



## PhD Project

### Project Details

Project Title	Development of bio-urea from synthesis of biological carbon dioxide and ammonia recovered from biogas, human and animal urine
Project Summary	<p>Anaerobic digestion (AD) of various kinds of organic waste into biogas is a proven and effective solution for the appropriate management and valorization of biomass. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste and is primarily composed of methane gas, carbon dioxide, and trace amounts of nitrogen, hydrogen, and carbon monoxide. The carbon dioxide accounts nearly 65% mass of the biogas produced. The use of untapped environmental resources with the aim of establishing a sustainable society is an attracting and increasing attention. Among these resources, sewage and livestock manure have been estimated to contain large amounts of ammonium ions (environmental ammonia), i.e., via ammonia stripping process we can recover environmental ammonia, which further can be treated with CO<sub>2</sub> (extracted from biogas) leading to catalytic synthesis of urea.</p> <p>Urea is directly synthesized from carbon dioxide and ammonia (from Haber process) commonly. The reaction generally operates at 150 °C and at a pressure of 2 MPa, and the urea-synthesis plant can be sustained because of its vicinity to the ammonia-synthesis plant from which it derives much of its input energy. Due to these energy factors, conventional energy-consuming urea synthesis method is not suitable for environmental ammonia usage. On the other hands, since nitrogen in recovered ammonium ion does not have extreme strong triple bond as N<sub>2</sub>, there is no need additional energy for dividing N<sub>2</sub> bond like Haber process and is an advantage compared with conventional urea synthesis method via Haber process. It is crucial for urea synthesis reaction to decrease the input energy to be accepted by society and beneficial for rural development because one of the purposes of environmental ammonia usage is to reduce the ammonia treatment energy.</p> <p>Urea has also been synthesized from ammonium carbamate as the substrate and a Cu catalyst, a 54% yield of urea was obtained at 140 °C, 14 MPa, and 3 d of incubation. However, large amounts of energy are still required for the reaction. In other report, urea has been synthesized from ammonium carbamate and ammonium bicarbonate mixtures as the substrate, a 48.9% yield of urea was achieved at 165 °C, 3.6 MPa, and 90 min of incubation. Large amounts of energy for heating and compressing are still required for the reaction.</p> <p>This proposal aims to devise a technology for the production of bio-urea using the available resources (bio-carbon dioxide from biogas system, and ammonia recovered from various naturally available resources. The proposed research could be highly beneficial to the rural society, who are engaged in the agricultural production system.</p>

### PhD Supervisors

Role	Faculty	Academic Unit in IITD	Email ID
Supervisor 1	Dr. Ram Chandra	CRDT	<a href="mailto:rchandra@rdat.iitd.ac.in">rchandra@rdat.iitd.ac.in</a>

**Project requirements (Student qualifications, experience required, etc.)**

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

**Source of funding (IRD/FITT Project details, if any)**

Sponsored (JRF/SRF, Industry) or Part-time candidate (no full-time funding available with the PI's)

**Role of Faculty Members involved:**

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

Supervisor 1: Anaerobic digestion of various type of biomass for biogas production, biogas upgradation and CO<sub>2</sub> recovery system.

Supervisor 2: Biochemical engineering technologies for the production of renewable chemicals and energy