WP6: Activity Report

November 04- April 05

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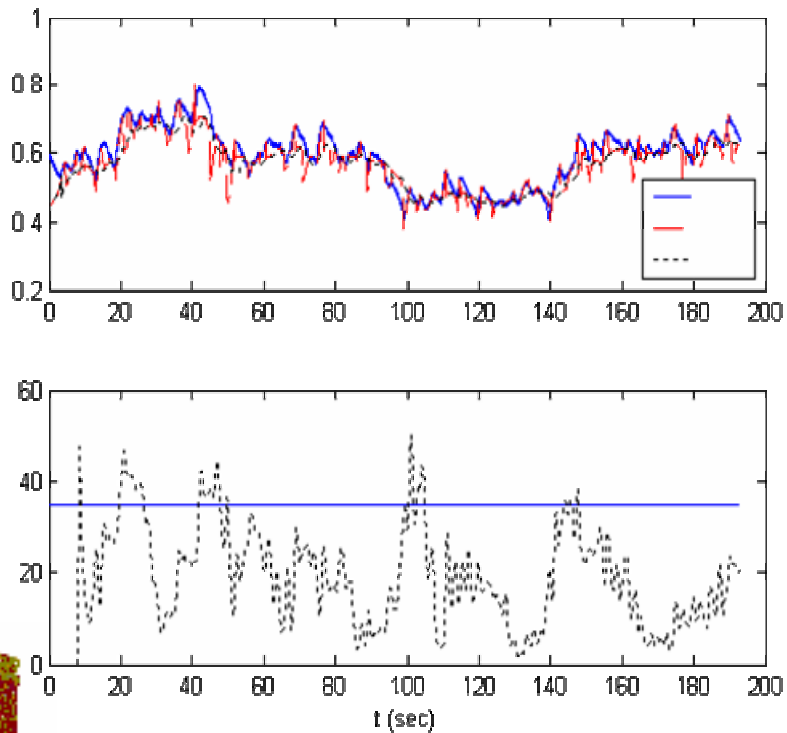
Activities

A1: Improvement of the FDI method for the valve by DPCA, considering physical constraints.



Valve output and residual with changes in the set point without faults

REMARK: An adaptive threshold will be implemented

Activities

A2: Adjusted of the parameters in the FDI method for the membrane of the DOx.

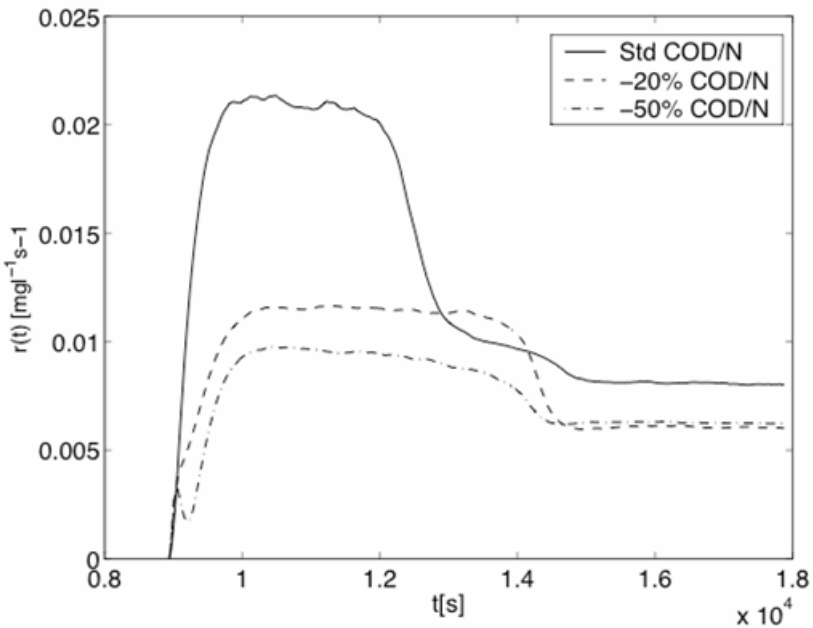
$$\int_{h_1}^{h_2} i(t)\,dt = i_{ss} \sum_{n=1}^{\infty} f_{nl}(\tau, n, h_1, h_2)$$

h1 (s)	I/iss	Estimated value	% estimation error
2	5.1198	59-9988	0.0033
4	7.2421	59.9985	0.0025
6	8.9001	59.9990	0.0016
7	9.6578	59.9997	0.0005
8	10.4019	60.0002	0.0003
10	11.8980	60.0011	0.0018
12	13.4554	60.0025	0.0045

REMARK: initial time h1 between [7,8] s is suggested

Activities

A3: Analysis of the abnormal condition (nitrite accumulation) in the POLIMI reactor considering all the stored experiments.



The r(t) evolution confirms that there is causal link between COD/N ratio in the influent and the respiration rate

REMARK: More details of the cause effect relation has not been obtained until now.

Activities

A4:Search of redundancy relations for the respiration rate *r(t)* to monitor the process

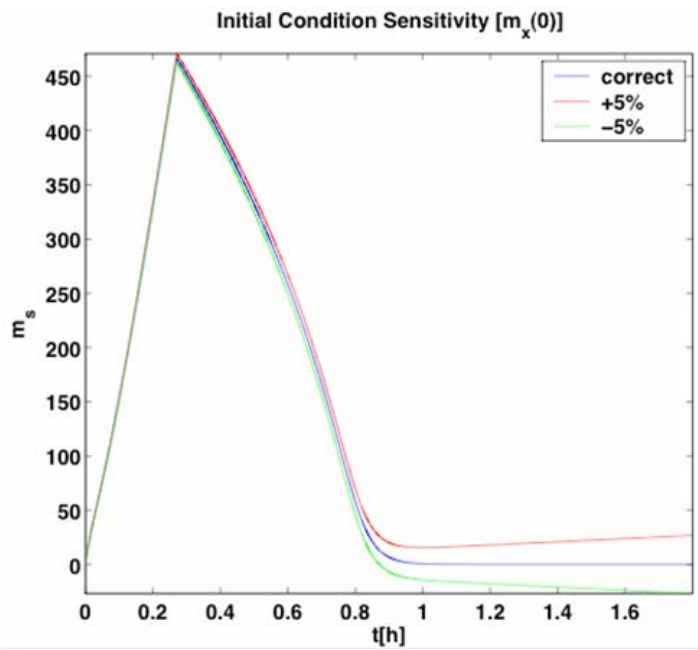
Idea: One relation could be obtained assuming that r(t) is estimated from the DO, and the other could be evaluated using the SS of WP4.

Result: The structural model analysis has shown that the system is causal, if the initial values of mx(0) and ms(0) are known.

REMARK: A sensitivity analysis of the SS is required

Activities

A5: Sensitivity analysis o the SS with respect to nominal values of the parameters model given in WP2.



REMARK: The SS sensitivity does not allow to estimate the initial condition of the states

Interaction Activities

- To get a respiration rate redundancy relation which is necessary to solve a FDI issue with analytical methods, the deliverables of WP4 were considered. In particular the idea was to estimate the internal behavior of the EM1 reactor and from them to build the required respiration rate.
- To establish the causal model for the POLIMI reactor, participants of WP6 established a communication with POLIMI. The data reported in WP1 for the POLIMI reactor were analysis together.

WP6-M1 Milestones

The FDI system for EOLI assumes three cause of faults:

1) Damage in the sensor of *DOx* membrane,

2) Damage in a generic valve with control

3) Faults in the aeration system

4) Diverse ab-normal conditions in the process during the reaction time; the specific cases are:

- **The case of nitrification/denitrification problem for the POLIMI reactor.**
- **Deviations of the parameters *Ki* and *Ks* from the normal values given by WP2 with a fixed reaction time.**
- **Incomplete reaction cycle when a open loop control is implemented.**

REMARK: The first milestone of WP6 has been achieved.

WP6-M2 Milestones

1) The monitoreability of the process by the model given in WP2 with the measured variables is very sensitive, even by simulations. Then, only some part of the cycles and subset of variables of the process can be monitored.
2) A fault detection algorithm for a damage in the *DOx* membrane has been tested and adjusted by simulations.
3) A fault in the aeration system of the reactor can be detected estimating the parameter *Kla* online, each cycle of the process.

WP6-M2 Milestones

4) The existence of substrate at the end of the reaction cycle is considered as a fault in the process and can be detected on-line using the pattern of the *DOx*. More details (IFAC-July 05)

5) The DPCA has been used to detect faults in a generic valve. The adjust of an adaptive threshold is under developed.

6) Qualitative Pattern recognition methods for abnormal conditions are been considered as the only way to supervise the evolution of the reactor during a set of cycles. Particular procedures are under developed for *Ki* and *Ks* values.

REMARK: second milestone of the WP6 and D6.1 are partially achieved

WP6-M3 Milestones

1) The detection of faults in the *DOx* sensor has been validated by simulation. Real experiments has not been carried on, because of the absence of an unoccupied sensor in which hardware modification could be feasible.
2) The detection of substrate as an abnormal condition at the end of the reaction cycle has been tested by simulation and with data off line.
3) The detection of faults in the valve has been partially tested by simulation and the improvement of the algorithm is under developed.
4) The rest of the validation results to achieve the third milestone of WP6 and D6.2 are scheduled for the last semester of the project.

REMARK: Some FDI algorithms cannot be tested in a real process

Planning

- The design of the FDI algorithm based on DPCA and adaptive threshold to detect and isolate valve faults must be finished and the validation will be done by simulation of artificial faults.
- All the FDI methods for the abnormal conditions will be integrated to have a simple tool for the operator of a SBR which can be used by the supervision system WP7.
- Validation of the tool for the operator using artificial faults.
- Write the final report and finish D6.1 and D6.2.