

# IMPLEMENTATION OF AN EXTREMUM SEEKING CONTROLLER IN A UASB-REACTOR

*4th Frech-Chilean Workshop on Bioprocess Modeling*

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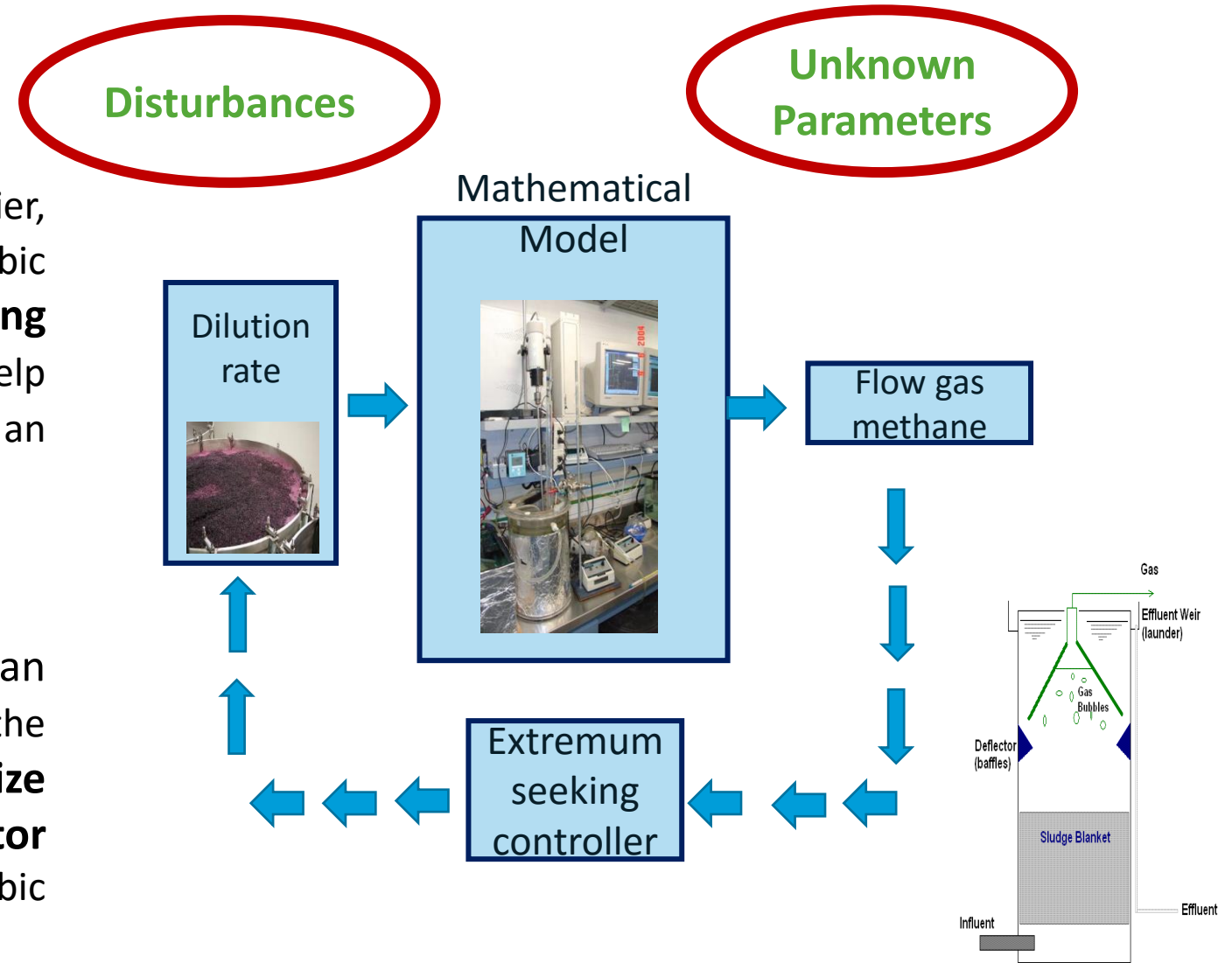
# OUTLINE

- I. Problematic
- II. Justification
- III. System modeling
- IV. Results
- V. Test robust
- VI. Future work
- VII. References

# PROBLEMATIC

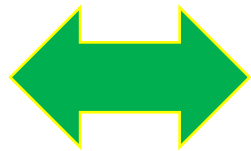
As a renewable and clean energy carrier, **methane**, obtained from the anaerobic biodegradation of waste is **an emerging technology** with a **high potential** to help addressing **the current energetic** an environmental problem [3].

The objective of this work is to **implement** an **optimization strategy on-line**, through the Extremum Seeking Control to **maximize methane production** in a **UASB reactor** (Upflow Anaerobic Sludge Blanket) of an anaerobic process applied in the **wine** industry.



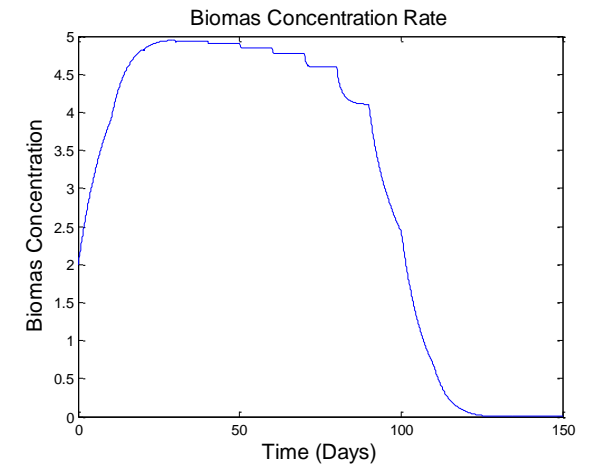
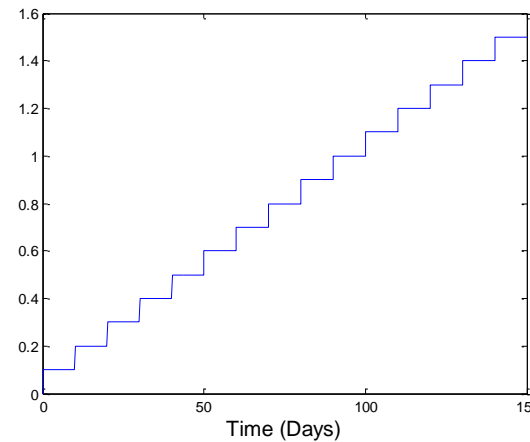
# JUSTIFICATION

- Applicable in situations where there is a non-linearity in the control problem and the **nonlinearity** has a **local minimum** or **maximum** [2,4].
- On-line optimization.
- Not based on the mathematical model.
- Maximum level methane production rate.
- **Robustness** of the disturbance models.

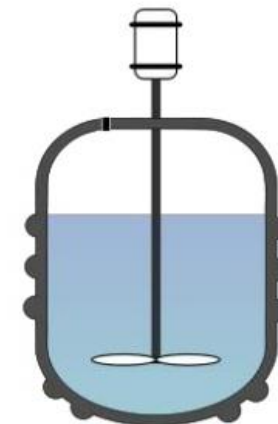


FREE SOFTWARE

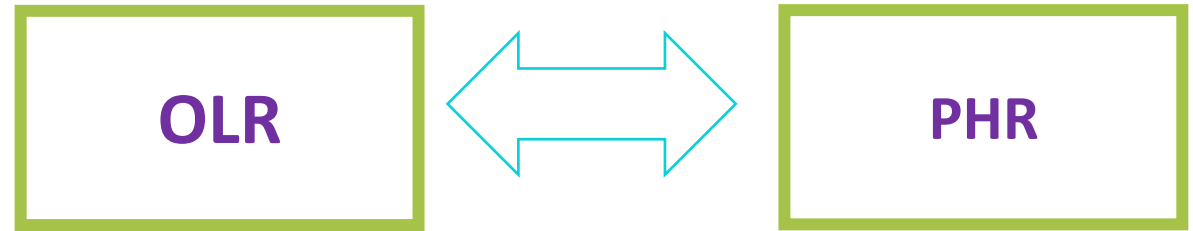
## Dynamic model of a continuous stirred tank reactor.



### Biotechnological Process

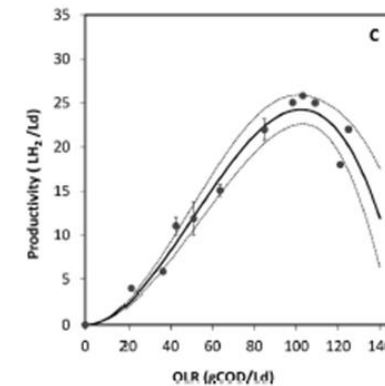
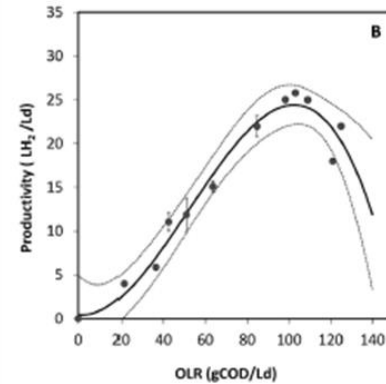
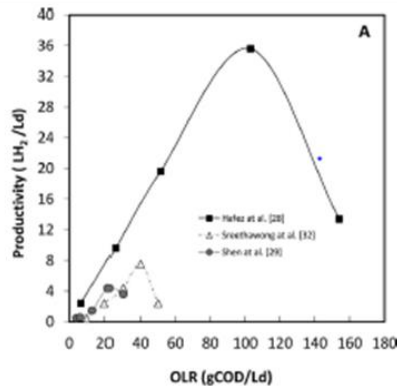


# SYSTEM MODELING



## ➤ STATIC MAP

*On-line heuristic optimization strategy to maximize the hydrogen production rate in a continuous stirred tank reactor.*



## ➤ DYNAMIC MAP

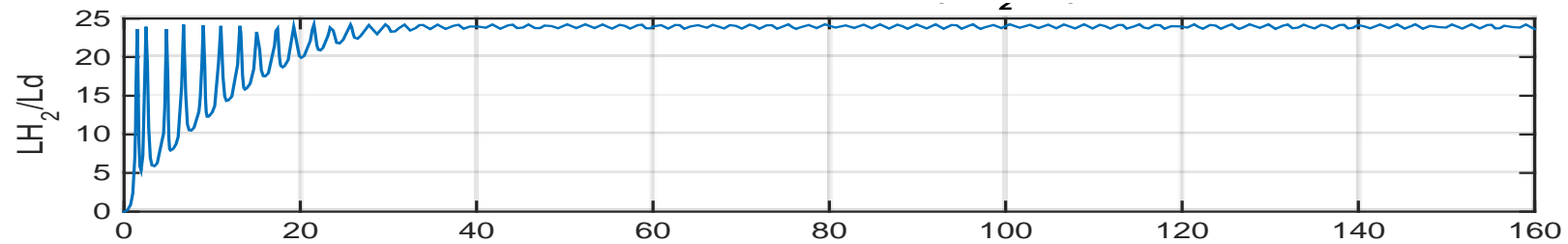
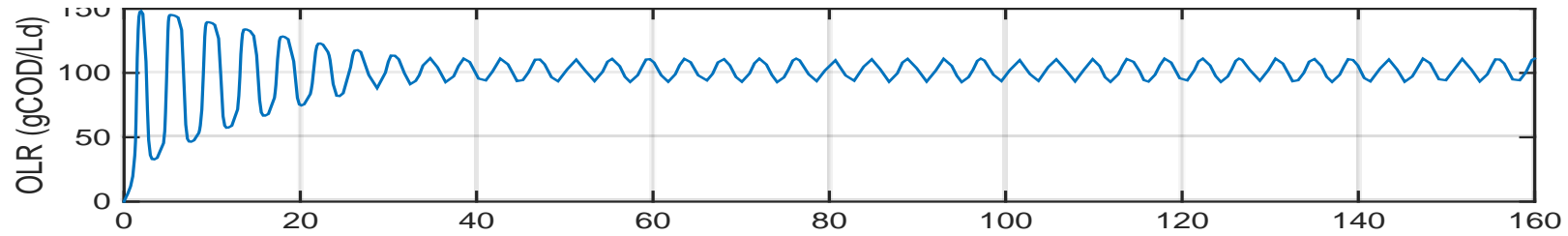
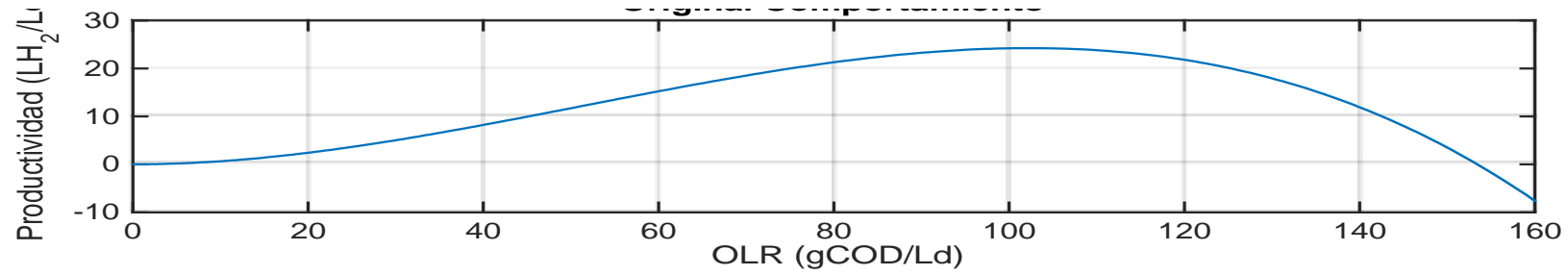
- a) Anaerobic Digestion Model No.1 (**ADM1**) by Rosen, C. and Jeppson, U. reference BSM2 [2].
- b) 35 state variables. ( Biomass, Sugar, Flow Gas)
- c) **Parameters** kinetics and physic-chemistry and Biochemistry



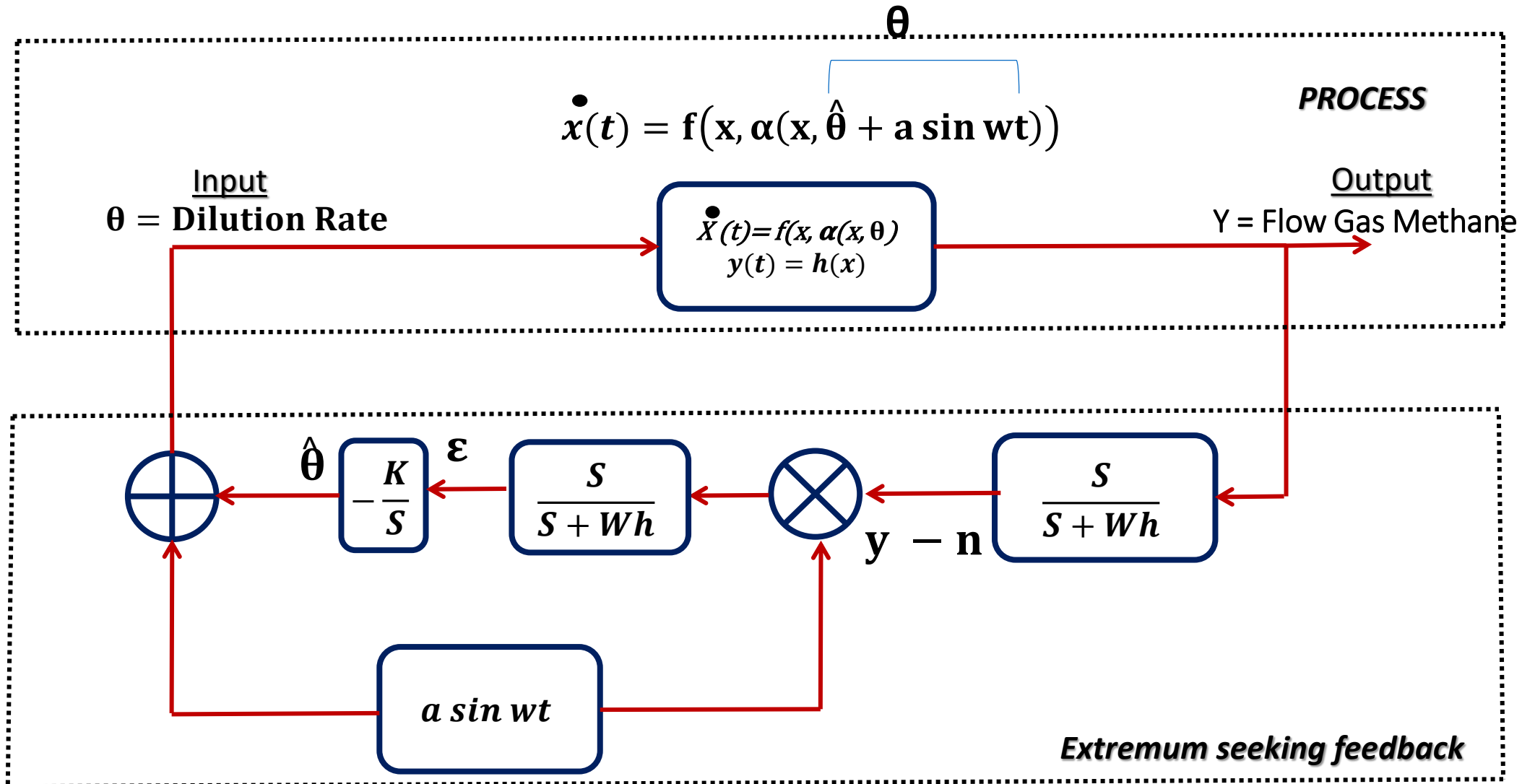
Find an input optimal

Maximize HPR

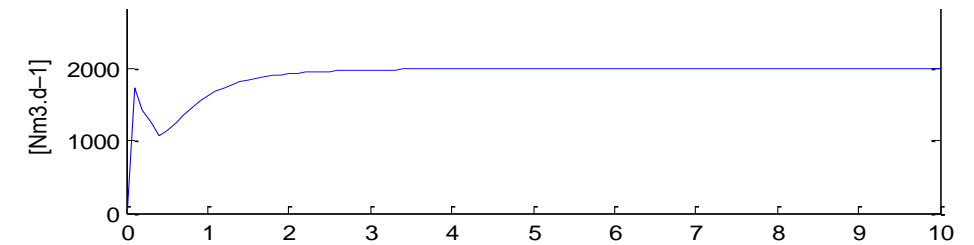
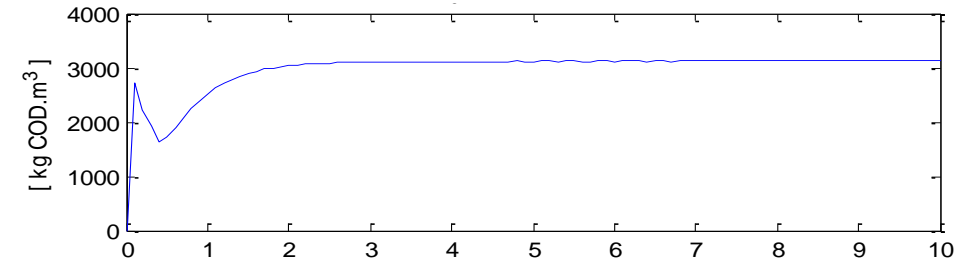
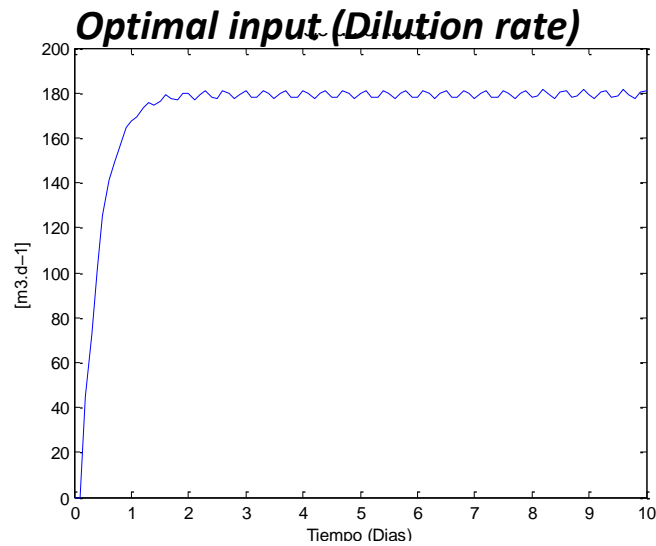
ESC Improve



# EXTREMUM SEEKING CONTROL VIA THE DILUTION RATE



# RESULTS. Law close-loop

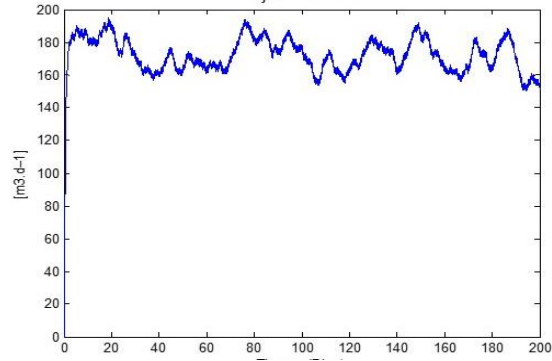


**Optimal output (Flow gas total and Flow gas methane)**

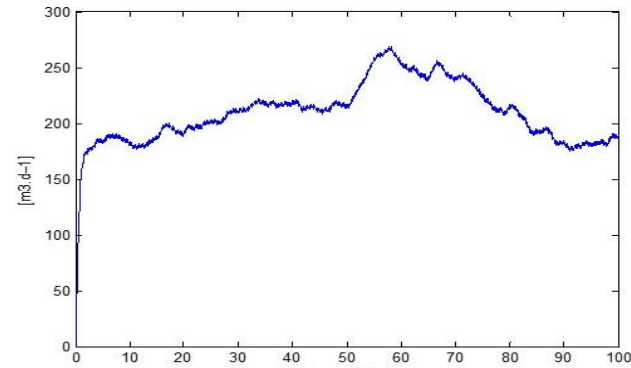
**Extremum  
seeking  
controller**

# TEST ROBUST

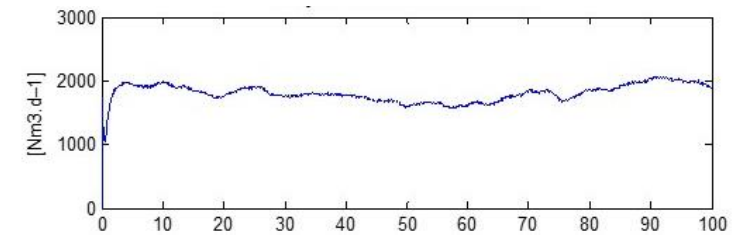
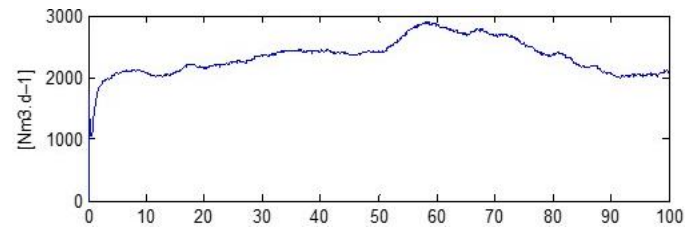
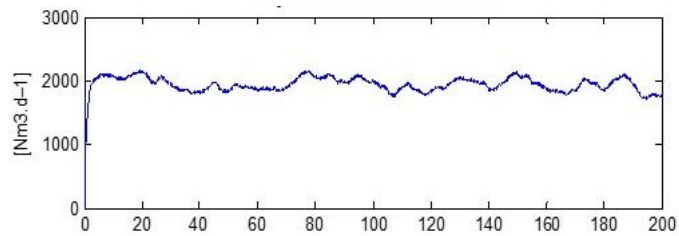
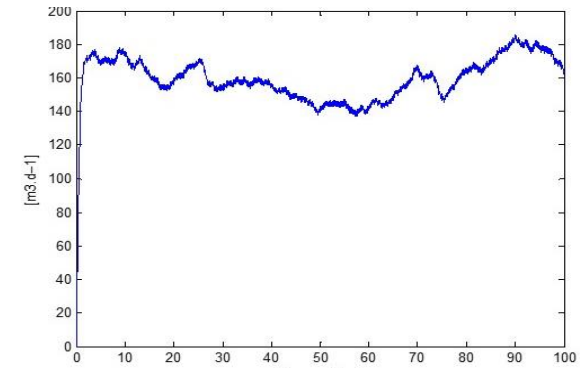
White noise to the output variable.



Variation of the Chemical Oxygen Demand. (Disturbance)



Variation of the kinetic parameters.





# REFERENCES

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- [4] K. B. Ariyur and M. Krstic, *Real-time optimization by extremum-seeking control*. John Wiley & Sons, 2003.
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