INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study	:	Ph.D.

Thesis Title: Design, Optimization, and Intensification of a Biological Gas to Liquid (BioGTL) Process for Methane Conversion to Methanol

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This study investigates the methane bioconversion to methanol using biological gas-to-liquid (BioGTL) technique and especially addresses the United nation's SDG 7 (Affordable and clean energy) and SDG 13 (Climate action). The principal aim of the present thesis is to design, optimize and intensify a bio-process for conversion of methane into methanol. Chapter 1 introduces and discusses impact of methane in climate change and why methane bioconversion to methanol is essential. The critical bioconversion of methane to methanol is made possible by soluble methane monooxygenases (sMMO) and particulate methane monooxygenase (pMMO). Chapter 2 studies and reports the potential of methanotrophic consortium enriched from rice field soil in methanol production. The consortium achieved a high methanol production titre of 130 mM (4.16 g/L). The maximum methanol titre of 160 mM was obtained using the *Methylomicrobium buryatense* 5G. Further, *Methylotuvimicrobium buryatense* 5GB1C was studied for their methanol accumulation capability in Chapter 3. This study attempted to maximize the methanol production using statistical optimization of the crucial fermentation parameters (phosphate buffer concentration, pH and temperature) resulting in a methanol titre of 8.54 mM in 24 h. Further investigation employed a methanol dehydrogenase inhibitor to prevent methanol breakdown, leading to an increased accumulation of 10.37 mM. The process was scaled up to a 3.7 L bioreactor, and significantly improved both methanol concentration (23.7 mM) and methane conversion efficiency (47.8%). In Chapter 4, the methanol production was

intensified using ultrasound treatment at 33 kHz at 10% duty cycle leading to a 57% improved methanol titre of 20 mM within 10 h. The gene and protein expression profiles were studied and it was found that ultrasound treatment pushes the entire central dogma forward. This was confirmed with the increased production of *pmo*A gene and overall enzymes. Finally, the homology modelling, molecular docking and molecular dynamics simulation studies reveal that methanol binds strongly to pMMO but methane preferentially interacts with PmoB and PmoC subunits. Despite this, methane gets converted into methanol within the enzyme. These intrinsic factors lead to low methane consumption, in addition to mass transfer issues, that hinder efficient methanol production, resulting in low yields.