IRCC CONferences on emerging conceptS – ICONS 2024

IITB HYDROGEN WORKSHOP [February 16-17, 2024]

Industrial Research and Consultancy Centre (IRCC)
Indian Institute of Technology Bombay (IITB), Mumbai

Summary Report

The Industrial Research and Consultancy Centre (IRCC) at the Indian Institute of Technology Bombay (IIT Bombay) hosted a captivating workshop on Green Hydrogen Production and its Storage from February 16th to 17th, 2024. This workshop marked the 5th installment in the esteemed series of annual IRCC conferences on emerging concepts (ICONS), underscoring the institution's commitment to cutting-edge research and innovation. Set against the backdrop of the Prof. B. Nag Auditorium within the Victor Menezes Convention Centre (VMCC) at IIT Bombay, the event served as a melting pot of ideas, bringing together experts, scholars, and enthusiasts from across the world. Delving into the forefront of sustainable energy solutions, the workshop provided a platform for in-depth discussions, insightful presentations, and invaluable networking opportunities.

The main workshop boasted a distinguished line-up of speakers, comprising experts who work in various facets of hydrogen technology and its accompanying policy landscape. Among these luminaries were **Shri Lalit Bohra, Joint Secretary** at the **Ministry of New and Renewable Energy (MNRE)**, and **Dr. V. K. Saraswat**, **Member, NITI Aayog** and **former Secretary of the Defense Research and Development Organization (DRDO)**. Additionally, the event featured **Dr. Anita Gupta**, Head of the Scientific Divisions at the **Department of Science and Technology (DST)**, specializing in Climate, Energy, and Sustainable Technology.

The comprehensive agenda encompassed talks by notable representatives from governmental bodies and industries alike, complemented by insights from esteemed faculty members representing various departments of IIT Bombay. Their presentations spanned the spectrum of hydrogen production and storage methodologies, delving into topics such as water electrolysis, biomass gasification, and emerging techniques like Photoelectrochemical (PEC) and Photobiological Methods. Discussions also touched upon storage modalities including Compressed Hydrogen, Liquid Hydrogen, and innovative solutions like Liquefied Organic Hydrogen Carriers (LOHC), addressing crucial aspects such as cost, efficiency, safety, infrastructure, and environmental impact.

The workshop was attended by nearly 400 participants, including students and faculty members from both IIT Bombay and other industries, institutes and colleges in the region. The conveners of the workshop were **Prof. Pratibha Sharma (DESE, IIT Bombay), Prof. Arnab Dutta (Chemistry, IIT Bombay)**

With a focus on advancing the understanding and application of green hydrogen technologies, attendees were treated to an enriching experience characterized by thought-provoking dialogues and knowledge exchange. The event not only shed light on the latest developments in the field but also fostered collaborations to drive meaningful progress toward a greener and more sustainable future.

Day 1

Session 1: Chaired by Prof. Pratibha Sharma, IIT Bombay

Opening Remarks and Welcome Address:
The event's inauguration was performed by **Prof. Sachin Patwardhan, Dean R&D, IIT Bombay**, and **Prof. Avinash V. Mahajan, Acting Dy. Director, IIT Bombay.** And they warmly welcomed the attendees and provided insightful remarks regarding the workshop's agenda. During his address, the Dean underscored the pivotal role of IIT Bombay and the IRCC in promoting emerging fields and disciplines, emphasizing their commitment to fostering innovation and collaboration. This workshop marked the fifth annual installment facilitated by IRCC under the ICONS series, a testament to their dedication to promoting internal networking and forging connections with key stakeholders in the industry, government R&D organizations, and academia. The focus of this year's workshop on Green Hydrogen Production and its Storage couldn't be more timely or pertinent. With its potential to revolutionize renewable energy and mitigate the impacts of climate change, green hydrogen stands as a beacon for a resilient and harmonious future. The Dy. Director aptly highlighted the alignment of this workshop's theme with the goals outlined in various National Missions on Hydrogen-based Technologies and Applications recently launched, further emphasizing its strategic importance in the global pursuit of sustainable energy solutions.

1. ***Guest of Honour*: Dr. V. K. Saraswat, Member, NITI Aayog & Ex-Secretary, DRDO.** Dr. Saraswat provided an excellent overview of the current scenario of Indian hydrogen economy. He also provided appropriate future pathways to strengthen our pursuit of a sustainable and practical hydrogen-based infrastructure. Dr. Saraswat expertly discussed the major components for this green hydrogen evolution.

2. ***Address by Chief Guest*: Mr. Lalit Bohra, Joint Secretary** of **MNRE**, underscored the critical role of policy frameworks in propelling the transition towards renewable energy sources. He emphasized the imperative of crafting policies that not only incentivize the adoption of renewables but also foster robust collaboration between industry and academia for innovative solutions. Delving deeper, Mr. Bohra elaborated on India's potential to emerge as a global hub for green hydrogen production. He elucidated how green hydrogen is key to decarbonizing pivotal sectors such as steel, fertilizer, and petrochemical refining, thus aligning with India's broader sustainability goals. Moreover, he explored avenues for exporting green hydrogen to nations with minimal costs, stressing the need for a cost-effective and efficient hydrogen supply chain to capitalize on emerging international markets.

3. ***Keynote Speaker*: Dr. Kanakasabapathi Subramanian, Sr. Vice President** of **Ashok Leyland**, provided a nuanced perspective on hydrogen's role as a versatile energy vector. He elucidated the practical applications of hydrogen fuel across diverse platforms, including fuel cells and internal combustion engines. Dr. Subramanian delved into the transformative shifts underway in the automotive industry, particularly amidst challenging operational environments such as low oxygen settings or mining areas. Additionally, he navigated through the key challenges impeding the widespread adoption of hydrogen-powered vehicles, offering insights into indigenous technological advancements aimed at overcoming these hurdles.

4. ***Plenary Speaker*: Dr. Anita Gupta, Head of Climate, Energy & Sustainable Technology** at **DST**, offered a comprehensive overview of DST's ambitious projects aimed at scaling up hydrogen technologies. She outlined disruptive pathways that promise to revolutionize the energy landscape and underscored the importance of bolstering institutional capabilities and workforce development to support these endeavors. Dr. Gupta provided insights into the DST Hydrogen program, emphasizing its focus on fostering industrially viable hydrogen fuel cell technologies. She also highlighted the significance of international collaboration initiatives, such as the Hydrogen Valey Cluster, in driving global innovation and knowledge exchange.

5. ***Keynote Speaker*: Dr. Suman Roy Choudhury** from **DRDO** delved into various scenarios for integrating hydrogen into existing energy infrastructure, including the conceptualization of a hydrogen grid. He emphasized the necessity of calibrating theoretical advancements with practical realities through rigorous research and development efforts. Furthermore, Dr. Choudhury shed light on novel developments within the defence sector, showcasing how

hydrogen-driven technologies pave the way for innovative and applicable solutions in strategic domains.

6. ***Plenary Speaker*: Dr. Sunita Satyapal, Director of Hydrogen & Fuel Cell** at the **US DoE**, provided valuable insights into the Clean Hydrogen strategy, elucidating how international collaboration is essential for advancing hydrogen technologies. She emphasized the importance of cross-border partnerships in accelerating research, development, and deployment efforts, thereby fostering a more sustainable and resilient global energy ecosystem.

Session 2: Chaired by Prof. Arnab Dutta, IIT Bombay

1. ***Session Speaker*: Mr. Atul Choudhari, CTO** of **Tata Consulting Engineers**, conducted a deep dive into the omnipresent applications of hydrogen and the myriad production routes available for green hydrogen. He underscored the pivotal role of materials research in driving innovation across various hydrogen verticals, from production to storage and utilization. Moreover, Mr. Choudhari elaborated on ongoing initiatives aimed at reducing costs and enhancing scalability within the hydrogen sector while also identifying promising research opportunities for future advancements.

2. ***Session Speaker*: Prof. Sandeep Kumar** from **IIT Bombay** elaborated on the gasification process and the utilization of solar, waste heat, and biomass resources for hydrogen production. He expounded upon the potential of leveraging these renewable sources to achieve sustainable hydrogen production, with particular emphasis on applications in plastics manufacturing, thus highlighting the diverse avenues for integrating hydrogen into existing industrial processes.

3. ***Session Speaker*: Dr. Atul Verma, CTO** of **Adani Green Energy Ltd.**, provided insights into cutting-edge initiatives such as New Industries Limited and electrolyzer testing labs, aimed at accelerating technological innovation within the hydrogen sector. He outlined the various segments comprising the hydrogen value chain, from production to pipeline transport and ammonia synthesis. He also delineated a broader strategic blueprint for harnessing hydrogen's potential across multiple sectors.

4. ***Plenary Speaker*: Dr. Ashish Lele, Director** of **NCL Pune**, illuminated the landscape of green hydrogen within India's energy transition, elucidating the critical nexus between research and commercialization. He contextualized India's efforts within the backdrop of exponential global growth in hydrogen deployment and shed light on the National Green Hydrogen Mission spearheaded by MNRE. Furthermore, Dr. Lele dissected the levelized cost of hydrogen, unraveling the intricacies of technologies involved in its production, storage, distribution, and utilization. He provided insights into CSIR's PEMFC program and its applicability in stationary and automotive applications, underscoring India's trajectory towards self-reliance.

Day 2

Session 1: Chaired By – Prof. Suneet Singh, IIT Bombay

1. ***Plenary Speaker*: Dr. S. S. V. Ramakumar, Ex-Director (R&D) of Indian Oil Corporation Ltd.**, navigated through hydrogen initiatives within the oil and gas industry, particularly within the Indian context. He elucidated diverse pathways for hydrogen production, including water electrolysis and waste-to-hydrogen conversion, alongside novel indigenous hydrogen storage materials and transportation solutions. Dr. Ramakumar outlined the roadmap for the National Hydrogen Mission, emphasizing key developments and the Indian oil and gas sector's ambitions to ramp up green hydrogen production and electrolyzer capacity.

2. ***Session Speaker*: Dr. Inderjeet Singh, Vice President - Technology** at **Adani New Industries Ltd.**, delved into the fundamental properties of hydrogen and unpacked the inherent challenges associated with its storage. Dr. Singh elucidated the complexities surrounding hydrogen embrittlement and explored a spectrum of storage options, ranging from conventional approaches to cutting-edge innovations. He provided a nuanced analysis of the cost and safety considerations inherent in hydrogen storage solutions, drawing upon Adani New Industries Limited's expertise and insights gleaned from practical experience.

3. ***Session Speaker*: Dr. Renny Andrew, Chief Manager at Bharat Petroleum Corporation Ltd.**, underscored the imperative of hydrogen storage R&D in driving India's quest for energy independence and import bill savings. He outlined BPCL's presence in green hydrogen production, storage, and delivery, emphasizing research on new and advanced technologies such as carbon fibre-based composite cylinders and proton batteries.

4. ***Session Speaker*: Mr. Puneet Khurana, Managing Director of Everest Kanto Cylinder**, showcased innovative hydrogen storage and transportation solutions tailored to India's evolving needs. He highlighted Everest Kanto Cylinder's pioneering efforts in developing Type 1 and Type 3 cylinders equipped with cutting-edge technologies to ensure safety, reliability, and efficiency in bulk storage and transportation applications. Mr. Khurana provided compelling visual demonstrations, including photos and videos of hydrogen skids, underscoring the company's commitment to delivering practical solutions aligned with India's burgeoning hydrogen ecosystem. Moreover, he outlined proposals for ground-breaking hydrogen ground storage infrastructure and refueling stations, aimed at catalyzing the widespread adoption of hydrogen as a clean and sustainable energy carrier.

5. ***Session Speaker*: Prof. Asim Tewari** from **IIT Bombay** offered profound insights into the cutting-edge research endeavours to advance hydrogen storage technologies. He elucidated the intricate nuances of advanced fibre-reinforced plastics composites and machining technologies, showcasing IIT Bombay's formidable expertise in optimizing Type-4 hydrogen pressure vessel design and manufacturing processes. Prof. Tewari expounded upon the formidable challenges encountered in manufacturing precision-engineered hydrogen storage solutions and proposed innovative strategies to address these hurdles, emphasizing the pivotal role of interdisciplinary collaborations and technological innovations in driving sustainable progress.

   Poster Session and Prototype Display:
   The workshop culminated with an engaging session featuring open interaction with speakers, poster sessions, and prototype displays, fostering vibrant exchanges of ideas and facilitating collaborative initiatives aimed at advancing the frontiers of hydrogen technology. Participants had the opportunity to engage with thought leaders, exchange insights, and explore synergies for transformative collaborations, underscoring the workshop's profound impact in catalyzing collective action toward a sustainable and hydrogen-powered future.

Session 2: Chaired by - Prof. Sanjay Mahajani, IIT Bombay

6. ***Guest of Honour:* Mr. Chidambaran Subramanian, Chief Strategy Officer** at **Cummins India**, offered valuable perspectives on accelerating hydrogen consumption, emphasizing the pivotal role of technical performance, availability, accessibility, and total cost of ownership. He navigated through a spectrum of strategies and interventions aimed at enhancing hydrogen uptake across diverse applications, underscoring Cummins India's commitment to driving technological innovation and facilitating the transition towards a sustainable energy paradigm.

7. ***Session Speaker*: Mr. Shekhar Kashalikar, CEO** of **John Cockerill Greenko**, provided profound insights into hydrogen utilization, with a special emphasis on hydrogen refueling stations and mobility solutions. He outlined John Cockerill's visionary initiatives aimed at accelerating the transition to green hydrogen, leveraging innovative technologies and strategic partnerships to unlock new frontiers in sustainable mobility. Mr. Kashalikar showcased the company's proprietary Hyptimise® software, offering unparalleled capabilities in optimizing hydrogen refueling station design and infrastructure, thereby laying the foundation for a resilient and future-ready hydrogen ecosystem.

8. ***Session Speaker*: Prof. Prakash C. Ghosh** from IIT Bombay delved into the multifaceted role of platinum in catalyzing the hydrogen economy, exploring its profound implications for advancing sustainable development goals. He expounded upon the transformative potential of hydrogen in daily life, highlighting its diverse applications and far-reaching impacts, particularly in rural areas. Prof. Ghosh underscored the critical importance of harnessing hydrogen's potential to address pressing societal challenges, including maternal health and well-being,

underscoring the need for innovative interventions and collaborative initiatives to realize hydrogen's transformative potential.

9. ***Session Speaker*: Mr. Narasimham B.**, Lead Process Safety at Reliance Industries, provided a comprehensive overview of the global energy economy, outlining RIL's strategic approach towards hydrogen projects and initiatives. He navigated through key milestones, timelines, and efforts driving RIL's ambitious endeavours in the hydrogen domain, showcasing the company's unwavering commitment to driving technological innovation and fostering sustainable progress. Moreover, Mr. Narasimham elucidated the myriad considerations governing site layout options, hydrogen hazards, and process safety risks, offering profound insights into the holistic approach being adopted to navigate the complex challenges inherent in the transition towards a hydrogen-powered future.

Vote of Thanks:

The workshop concluded with a vote of thanks by **Prof. Upendra Bhandarkar, Associate Dean R&D at IIT Bombay**, acknowledging the contributions of speakers and participants in enriching the discourse on hydrogen technology and its potential for driving sustainable development. The conveners thanked the institute dignitaries, senior officials and IRCC for their gracious support.