Enzyme supplemented membrane bioreactor (EnMBR) for degradation of recalcitrant compounds in industrial wastewater

M Balakrishnan
The Energy and Resources Institute (TERI), New Delhi, India
Who are we?

The Energy and Resources Institute (TERI)
New Delhi, India
(Indian Project Coordinator)

Katholieke Universiteit Leuven (KULeuven)
Leuven, Belgium
(EU Project Coordinator)

Centre Tecnologic de la Quimica de Catalunya (CTQC)
Tarragona, Spain
The project is about...

Wastewater from industries
- e.g. sugarcane molasses alcohol distilleries, pulp & paper mills
- contains difficult-to-degrade recalcitrant compounds
- cost effective treatment meeting discharge standards a challenge

Enzymes
- biological molecules that can degrade recalcitrant compounds
- environment-friendly
- stability and recovery for repeated use a challenge

Membrane bioreactors (MBRs)
- integrate biological treatment with membrane filtration
- compact treatment system leading to high quality of treated wastewater
- membrane fouling control is a challenge

Aim: To develop enzyme supplemented membrane bioreactors (MBRs) to enable degradation of recalcitrant compounds from industrial wastewaters

Activities:
- Enzyme immobilization on suitable media
- Testing of immobilized enzyme in MBRs
- Performance evaluation

http://www.aidaindia.org/ (accessed 12 Oct 2015); https://biochemix.files.wordpress.com/2014/03/enzyme.jpg (accessed 12 Oct 2015);
The main results of the project - 1

Scientific publications/presentations


The main results of the project - 2

Workshops

• Workshop on “Advances in Industrial Wastewater Treatment”, 27 June 2013, TERI-RETREAT, Gual Pahari, Haryana, India

• Indigo-BMG (Belgian Membrane Group) -EUDIME (Erasmus Mundus Doctorate in Membrane Engineering) workshop, 17-30 September, 2013, The Leuven Institute for Ireland in Europe, Leuven, Belgium

• Workshop on “Membranes, Catalysts and Nanomaterials for Advanced Water Treatment”, 16 April 2014, TERI University, Vasant Kunj, New Delhi, India

• “Tarragona International Forward Osmosis Workshop”, 12 December, 2014, CTQC Tarragona, Catalonia, Spain
The main results of the project - 3

**Mobility**

**India-EU (5 nos.)**
- Ms N. Singh (TERI) to KU Leuven, 10 Apr -21 Jun 2013 (Experimental work)
- Ms N. Singh (TERI) to KU Leuven, 16-21 Sep 2013 (Participation and oral presentation in Indigo-BMG-EUDIME workshop)
- Dr M. Balakrishnan (TERI) to KU Leuven, 16-21 Sep 2013 (Participation and oral presentation in Indigo-BMG-EUDIME workshop)
- Ms N. Singh (TERI) to KU Leuven, 15 Jun-30 Aug 2014 (Experimental work)
- Mr G. Pande (TERI) to CTQC, 5 May-31 Jul 2015 (Experimental work)

**EU-India (4 nos.)**
- Dr. M Roil Bilad (KU Leuven) to TERI, 26-29 Jun 2013 (Participation and oral presentation in project workshop)
- Mr. Stefaan Reyniers (KU Leuven) to TERI, 26-29 Jun 2013 (Participation and oral presentation in project workshop)
- Ms. Lisendra Marbelia (KU Leuven) to TERI, 26-29 Jun 2013 (Participation and oral presentation in project workshop)
- Prof I F J Vankelecom (KU Leuven) to TERI, 14-17 Apr 2014 (Participation and oral presentation in project workshop; discussions on work plan and publications)

**Market related impact**

None at present (Early stage research)
Success factors

• Research staff (India) working full-time on project ensured continual progress was achieved

• Open communication between partners; importantly, team members were flexible and willing to adapt to existing situation

  • Project start date was different for each partner (March 2012 for KU Leuven, July 2012 for TERI and Feb 2014 for CTQC) making coordination and integration of research activities a significant challenge

  • The enzyme immobilization component (a key research component) could not be initiated by the responsible partner CTQC due to late release of funds in Spain. So TERI (with no earlier experience in enzyme immobilization) took over this work component to meet the project objectives

  • Exchange visit of a PhD student from TERI to CTQC was initiated in 2015 even though the Indian component of the project was officially concluded
The follow up activities..

The project findings have helped in research on agro-industry waste valorisation component of an on-going EU-India project Water4Crops ("Integrating bio-treated wastewater reuse and valorization with enhanced water use efficiency to support the Green Economy in Europe and India") [http://www.water4crops.org/](http://www.water4crops.org/)
The impacts of the project

• Peer reviewed publications and conference presentations

• Wide exposure to the 9 young scientists (post-docs, PhD students, Masters students and research staff) who were involved in the project – visiting partner labs and attending workshops/conferences allowed them to interact with other young researchers and with subject experts

• Informal linkages (including technical linkages) continue among project team members
Why a joint EU-India project?

• Varied perspectives are obtained to a given problem, allowing learning from each others experiences

• Exposure to range of experimental/analytical facilities and research areas in partner institutions

• Rich learning through working in multi-disciplinary, multi-cultural teams
Message to IPP1 project coordinators

Detailed project planning and regular communication among team members essential!
Thank you for your attention