TANNIN-DERIVED COAGULANTS FOR MUNICIPAL WASTEWATER TREATMENT

J. Sánchez-Martín*, J. Beltrán de Heredia[2]

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

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

Abstract

A new tannin-based coagulant and flocculant agent has been tested in order to treat urban wastewater. It has showed a high effectiveness in turbidity removal (almost 100% depending on the dosage) and around 50% of BOD_5 and COD removal, which makes it an appropriate coagulant agent with an efficiency that is comparable to alum's. Sedimentation process seems to be a flocculent separation, so Sludge Volumetric Index and its evolution with flocculant dosage was determined. This new type of coagulant has been revealed as a quite effective agent in wastewater treatment, especially for communities with low expertise level or poor technological development.

Introduction

Human activity is a source of wastes. Particularly in urban settlements, wastewater that came from domestic and industrial effluents may be a hazardous, noxious product which should be adequately treated in order to avoid environmental and health implications. 2008 has been actually declared the International Year of Sanitation by the General Assembly of the United Nations through its Resolution A/C.2/61/L.16/Rev.1 dated on December, 4th, 2006. Ineffective sanitation infrastructures facilitates every year 2.2 millions of deaths by diarrhoea, mainly among child under 3 years old, 6 million people blind from *trachoma* and 200 million people infected with *schistosomiases*, just for giving some data (WHO, 2000). Obviously, most of them in developing countries, so appropriate technologies referring urban wastewater may be investigated in order to broad the variety of technical possibilities of treatment.

Researching on other procedures of water treatment has been the scope of this and other papers. For several years, investigators are concerned towards cooperation among developing countries and they are working on alternative process for water treatment, mostly bearing in mind concepts as sustainability, affordability and social feasibility. In this sense, natural coagulants/flocculants are wide-spread, easy-handling resources that are not difficult to work with by non-qualified personal. There are some examples of these agents, as *Moringa oleifera* (Fuglie, 2001) or *Opuntia ficus* (Young et al, 2005). Tannins may be a new source for coagulant and flocculant agents.

Methods

Reagents – Tannin-based coagulant (TANFLOC) was kindly supplied by TANAC (Brazil). $Al_2(SO_4)_3.18H_2O$ has been supplied by SIGMA. All reagents involved in analytical procedures have analytical purity.

Raw water – Raw water was obtained from the Wastewater Treatment Plant of La Albuera, a little town near Badajoz (South West of Spain). This treatment plant was designed some years ago. It receives municipal wastewater from 4,000 people. There are no significative influent of industrial wastewater, but some agricultural and livestock farms are present, so such diffuse pollution may occur. The effluent has a moderately low COD charge. Average incoming flow rate is 41.63 m^3/h. Water involved in this study is collected after previous big solids separation and before oil and sand separation. If compared with other wastewater data found in literature (Gómez-Cerezo et al., 2001) our working water has less pollutant charge, due surely to the nature of dumpings and above all the domestic origin of wastes.

Results and discussion

As a first approaching to the importance of this new flocculant agent, a general test comparing with alum effectiveness has been carried out. Raw water has been treated with 100 ppm of each product in a standard Jar-test procedure, which consisted of 100 rpm for 2 minutes and 30 rpm for 20 minutes, 1-hour settling and samples collected from supernatant clear surface. Both products have demonstrated a high level in clarifying, almost the same in turbidity removal, COD and BOD_5. In the case of $KMnO_4$ oxidability (another measure of organic matter) TANFLOC has revealed a very slight enhancement compared with alum. These results may be seen in figure 1.

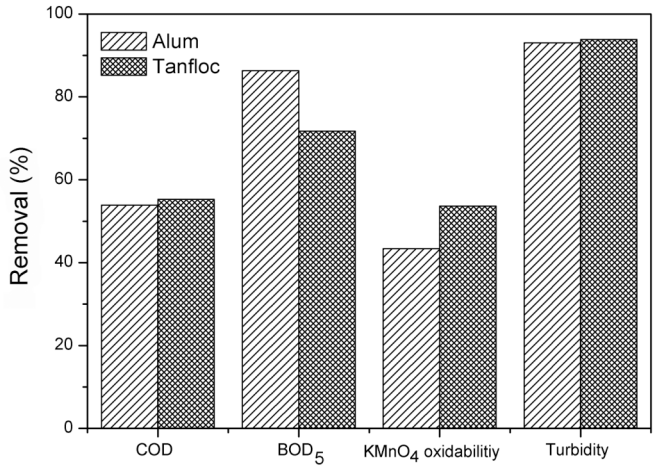

Fig. 1. Comparison with alum.

Using this new tannin-based flocculant may be encouraged attending to three main aspects:

a) Natural origin of TANFLOC makes it more affordable and more available than alum, as it can be synthesized directly *in situ*.
b) pH adjustment is not needed in TANFLOC water treatment, so reagents saving is guaranteed.
c) Several health considerations may be done referring Alzheimer's disease and alum (Flaten, 2001).

Trials with dosage variation have been carried out. Flocculant dosage has been varied between 0 and 150 ppm. As it can be appreciated in figure 2, turbidity removal increases quite quickly with flocculant dosage. 80%-effectiveness is achieved rather fast, with no more than 40 ppm of TANFLOC. Almost a total turbidity removal appears with dosages around 100 ppm. These results are quite competitive to those reported by other researchers. For example, Sansalone and Kim (2008) has recently used up to 150 ppm of alum ($Al_2(SO_4)_3.18H_2O$) and up to 100 ppm of iron chloride ($FeCl_3$) to achieve a turbidity reduction of 75% in a similar municipal wastewater.

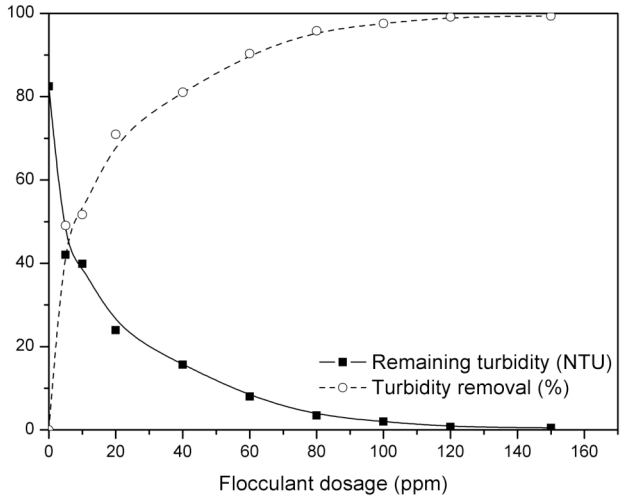

Fig. 2. Turbidity removal with coagulant application

Conclusions

The appropriate treatment of water and wastewater drives to the need of new and more efficient systems that should be feasible for small communities with low technical level. Tannin-derived coagulants, such as TANFLOC, represents a real alternative to traditional products, since its application leads to an almost total removal of turbidity and similar COD, BOD_5 and $KMnO_4$ oxidability removal levels.

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

WHO, World Health Organization (2000). Global Water Supply and Sanitation Assessment Report. Geneva-London.

Fuglie, L. (2001) The miracle tree. The multiple uses of Moringa oleifera. CWS, Dakar.

Young, K.; Anzalone, A. and Alcantar, N.A. (2005) Using the Mexican cactus as a natural based process for removing contaminants in drinking water. Polym. Mat. Sci. Eng., 93, 965-966.

Gómez-Cerezo, R.; Suárez, M.L. and Vidal-Abarca, M.R. (2001). The performance of a multi-stage system of constructed wetlands for urban wastewater treatment in a semiarid región of Spain. Ecol. Eng., 16(4), 501-517.

Flaten, P. (2001) Aluminium as a risk factor in Alzheimer's disease, with emphasis in drinking water. Brain Res., 55(2), 187–196.

Sansalone, J. and Kim, J–Y. Suspended particle destabilization in retained urban stormwater as a function of coagulant dosage and redox conditions. Water Res., 42(4–5), 902–922.