Virtual labs development using Easy Java Simulations for the study of the micropollutant removal by solar photo-Fenton in secondary WWTP effluents

José L. Casas[1,*], Ana B. Esteban[1], M. Guadalupe Pinna-Hernández[1], José L. García[1], José L. Guzmán[2], José A. Sánchez[1]

*e-mail: **jlcasas@ual.es**

[1] Universidad de Almería, Departamento de Ingeniería Química, Escuela Superior de Ingeniería, Ctra. de Sacramento s/n, Almería, España

[2] Universidad de Almería, Departamento de Informática, Escuela Superior de Ingeniería, Ctra. de Sacramento s/n, Almería, España

Introduction

The micropollutant removal from secondary WWTP effluents by solar photo-Fenton is currently one of the most successful applications of solar photochemistry. The photo Fenton process is considered as an advanced oxidation process, and is a photochemically system that involves the generation of highly oxidant species from the reaction of iron salts with hydrogen peroxide. The evaluation of the process requires the simultaneous resolution of systems of algebraic and differential equations. These equations are considered as the dynamic model of the system, whose analytical resolution is not always possible to achieve in an easy way. The obtaining of results from the mathematical model is carried out through dynamic simulation for which the need for the development of tools that refer to the study of the process autonomously by students is raised. Virtual teaching labs are software tools that can be used locally and remotely and through the use of a model and together with an experimentation interface simulate the main aspects of a real plant, allowing the student to perform the same operations as in a laboratory traditional but virtually.

Teaching working group: Virtual labs for the study of dynamic processes in chemical engineering

The general objective of the teaching working group is the development of a repository of virtual labs and interactive tools to be apply in teaching of Chemical Engineering in different courses subjects. For this, the teaching working group aims to generate resources and teaching materials that promote autonomous learning and the practical application of knowledge through advanced simulation tools programmed through Easy Java Simulations.

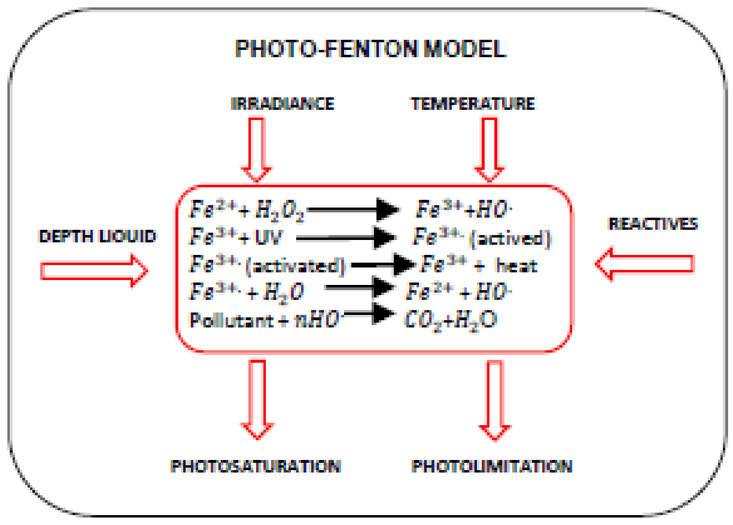
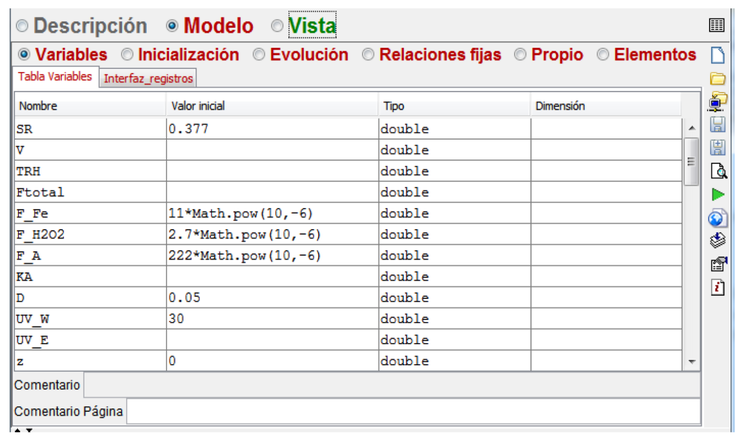


Photo fenton reaction model

Objective

To develop a virtual lab based on Easy Java Simulations for the simulation of the micropollutant removal using the solar photo-Fenton process, implementing the continuous process model. With this, it will be possible to carry out a simulated follow-up of the evolution of the different variables of the system in addition to the possibility of interacting with it.



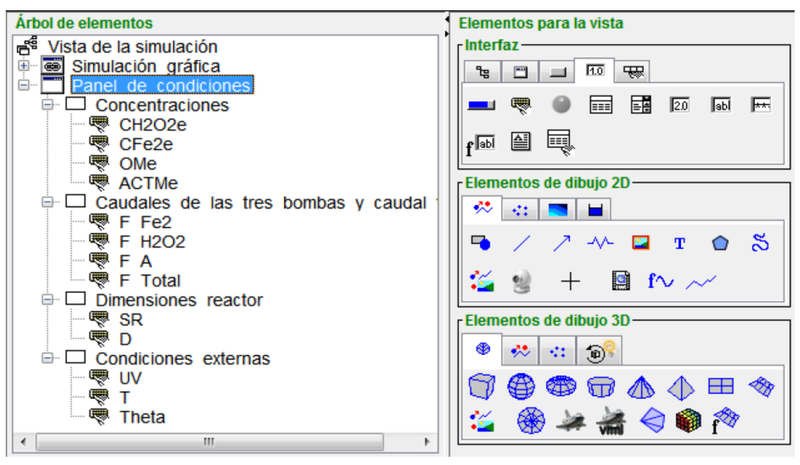
Subchannel page for the definition and initialization of the process variables

Simulating with Easy Java Simulations (EJS)

The Easy Java Simulations program was specifically designed to create simple and fast interactive scientific simulations, usually for teaching or learning purposes. It was created by the professor of the Department of Mathematics of the University of Murcia, Dr. D. Francisco Esquembre within the Open Source Physics.

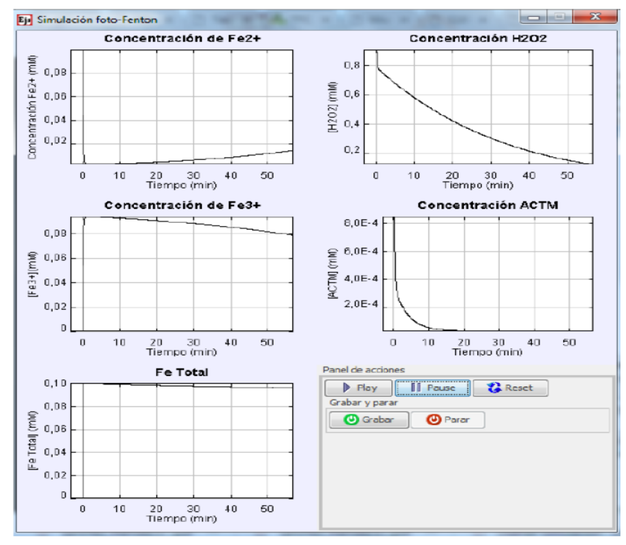
Users are students and teachers who have a basic knowledge of programming and who, being able to describe the models of the phenomena of each discipline in terms of algebraic and differential equations, cannot afford the large amount of time needed to create a complete graphic simulation.

Using Easy Java Simulations base, a design was made to allow a person who wants to create a simulation, to concentrate most the time in writing and refining the algorithms of the scientific model and consume short time in programming techniques. Being a great help for the teacher.



The view development window allow to included sliders to modify the process variables (reagents concentrations, flow rates, liquid depth, irradiance, reactor dimensions and external …).

During the execution of the simulation, a figure showing the dynamic concentration profiles of the different species involved in the process are obtained



EJS Interactive tool for wastewater tertiary treatment by solar photo-Fenton

This work focuses on the development of a virtual laboratory for the study of the photo Fenton process in raceway photoreactor (RPR) for the micropollutant removal of secondary WWTP effluents. The developed virtual lab is a valuable aid for both teaching and research in this subject. It helps to learn how a RPR works and to understand how the essential variables involved in the photo-Fenton process behave and interrelate between each other. As the treatment capacity of a RBR is to a great extent dependent on both hydrodynamic and geometric parameters, using this interactive tool, the performance of a specific design can be analysed. This can help either to address any issues that occur during photo Fenton process or to provide solutions in the design of an optimal RPR, resulting an interesting way of achieving the highest treatment capacity.

References

[1] Alfonso Urquía y Carla Martín. (2007). Aplicación de la simulación por ordenador a la enseñanza de las ciencias. Programa de Formación del Profesorado y Formación Continua de la UNED.

[2] Francisco Esquembre. Sitio oficial de Easy Java Simulations, https://www.um.es/fem/EjsWiki/