

A. Title* Enter the full title of your submission. This will be used for printing in the final program.

Real time monitoring of anaerobic fermentation by Raman and FTIR spectroscopy

Short abstract* Enter a short abstract of the work you wish to present, highlighting the take-home messages (max 100 words).

A major challenge in carbon recovery through the carboxylate platform is the poor selectivity of anaerobic fermentation in a given carboxylate (e.g. acetate, propionate, butyrate...). Furthermore, our understanding of how changes in fermentation (pH, retention time, substrate concentration...) may be used to steer the fermentation to a targeted product is limited. Vibrational spectroscopy methods (i.e. Raman and FTIR) can be used for real-time process monitoring by estimation of fermentation metabolites and, in some cases, substrate uptake. Combined with process mathematical models, it is possible to obtain real-time evaluation of the fermentation state and propose corrective actions.

B. Authors and affiliations* You must enter the names of all authors here - including yourself if you are an author - in the order in which you wish them to appear in the printed text. Names omitted here will not be printed in the author index or the final program

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C. Presentation* Choose your preferred means of presentation

Oral

D. Session* Choose the session that fits your submission the best.

Carbon recovery and its dilemma's

E. Extended abstract* Please enter an extended abstract of your paper (max 300 words). You can use 1 figure and 1 table maximum. Think about describing the motivation behind your work, its novelty and the key results.

Carbon recovery from waste streams focuses on the production of carboxylates or volatile fatty acids by anaerobic fermentation constituting the so-called carboxylate platform. A challenge in the development of the carboxylate platform is the poor selectivity in a given carboxylate (e.g. acetic, propionic, butyric acid...) and the lack of thorough understanding of how changes in operational conditions (pH, retention time, substrate nature and concentration) have an impact on the carboxylates produced. Currently, the analysis of products, often present in aqueous solutions at moderate/low concentrations, tends to be done by gas chromatography (GC) or high-performance liquid chromatography (HPLC) which prevents real-time or near real-time monitoring.

Spectroscopic methods can enable faster monitoring rates if configured in- or online. The potential of vibrational spectroscopy in anaerobic fermentation monitoring lies in the possibility of quantifying the main metabolites (carboxylates) and substrates (e.g. glucose, ethanol, starch, amino acids). In this work, we compare the capability of Fourier-Transform Infrared (FTIR) and Raman spectroscopies to effectively monitor the main metabolites of anaerobic fermentation in real time.

Fermentations using xylose and xylene were used to train the monitoring methods. Partial least square (PLS) models for each of the analytes were finally selected based on the goodness of fit for the calibration

and validation models. To improve the predictive accuracy, the PLS results were integrated with mathematical models of the fermentation process by observers (e.g. nonlinear versions of Kalman filters) leading to more accurate monitoring capabilities (Figure 1). Upcoming work will focus on the use of this real-time information to provide corrective actions and process control strategies.

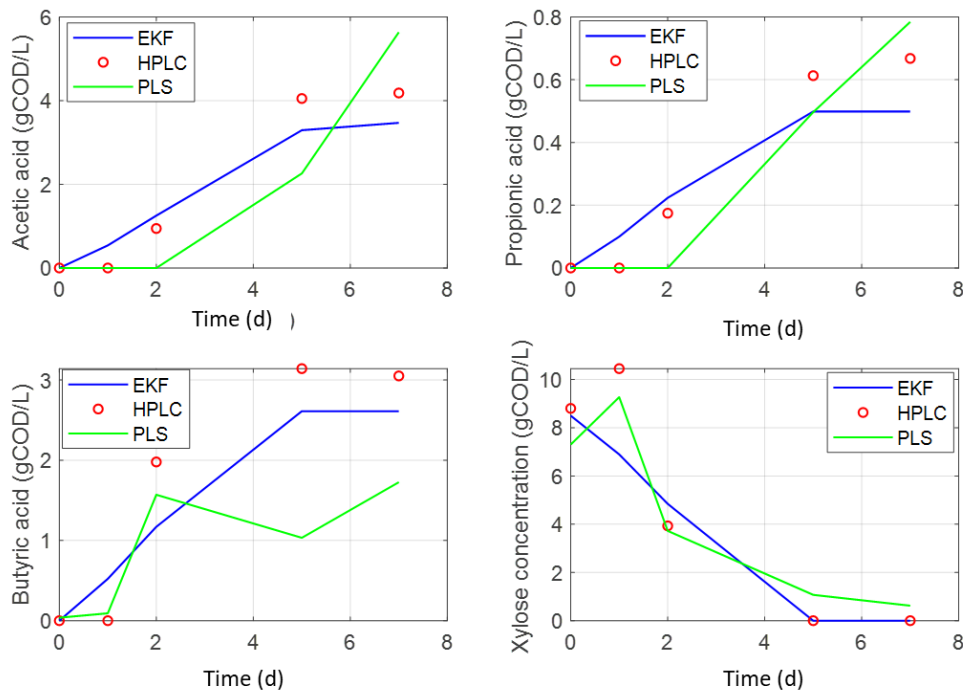


Figure 1. Comparison of prediction of an experimental xylose fermentation (batch) by HPLC, considered as the gold standard here, the spectroscopy PLS model (PLS) and the combination of the PLS with the extended Kalman Filter (EKF).

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F. What is the added value of your submission to our program?* Describe in 50 words what is the added value of your contribution to the conference program.

Processes for carbon recovery by anaerobic fermentation are now at high TRL (depending on the substrate). This contribution supports the development of process monitoring, which is essential in industrial-scale applications and opens the door to new real-time control strategies.

G. Permission to publish* Check a box to indicate whether your short abstract (100 words) can be published on electronic media and in hardcopy if accepted for presentation.

Yes