INCO : International Scientific Cooperation Projects (1998-2002)

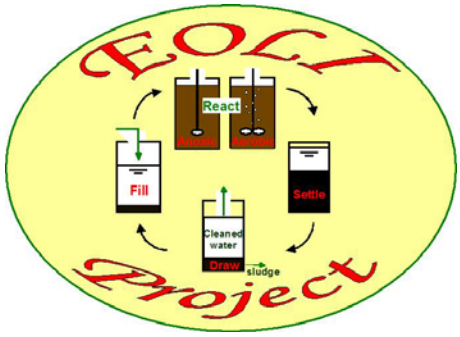
Contract number : ICA4-CT-2002-10012

WP8 results (from WP5) at UNAM
REPORT covering period from 1 November 2004 to 1 May 2005

Efficient Operation of Urban Wastewater Treatment Plant (EOLI)

Project homepage : http://www.auto.ucl.ac.be/EOLI/

Keywords : wastewater treatment (WWT), aerobic digestion, sequencing batch reactor (SBR), monitoring, control system



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TITLE : Efficient Operation of Urban Wastewater Treatment Plant (EOLI)

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SUMMARY

Within WP5 UNAM studies the aerobic SBR uses for treating toxic wastewaters. In previous periods a control strategy was developed, the Event Driven Time Optimal Control (EDTOC), which demonstrated being able to solve the desired optimizing criteria, for the given restrictions, both in standard and shock lab-scale experiments.

During the reported period, following the WP8 interactions policy, UNAM-WP5 has performed the redesign of the EDTOC software for both, a lab-scale and a field-scale, Sequencing Batch Reactors (SBRs), using the integration criteria given by SPES six months ago, during the last meeting at Milan. Modbus protocol tests were performed in the field-scale SBR platform to assure that other WP results could be smoothly integrated, when delivered, to the WP5 modules already working.

REPORT

The original programming made for the lab-scale SBR was modified in order to allow its use in any of the hardware platforms following the EOLI integration criteria. It has been successfully tested in both the lab-scale (UNAM-01) and in the first essays of the field-scale (UNAM-02) SBRs.

- *Activities*

In the first year period a laboratory-scale pilot reactor was instrumented and the necessary control software developed (it was called BIOREC, acronym for BIOREeactor Control). This was needed in order to allow WP1 to perform process experiments, very early in the project, to provide experimental data to WP2 for parameter identification of the dynamical model. At that time there was yet no clear definition of the details for the Integration policy, so such a solution was somewhat isolated and custom made to fulfill WP1-EOLI-project scheduling needs. Now, in the reported period, such software was modified (rewritten) in order to comply with specification given by SPES. The goal is to provide integration, i.e. the capability of using the same control software in different hardware platforms and in different high level software configurations.

The WP5 software structure, for controlling UNAM-01 and UNAM-02 SBRs, was modified in such a way that the user interface, the control algorithm and the I/O functions are modular. UNAM-01 (see Fig. 1) hardware is made of National-Instruments plug-in cards, running in an IBM-type PC (Windows). UNAM-02 (see Fig. 02) hardware is much more robust as it is designed to be portable (Fig. 03) and industrial use resistant. I/O functions are performed via a remote Module (Beckhoff BK-9000 series) and communications run over a Modbus TCP protocol. This allows multiple users to access the I/O modules and allows also interaction between software modules running in different machines with different languages and even different operating systems. For example it would be possible to have a Fault Detection System running in a microprocessor and communicating directly to the BK-9000 I/O modules and, at the same time, the EDTOC strategy in BIOREC software may be running in a PC-based system, using the same I/O modules and interacting with the Fault detection system or even with any other additional system as a supervision one.

Figure 1. UNAM-01 Lab-sacle SBR instrumented with National-Instruments I/O

Figure 2. UNAM-02 Field-sacle SBR instrumented with BK-9000 Beckhoff I/O

Figure 3. UNAM-02 Field-scale portable SBR

This same software architecture allows using the exact same code to operate different SBRs in different platforms, just by changing the I/O software-module according to the specific hardware. A configuration "Hardware Type" parameter tells the general I/O routine which platform is being used, as follows:

- "Hardware Type" = 0
  The system runs in simulation mode. A virtual SBR is simulated and the I/O uses the virtual signals as if they were the real ones. This mode is extremely useful to test software changes and validate them before attempting to test them in the real SBR. No additional integration is possible for this setting.
- "Hardware Type" = 1
  The I/O hardware is a National-Instruments plug-in hardware, as used for lab-scale reactor UNAM-01. There is only one Dissolved Oxygen probe and only one inflow pump. No additional integration is possible for this setting.
- "Hardware Type" = 2
  The I/O hardware is a BK-9000 Beckhoff arrangement, as used for field-scale reactor UNAM-02. There are two Dissolved Oxygen probes and two inflow pumps (Variable and Fixed fast inflow). Additional Integration (Fault detection, Supervision system, …) under Modbus protocol is possible for this setting, but no XML integration is supported.
- "Hardware Type" = 3
  The I/O hardware may be a SPES hardware communicating via XML. Unfortunately the XML specs are not yet delivered so the particular I/O module could not be yet programmed, but the total EOLI integration under this protocol should be possible for this setting. BIOREC Control module and User interface module are written in LabView. They will keep their local utilities (as they are needed for the other hardware types), but will rely completely in SPES XML architecture to operate.

Note that another advantage of having preserved EOLI integration policy for all platforms (Commercial external to EOLI and SPES generated for EOLI) consists on the possibility of writing changes to the, or a new, control strategy and then testing it first in a simulator for validation. Then, without changing a single code-line it can be run, and validated again, in the lab-scale SBR. If everything is ok it can then be scaled up to the field-scale SBR, again without changing a single code-line.

LIST OF ABBREVIATIONS

4CP	4-Chloro-Phenol
ASM	Activated Sludge Model
CESAME	Centre for Systems Engineering and Applied Mechanics
D1.x – D9.x	Deliverables
DO	Dissolved Oxygen Concentration
DSS	Decision Support System
EC	European Commission
EDTOC	Event Driven Time Optimal Control (New way to operate a SBR)
EM1, 2	EOLI Model 1, 2
EOLI	Efficient Operation of Urban Wastewater Treatment Plant
FDI	Fault Detection and Isolation
FTC	Fixed Timing Control (Traditional way to operate a typical SBR)
GRADIENT	Groupe de Recherches et d'Animations pour le Développement, l'Innovation et l'Enseignement en Technologie
INCO	International Scientific Cooperation Projects
INRA	Institut National de la Recherche Agronomique
LBE	Laboratoire de Biotechnologie de l'Environnement
POLIMI	Politecnico di Milano
SBR	Sequencing Batch Reactor
SPES	Società di Progettazione Elettronica e Software
UCL	Université Catholique de Louvain
UNAM	Universidad Nacional Autónoma de México
UTC	Université Technologique de Compiègne
UU	Universidad de la República Oriental des Uruguay
WP	Work Package
WWTP	Wastewater Treatment Process