



Project Proposal for Ph.D.

Project Details

Project Title	Chemo-catalytic production of 1,3-butanediol and n-butanol from acetaldehyde produced by fermentation
Project Summary (Minimum 500 and maximum 2000 characters)	This proposal aims to integrate the novel strategies of chemo-catalysis with microbial synthesis for the production of acetaldehyde and downstream compounds. Acetaldehyde is an extremely important C2 compound that can be synthesized microbially and converted to various products of industrial importance. These include C4 compounds including butanol, butanediol, butadiene and other higher chain carbon molecules which can be produced by aldol condensation via the carbonyl groups of acetaldehyde. Microbially, acetaldehyde is synthesized by decarboxylation of the C3 molecule pyruvate by pyruvate decarboxylase. Acetaldehyde is immediately converted to ethanol and no microorganisms natively produce acetaldehyde in any significant quantities because of its toxicity to the cell. However, acetaldehyde has a boiling point of 20 °C and can easily be stripped from the fermentation vessel by using a gas which would allow its microbial production while addressing toxicity issues. We propose to identify a suitable microbial host lacking native pyruvate decarboxylase activity and engineer a pyruvate decarboxylase gene for the production of acetaldehyde. This will be followed by process development for its separation and collection from the fermentation vessel followed by liquefaction. Aldol condensation is a widely studied reaction for the production of higher C molecules from lower C molecules. This will be investigated for chemo-catalytic conversion of acetaldehyde to 1,3-butanediol and n-butanol. Suitable catalysts will be screened for these specific conversions based on prior literature and newer catalysts designed to improve specificity. A detailed catalytic study will be performed to find the optimum parameters for reaction conditions. This will be followed by techno-economic analysis and environmental impact assessment of the proposed process.

Ph.D. Supervisors

Role	Faculty	Academic Unit in IITD/Institute/University	Email ID (Official)
Supervisor 1	Prof. K. K Pant	Chemical Engineering	kkpant@chemical.iitd.ac.in
Supervisor 2	Prof. Ashish Misra	DBEB	ashishmisra@iitd.ac.in

Project requirements (Student qualifications, experience required, etc)

- B. Tech or M. Tech in Chemical/Biochemical Engineering/Chemistry with experience in organic chemistry AND/OR process development

Source of fellowship/funding

(CSIR/UGC/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE/IRD/FITT Project details, if any)

Candidate with his/her own fellowship

Role of Faculty Members involved:

The supervisors have expertise in the following areas relevant for the project.

Supervisor 1: Catalysis; reaction engineering; Green chemistry

Supervisor 2: Metabolic engineering for production of valuable products, microbial fermentations

Supervisor 3: Sustainable bioprocesses for valorization of waste; microbial fermentations

Supervisor 1 will guide the chemo-catalytic route for conversion of acetaldehyde to 1,3-butanediol and n-butanol. Supervisor 2 will guide the selection of suitable microbial host and engineering of pyruvate decarboxylase alongside preliminary fermentation studies. Supervisor 3 will guide further process development for acetaldehyde production, separation and collection. The complementary expertise of the supervisors is important for project execution.