



**UNIVERSIDAD
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**TREATMENT OF FLORENCIA-CAQUETÁ
MUNICIPAL WASTEWATER BY THE
COMBINATION OF BIOLOGICAL PROCESSES
AND FENTON-TYPE ADVANCED OXIDATION
PROCESSES**

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SUMMARY

In developing countries, small cities such as Florencia-Caquetá (Colombia), municipal wastewaters (MWW) are directly disposed on environmental aqueous media without any treatment. Consequently, contaminants of emerging concern (CECs) as pharmaceuticals reach natural water bodies. These CECs have the potential risk for the environment due to their persistence properties and biological activity. Under such context, research about technologies to treat MWW and eliminate CECs are needed.

Considering the absence of efficient municipal wastewaters treatment plants in Florencia-Caquetá, the present doctoral thesis was focused on the treatment of MWW by alternative and conventional processes considering local economic and environmental conditions. It was evaluated the combination of biological treatments with solar photo-Fenton (SPF) at near neutral pH.

The thesis is organized in six chapters. Chapter 1 contains the research background, i.e., the problem statement, the conceptual framework about biological processes and photo-Fenton, the objectives as well as the new contributions of the thesis. In Chapter 2 is presented the characterization of MWW from Florencia-Caquetá in terms of global parameters (e.g., chemical oxygen demand, pH, organic matter content, conductivity, etc.) and presence of relevant CECs (e.g., pharmaceuticals). In Chapter 3 is depicted the treatment of MWW from Florencia through two biological systems (aerobic or anaerobic) at lab-scale. Initially, the acclimatization of microorganisms to the water sample was studied. Afterwards, the action of the stabilized biological systems to remove four representative pharmaceuticals (selected from Chapter 2) and biodegradable organic matter in the MWW from Florencia was established. The processes efficiency was tested by monitoring the concentration of pharmaceuticals, the removal of total organic carbon (TOC) and evolution of nitrogen forms (NH_4^+ , NO_3^-).

In Chapter 4, the application of solar photo-Fenton process for treating the representative pollutants at lab-scale is presented. Also, the improvement of SPF performance by Amazonian fruit extracts is considered. This chapter analyzes the limitations of classical photo-Fenton for degrading the target pharmaceuticals and it

shows the possibility of addition of Amazonian fruit extracts (copoazu, canangucha and coffee) as complexing agents of iron to enhance the degrading ability of SPF process for treating MWW. The performance of process was evaluated as a function of removal efficiency of organic matter and pharmaceuticals present in MWW from Florencia. Additionally, the evolution of dissolved iron and peroxide consumption were monitored.

Chapter 5 deals with the combination of the biological processes with SPF for treating MWW from Florencia. It was evaluated the effect of combination order (first biological process and second SPF or vice-versa) at lab scale. In Chapter 6, it is initially described the acclimatization of a pilot biological reactor (which was operated under non-controlled conditions of temperature, humidity and pH). Then, the combination at pilot scale of the SPF process (in presence of an extract of Amazonian fruit) and a biological system to treat MWW from Florencia is shown. It was evaluated the ability of combination to remove target pollutants and organic matter, in addition to evolution of nitrogen species.

The development of this research work provides new information about: i) the occurrence of CEC in raw MWW from Florencia-Caquetá (which could be used as a primary indicator of pollution of water environment of the Colombian Amazonia); ii) A green solar photo-Fenton process at natural pH promoted by Amazonian natural products as iron complexing agents; iii) the use anaerobic treatment in combination with SPF for the elimination of CECs and mineralization of organic matter present in MWW; and iv) combination of an anaerobic biological process with SPF at pilot-scale, which represents a useful background for the construction of systems at a bigger scale and its subsequent application to MWW in Florencia or other towns belonging to Colombian Amazonia.