PRATHAM ARORA

Ph. D. (Energy Systems Engineering and Chemical Engineering)

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Education:

Examination	University	Institute	Year	CPI/%
Doctorate	IIT Bombay/Monash University	IITB-Monash Research Academy	2017	9.00
Graduation	BITS Pilani	BITS Pilani K.K. Birla, Goa Campus	2011	8.59
Intermediate/+2	CBSE	Sachdeva Public School, Delhi	2007	84.0
Matriculation	CBSE	Sachdeva Public School, Delhi	2005	92.2

Areas of Interests:

- Techno-enviro-economic assessment.
- Multi-scale modelling and process integration.
- Renewable energy systems.
- Biofuels and bio-energy.
- Process modelling, simulation and optimisation
- Computational Fluid Dynamics (CFD).
- Life Cycle Assessment (LCA).
- Sustainable chemicals.

PhD Problem Statement:

Registered at **IITB-Monash Research Academy**—a joint venture between **IIT Bombay**, India, and **Monash University**, Australia

Supervisors: **Prof. Sanjay Mahajani**, Department of Chemical Engineering, IIT Bombay, Mumbai, India; **Prof. Anuradda Ganesh**, Department of Energy Science and Engineering, IIT Bombay, Mumbai, India; and **Prof. Andrew Hoadley**, Department of Chemical Engineering, Monash University, Clayton, Australia

Abstract:

Ammonia is often regarded as a chemical that changed the course of the 20th century. As a fertiliser, it has sustained global agriculture, and as an explosive, it has become indispensable to the mining industry. On the flipside, conventional ammonia production continues to have a significant environmental footprint by consuming 1.2% of the global primary energy and contributing to 0.93% of worldwide Greenhouse Gas (GHG) emissions. This stems from the fact that natural gas has remained the preferred feedstock due to its low price and wide availability. Biomass, with its wide availability and carbon neutrality, stands as a strong candidate for the replacement of fossil fuels. The present study tries to establish the viability of small-scale ammonia production from biomass. A scale of 70 tpd of ammonia production was selected to buffer the sporadic biomass supply, while the local demand for ammonia was simultaneously accommodated. The scale is much smaller when compared to conventional ammonia plants, and the effect of the economies of scale is expected to make the plant less appealing. To overcome these effects, the design incorporated features from the ICI Leading Concept Ammonia® process. This small-scale process, which was developed in the early 1990s, incorporated significant changes in terms of heat integration and process flow in order to suit small-scale ammonia plants.

The use of the dual fluidised bed gasifier technology also contributed to a cleaner syngas and easier energy integration. In order to predict and optimise the operation of the dual fluidised bed gasifier effectively, a compartment-based semi-detailed kinetic approach was used to model the gasifier. A Computational Fluid Dynamics (CFD) model was developed in ANSYS Fluent® for the gasifier in order to validate the assumptions. The CFD model was then used to carry out a Residence Time Distribution (RTD) analysis, which formed the basis for the compartment model. The gasifier model and the downstream gas conditioning that led to ammonia production were modelled in the ASPEN Plus® simulation software.

The output of ASPEN Plus® simulations was fed into an MS Excel®-based framework, which performs Life Cycle Costing (LCC) and Life Cycle Assessment (LCA) for the simulated flowsheet. Finally, these outputs are utilised by an MS Excel®-/VB-based Multi-Objective Optimisation (MOO) framework to optimise both LCC and LCA for changing flowsheet configurations as well as for different biomass feedstocks grown at different locations worldwide. **Apart from establishing the viability of a small-scale biomass-to-ammonia plant, this study also establishes the advantages of process modelling and simulation at different levels, namely, the phase level, the process unit level, the plant level and the environmental effects level.** The project has been funded by Orica Mining Services.

Technical Skills:

I bring to the table a unique blend of a clear theoretical background, excellence in using a variety of simulation tools at different scales, and experience in operation and maintenance of lab-scale plants.

- ASPEN Plus®, HYSYS® and DWSIM® simulation software.
- ANSYS Fluent® and COMSOL® CFD software.
- SIMAPRO® LCA software.
- Multi-Objective Optimisation (MOO) using genetic algorithms.
- Programming: C/C++, Matlab, Visual Basic.

Among other abilities, the skill that was honed the most during the course of my PhD is problem identification and problem solving.

Work Experience:

1. **Post-Doctoral Fellow,** Georgia Tech., Atlanta (Aug 2018–present).
2. **Associate Fellow,** The Energy and Resources Institute (TERI), New Delhi (Sep 2016–Jul 2018).
3. **Research Fellow**, Department of Chemical Engineering, IIT Delhi, with Prof. D.P. Rao. (Jan–May 2011).
4. **Summer Intern**, Centre for Rural Development and Technology, IIT Delhi, with Prof. V.K. Vijay. (May–Jul 2010).

List of Publications:

Publications in SCI-indexed and Scopus-indexed Journals (Published/Communicated):

1. **Arora, P.**, Sharma, I., Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2018. *Remote, small-scale, 'greener' routes of ammonia production*, Journal of Cleaner Production, 199, 177-192. (Impact Factor: 5.651; SCImago Journal Rank (SJR): 1.467)
2. **Arora, P**., Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2017. *Multi-Objective Optimization of biomass based ammonia production: Potential and perspective in different countries*, Journal of Cleaner Production, 148, 363-374. (Impact Factor: 5.651; SCImago Journal Rank (SJR): 1.467)
3. **Arora, P**., Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2017. *Compartment model for a dual fluidized bed biomass gasifier*. Chemical Engineering Research and Design, 117, 274-286. (Impact Factor: 2.795; SCImago Journal Rank (SJR): 0.847)
4. **Arora, P.**, Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2016. *Small scale ammonia production from biomass: A techno-economic perspective*. Industrial & Engineering Chemistry Research, 55(22), 6422-6434. (Impact Factor: 3.141; SCImago Journal Rank (SJR): 0.978)
5. **Arora, P**., Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2016. *Multi-level Modelling of Sustainable Chemical Production; From CFD to LCA*. Computer Aided Chemical Engineering, 38, 499-504. (SCImago Journal Rank (SJR): 0.19)
6. **Arora, P.**, Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2015. *Modelling and Optimisation of Dual Fluidisation Bed Gasifiers for Production of Chemicals.* Chemical Engineering Transactions, 45, 1111. (SCImago Journal Rank (SJR): 0.293)
7. Comer, B.M., Fuentes, P., Dimkpa, C.O., Liu, Y., Fernandez, C., **Arora, P.**, Realff, M., Singh, U. P., Hatzell, M. C., Medford, A. J., 2019. *Prospects and Challenges for Solar Fertilizers*, Joule (Submitted).

Book Chapter

1. **Arora, P.**, Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2018. *Sustainability assessment of the biomass gasification process for production of ammonia*. Coal and Biomass Gasification: Fundamentals, Recent Advances, and Future Challenges, Springer, 351-367.

Conference Publications

1. Sharma, I., **Arora, P**., Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2016. Greener Alternatives for Ammonia Production. In proceedings of ECOS 2016, Slovenia.
2. **Arora, P**., Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2015. Residence Time Distribution Study for Bubbling Fluidised Beds using Computational Fluid Dynamics, In Proceedings of APCChE 2015 Congress and Chemeca 2015, Melboune.
3. **Arora, P**., Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2014. Innovative Method of Production of Ammonia from Biomass. In Proceedings of 22nd European Biomass Conference and Exhibition, 1078 – 1085, Germany.

Conference Presentations

1. Prabhudessai, V.,**Arora, P**., Ganguly, A.,Mutnuri, S., 2010. Biochemical Methane Potential of Agrowastes.3rd IWA Asia Pacific Young Water Professionals Conference, Singapore.
2. **Arora, P.,** Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2014. Innovative Method of Production of Ammonia from Biomass. 22nd European Biomass Conference and Exhibition, Hamburg, Germany.

3. **Arora, P**., Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2015. Ammonia Production from Biomass. South Asian Symposium on Sustainable Development, TERI University, New Delhi.
4. **Arora, P.,** Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2015.Modelling and Optimisation of Dual Fluidisation Bed Gasifiers for production of chemicals, Modelling and Optimisation for Energy Saving and Pollution Reduction (PRES 15), Kuching, Malaysia.
5. **Arora, P.,** Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2015. Residence time distribution study for bubbling fluidised beds using computational fluid dynamics, APCChE 2015 Congress and Chemeca 2015, Melbourne, Australia.
6. **Arora, P**., Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2015.Sustainability assessment of ammonia production from biomass feedstock, APCChE 2015 Congress and Chemeca 2015, Melbourne, Australia.
7. **Arora, P**., Hoadley, A. F. A., Mahajani, S., Ganesh, A., 2019, Production of Ammonia from Biomass: Multi-Level Modeling for Sustainable Chemical Production, Southeastern Energy Conference, Atlanta, US**. (Best poster award)**

Research Projects:

1. **Design and Development of GHG Calculator for Distributed Rooftop Solar PV Projects** (Mar-Jun 2018), sponsored by International Finance Corporation (IFC), World bank, Grant Amount: Rs 45,00,000/-. Worked on development of online tool for rooftop solar PV potential and GHG emission reduction potential for textile sector in Bangladesh.
2. **Feasibility Study for Potential Applications of Waste Generated from the Katha industry** (Aug-Dec 2017), sponsored by Indian Wood Products (IWP)**,** Grant Amount: Rs 3,30,000/-. Feasibility study to identify from technical and economic perspective the most viable process for converting Gambier extract (wastes) to useful chemical/fuel/energy products.
3. **Biogas plant for IIT Bombay** (Jul-Dec 2012) with Prof. Anuradda Ganesh, Department of Energy Science and Engineering, IIT Bombay: The project involved design and techno-economic evaluation of the one-tonne-per-day capacity bi-phasic biogas plant to process IIT Bombay canteen waste.
4. **Operation of Pilot Plant for CO_2 Absorption with MDEA-activated with Piperazine** (Jan–June 2011) with Prof. D. P. Rao, Chemical Engineering Department, IIT Delhi: Worked on developing experimental procedures for the commissioning of the CO_2-absorption pilot plant of IIT Delhi.
5. **Design of a viable hybrid fuel supply system for villages** (Aug–Nov 2010) with Prof. Krishnaswami Ponnani, Chemical Engineering Department, BITS Pilani Goa: The project aimed to propose a sustainable fuel-supply system for villages by incorporating LPG, biogas and biomass gasification syngas.
6. **Designing a PSA Plant for Removal of Carbon Dioxide from Biogas** (May–July 2010) with Prof. V.K. Vijay, Centre for Rural Development and Technology, IIT Delhi: Proposed an algorithm for the designing of an adsorber column to be used in the enrichment of biogas.

Awards and Achievements:

1. Received the 2019 ***Processes*** **Travel Awards** for attending the FOCAPD conference.
2. Awarded the prestigious **Bioenergy-Awards for Cutting Edge Research (B-ACER)** fellowship by Indo-US Science & Technology Forum (IUSSTF).
3. Won the **Best Collaboration Oskar** award, 2014, at the annual IITB-Monash Research Academy Oskar awards event.
4. Stood **first** in **Utkarsh (Ideate)** held in Techfest 2012–13 in IIT Bombay for a presentation on a **low-cost water purification technology** based on ceramic water filters.
5. **Outstanding reviewer** for the Journal of Cleaner Production by Elsevier.
6. **Won** the **Paper Presentation competition** in Quark-08 - annual techfest of BITS Pilani, Goa Campus.
7. Stood **second** in the event '**Conwallz**' at Quark-10. The contest required the making of a wall that could maximise heat transfer under given conditions.
8. Recipient of prestigious **merit-cum-need scholarship** by BITS Pilani.

Position of Responsibility and Extra-Curricular Activities

1. Member of **Technology Need Assessment (TNA) committee** for the Transport Sector at **TIFAC**.
2. Conducted a **two day workshop** on **Process Modelling and Simulation** at BITS Pilani Goa in Dec. 2017.
3. Member of the organising committee for the International Conference on Advances in Energy Research **(ICAER 2015)**.
4. **Core-member** of the organising committee of the **ReDx MIT Health Tech Workshop** held at IIT Bombay in Jan. 2014.
5. Member of the organizing committee of the 3rd**Global Tech Workshop** that was held in IIT Bombay in Dec. 2011.
6. **Event manager** of **Paper Presentation Competition**, the largest event in Quark-09, with more than **1000 participants** from throughout the country.
7. Member of the academic committee of Alchemista, Chemical Engineering Students Association of BITS Pilani, Goa.
8. Practised **Taekwondo** up to yellow belt level.
9. Orchestrated **group meditation sessions** in the Goa campus of BITS Pilani.

References:

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