



Università degli Studi di Napoli Federico II

PhD in Biotechnology - 40th cycle

Dr. Mariateresa Arena

Methanotrophic fermentation for methanol and chemicals production

Tutors: Antonio Marzocchella, Francesca Raganati

Department: Dipartimento di Ingegneria Chimica, dei Materiali e delle Produzioni Industriali, Piazzale V. Tecchio 80, Napoli.

Methane is a chemical intermediate produced by several bioprocesses, natural (e.g. ruminants) and anthropic (e.g. anaerobic digestion) processes. It is a critical greenhouse gas as well as a key resource. Methane Capture and Utilization (MCU) strategies use methanotrophic microorganisms capable of growing on CH₄ and producing biochemicals at significantly higher efficiency than chemical methods¹ using methane-oxidizing enzymes. Methane is currently the most cost-efficient carbon source based on natural gas prices. Additionally, the use of biogas, a by-product of waste treatment, could further enhance the economic benefits of using methane as a carbon source ². Methanol is the first intermediate metabolite produced by these microorganisms. It is a fundamental building block in the chemical industry, and its market is growing³. The structured approach of this thesis combines fundamental research, system development, and applied engineering to improve the methane fermentation technology. Characterization of microorganism growth kinetics is crucial for identifying the optimal conditions to maximize methanol production. By varying the operating conditions insights, the process efficiency can be improved. Furthermore, an analysis of the bioreactor performance and adjustment of the operating conditions are required to achieve the best possible results.

References

1. Jackson, R. B. *et al.* Atmospheric methane removal: A research agenda. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* **379**, (2021).
2. Bennett, R. K., Steinberg, L. M., Chen, W. & Papoutsakis, E. T. Engineering the bioconversion of methane and methanol to fuels and chemicals in native and synthetic methylotrophs. *Current Opinion in Biotechnology* vol. 50 81–93 Preprint at <https://doi.org/10.1016/j.copbio.2017.11.010> (2018).
3. Schrader, J. *et al.* Methanol-based industrial biotechnology: current status and future perspectives of methylotrophic bacteria. *Trends in Biotechnology* vol. 27 107–115 Preprint at <https://doi.org/10.1016/j.tibtech.2008.10.009> (2009).