Development of an interactive tool for biological models into the microalgae-based wastewater treatment

A. Sánchez-Zurano[1], J.L. Guzmán[2], F.G. Acién[1], J.M. Fernández-Sevilla[1]

1Dep. of Chemical Engineering, University of Almería, Ctra. Sacramento s/n, ceiA3, CIESOL, Almería, 04120, Spain
2Dep. of Informatics, University of Almería, Ctra. Sacramento s/n, ceiA3, CIESOL, Almería, 04120, Spain

I. INTRODUCTION

Microalgae-based wastewater treatment is performed by complex microalgae-bacteria consortia which varies as a function of the environmental and operational conditions, especially the composition of the wastewater being processed (COD, N, P, etc). During the last decades, different types of mathematical models have been developed for understanding the interaction between microalgae and bacteria in wastewater treatment systems. However, due to the complexity of these models and the high number of parameters, it is very difficult to understand and analyze the effect of all of them in a simple way. As a result, many simulations should be carried out in order to study the effect of all the components involved in the process.

Interactive tools and virtual laboratories have been presented as tools that allow to simulate highly complex models and control systems quickly and easily. Especially, the interactive tools provide a high potential allowing a real-time interaction between the modification of parameters and the visualization of results. In essence, interactive tools show a graphical interface with dynamic and clickable components, which can be changed in order to visualize the system response immediately, which naturally lends itself to interactivity.

II. INTERACTIVE TOOL

BIOLOGICAL MODEL

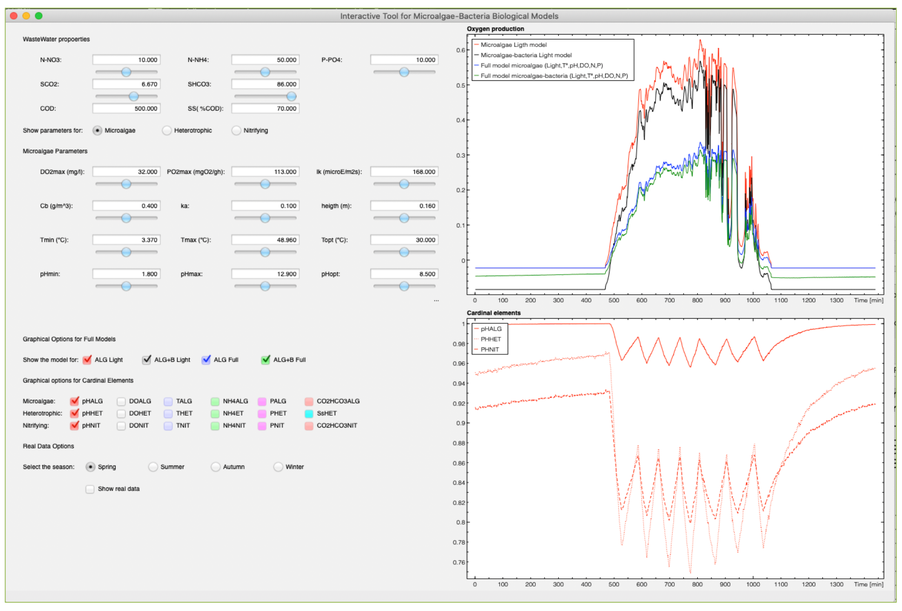
$$PO2_{ALG} = PO2(I) \cdot \overline{PO2(T)} \cdot \overline{PO2(pH)} \cdot \overline{PO2(DO2)} \cdot \overline{PO2(CO2)} \cdot \overline{PO2(N)} \cdot \overline{PO2(P)} - RO2(I)$$

$$RO2_{Het} = RO2max \cdot \overline{RO2(T)} \cdot \overline{RO2(pH)} \cdot \overline{RO2(DO2)} \cdot \overline{RO2(N)} \cdot \overline{RO2(P)} \cdot \overline{RO2(Ss)}$$

$$RO2_{Nit} = RO2max \cdot \overline{RO2(T)} \cdot \overline{RO2(pH)} \cdot \overline{RO2(DO2)} \cdot \overline{RO2(CO2)} \cdot \overline{RO2(N)} \cdot \overline{RO2(P)}$$

$$PO2 = PO2_{ALG} - RO2_{Het} - RO2_{Nit}$$

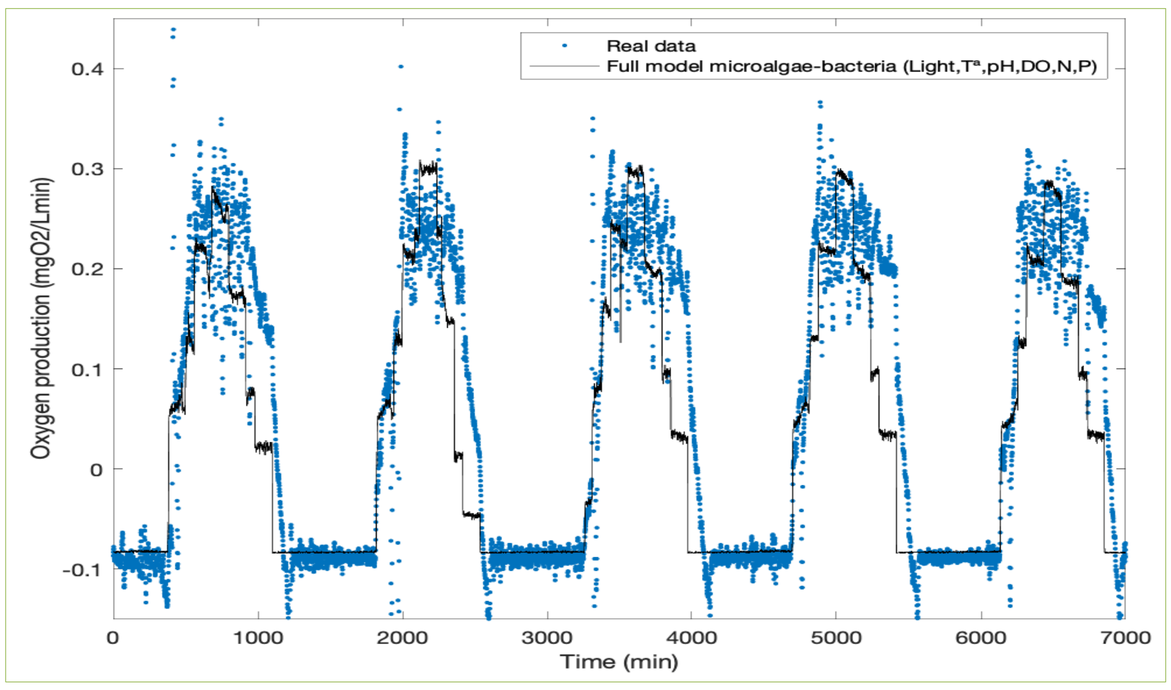
INTERACTIVE TOOL: Sysquake (MATLAB)



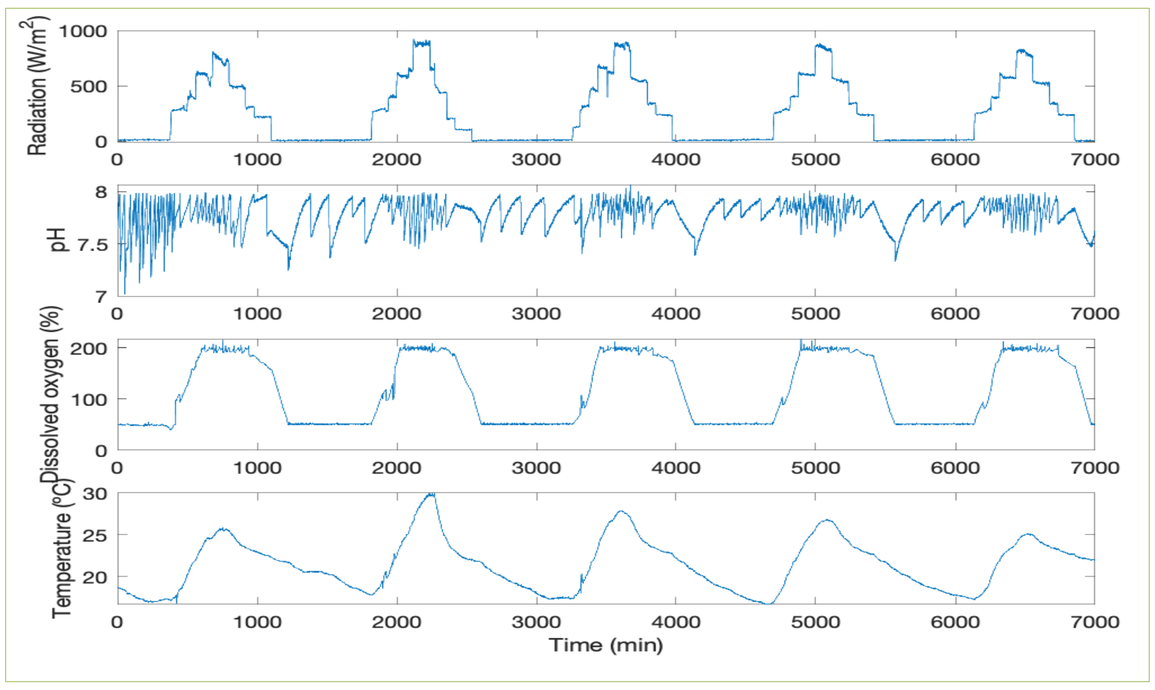
REAL DATA

III. RESULTS

Experimental validation of the full microalgae-bacteria model proposed

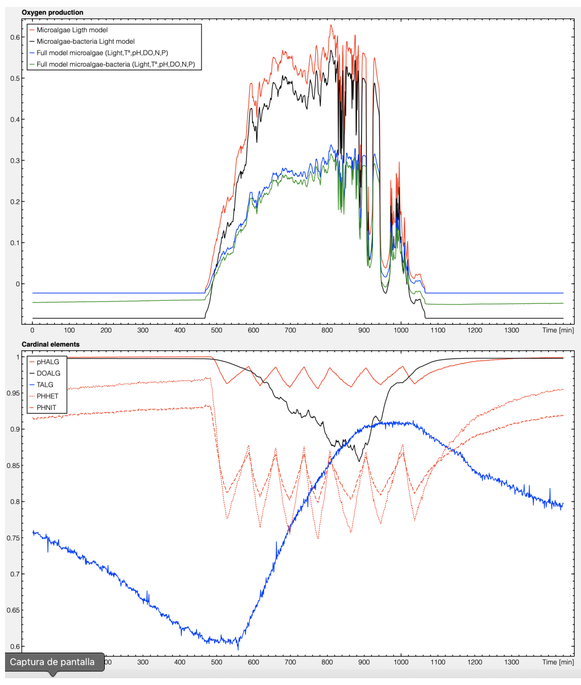


Real input used for the validation

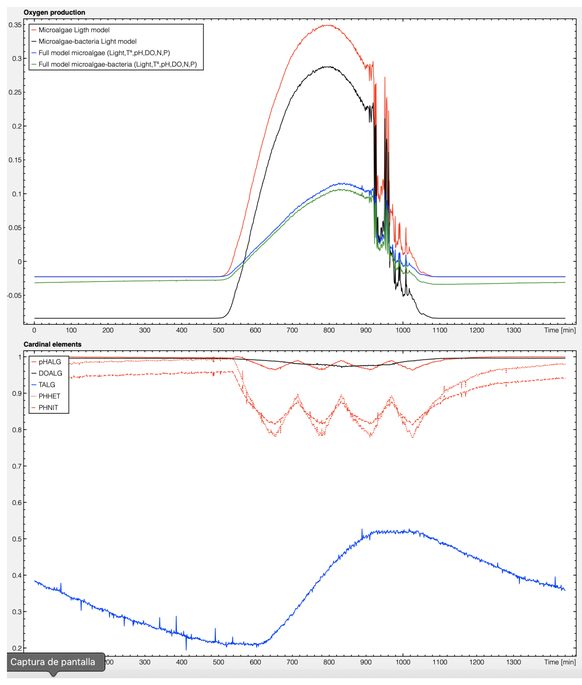


An example: Production of *Scenedemus almeriensis* using primary domestic wastewater as a nutrient source

SPRING



WINTER



In the example, it is observed that during spring season, the temperature in the light hours raise up to 24-25 ºC, which are considering favorable values for the microalgae strain evaluated (*Scenedesmus almeriensis*). However, when it is evaluating the oxygen production in winter, the situation is markedly different due to the low temperatures (10-15ºC). No different effect respect to the rest of variables (dissolved oxygen and pH) between both seasons. Temperature has remarkable effects on microalgae systems which implicated that below or above optimal temperatures, the activity drastically decreases.

Parameters ($mg \cdot L^{-1}$)	Primary Wastewater
COD	500
$N\text{-}NO_3$	2.4
$N\text{-}NH_4$	62.6
$P\text{-}PO_4$	11.3

IV. CONCLUSIONS

✓ The interactive tool is a promising alternative not only for understanding microalgae-bacteria processes, but also it is a possible solution to predict the productivity of microalgae-bacteria system and consequently, to avoid long experiments, waiting time, and additional costs.

V. REFERENCES

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