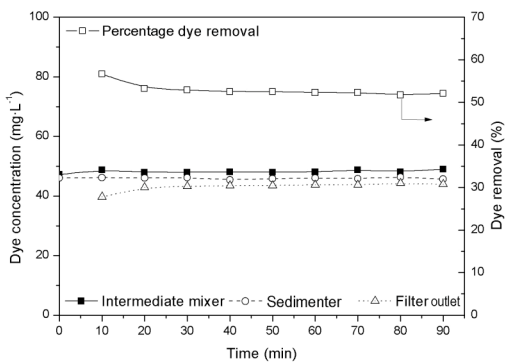


Figure 2. Dye removal

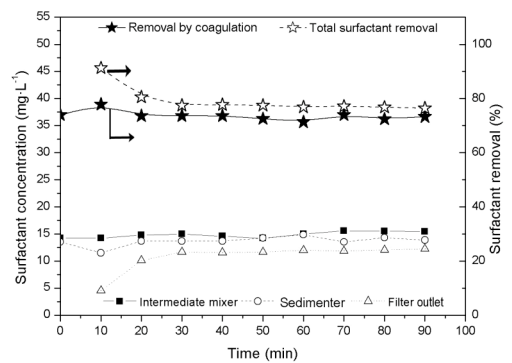


Figure 3. Surfactant removal

One observes that these systems are rather stable processes and the interaction between Tanfloc (and its corresponding active agents) and the molecules of each pollutants presents the high efficacy it was mentioned above.

Conclusions

Tanfloc is a highly effective treatment agent for the two types of wastewater. The pilot plant trials gave a very significant improvement in water quality and its stability allows its implementation in non-advanced technological scenarios. In spite of the continuous flow, the pilot plant studies showed an increase in the quality of the treatment for color reduction and surfactant removal.

Acknowledgments

Authors thank to COMISIÓN INTERMINISTERIAL DE CIENCIA Y TECNOLOGÍA (CICYT) CTQ 2010-14823/PPQ project as well as to JUNTA DE EXTREMADURA under PRI-07A031 project.

References

- Beltrán-Heredia, J., Sánchez-Martín, J. and Solera-Hernández, C. (2009). Anionic surfactants removal by natural coagulant/flocculant products. *Ind. Eng. Chem. Res.* 48(10), 5085-5092.
- Geay, M., Marchetti, V., Clément, A., Loubinoux, B. and Gérardin, P. (2000) Decontamination of synthetic solutions containing heavy metals using chemically modified sawdusts bearing polyacrylic acid chains. *J. Wood Science* 46(4), 331-333.
- Schofield, P., Mbugua, D. and Pell, A. (2001) Analysis of condensed tannins: a review. *Anim. Feed Sci. Technol.* 91(1), 21-40.
- Tramontini, M. and Angiolini, L. (1994) Mannich Bases. Chemistry and Uses. CRC Press, Boca Raton.