

**Tesis: Modelación matemática del tratamiento anaerobio de aguas residuales urbanas incluyendo las bacterias sulfatorreductoras. Aplicación a un biorreactor anaerobio de membranas**

**ABSTRACT**

With the increase in both population and goods and services demand on a global scale, there has been a decrease in the quality and availability of water. This shows the need for a change of society's mentality. This change should include both a tightening of laws to prevent pollution, and the development and implementation of more efficient, sustainable and environmentally-friendly wastewater treatment technologies.

Currently, in most developed countries, urban wastewater treatment is based on activated sludge processes. These systems are characterized by high energy consumption and high biological sludge production, which must be stabilized prior to reuse or disposal. An alternative to these classical technologies is based on anaerobic processes, whose implementation involves more sustainability (lower costs and energy consumption, and lower environmental impact). However, it is necessary to overcome the limitations associated with the slow growth rates of anaerobic biomass (compared with aerobic microorganisms) and the low efficiency in biomass separation by sedimentation processes. To overcome the aforementioned drawbacks, anaerobic degradation of organic matter can be combined with a membrane filtration process. This allows a high sludge retention time without increasing the reaction volume and high effluent quality can be achieved.

One advantage of anaerobic systems is the energy recovery from organic matter in the form of methane. However, when there is sulphate present in the water the sulphate-reducing bacteria will grow and compete with the other microorganisms for the substrates. This reduces the efficiency of methane production, and generates hydrogen sulphide (sulphidegenesis), which inhibits the biological processes and reduces the quality of the produced biogas.

Due to the importance of sulphidegenesis process in wastewater treatment systems, several authors have proposed mathematical models that include the biological, physical and chemical processes associated with sulphate-reducing bacteria. However, there are no global models to simulate this process in combination with the processes taking place in the whole wastewater treatment plant. Also noteworthy is the absence of a systematic methodology for parameter calibration in anaerobic wastewater treatment models.

The main aim of this thesis is the mathematical modelling of anaerobic treatment of urban sulphate-rich wastewater. To this end, a mathematical model capable of describing the biological process of sulphate reduction has been developed and a methodology for parameters calibration has been proposed. The developed model has been incorporated into the global model Biological Nutrient Removal Model No. 2 (BNRM2).

Both the model and calibration methodology have been validated by simulation using the software DESASS. The results predicted by the model have been compared with the experimental values obtained in an anaerobic membrane bioreactor at semi-industrial scale.