

NEW GENERATION IDEATION CONTEST



HPCL

Hindustan Petroleum Corporation Limited (HPCL) is a Government of India enterprise operating in Oil and Natural Gas sector which has been conferred with Navratna Status. Apart from various other innumerable recognitions, it also holds the distinction of featuring on the Forbes 2000 list. HPCL is expanding its wings to the R&D activities towards fulfilling its mission to be a fully integrated company in the hydrocarbon sector (exploration & production, refining & marketing) and alternative energies.

HP Green R&D Centre

HPCL has set-up its prestigious HP Green R&D Centre (HPGRDC) in Bengaluru in the year 2016. It is a vibrant research Centre in India for carrying out research and development activities in oil refining and alternate energy sector. HP Green R&D Centre is currently working in the following areas:

- Refining technologies advancement
- Valorisation / Upgradation of low value / heavy refinery streams
- Novel & Nano materials
- Novel Separations
- Process Intensification
- Alternate / Renewable energy sources: Biofuel / Solar
- CO₂ capture & conversion

About the Competition

HPGRDC is initiating an innovation drive with a motto to encourage students in India to come up with bright ideas to tackle modern world challenges such as clean and sustainable energy, environmental pollution and growing consumerism, etc. As part of this initiative, HPCL is organizing “New Generation Ideation Contest”, to provide a platform for the students and young researchers to share their innovative solutions.

Ideas are invited in the following categories:

1) Bioprocess

At present, research on renewable liquid fuels has garnered worldwide attention. However, in order to achieve full scale commercial viability, specific challenges in unit processes of Lignocellulosic biofuel technology needs to be resolved. The most prominent challenges include, finding solutions to effective biomass pre-treatment and cost effective enzyme production. Novel ideas are required in following areas:

- Reusable catalysts for lignin removal: New chemical catalysts (single or in combination that work in a heterogeneous phase) that are preferably reusable and can carry out delignification of biomass under low severity conditions and ensure maximum cellulose recovery and minimum inhibitor formation.
- Enzyme enhancers for cellulose hydrolysis: New Chemical or bio-chemical enhancer compounds that are cost-effective and reduce requirement of cellulases during biomass hydrolysis.

2) Biomass Pyrolysis

Biomass is a renewable energy resource which has the potential to reduce global dependency on fossil fuels. Pyrolysis of biomass produces a liquid called bio-oil consisting of an aqueous phase and an organic phase apart from biochar and non-condensable gases. The organic phase consists of numerous oxygenated compounds. The aqueous phase consists of water and some dissolved organic compounds like acids, alcohols, aldehydes, ketones etc. The most popular pathway for upgrading the organic phase is hydrodeoxygenation which requires hydrogen and a suitable catalyst. Due to the high hydrogen requirement, it is suggested to produce the hydrogen in-situ utilizing one of the by-products of the pyrolysis process e.g. the aqueous phase to improve the overall process economics.

A new process along with novel heterogeneous catalyst with less deactivation is required to convert the aqueous phase (which consist of carboxylic acid, phenol, ketone and aldehyde and having pH of 2-3) produced from biomass pyrolysis in to hydrogen to make the overall process self-sufficient in terms of hydrogen requirement. Innovative ideas are invited on devising a scheme for conversion of aqueous phase bio-oil into hydrogen and other valuable by-products.

3) Biodegradable Plastic

'Biodegradable' plastic lead people to believe that it will just naturally decay over time, the same way as a banana might. Unfortunately, this is not the case. For this type of plastic to biodegrade it requires high temperatures and sunlight. Biodegradable plastic is designed to decay at temperatures above 50°C, which means it is not going to biodegrade if it is just disposed. In fact, it's not going to biodegrade anywhere other than in specialised facilities. Another issue is the fact that the process requires sunlight to work properly. Biodegradable plastics are not buoyant, meaning the plastic will sink in the ocean and not be exposed to sunlight. It also means they won't decay when buried in a landfill. Innovative ideas are required to make a 100% biodegradable plastic which can degrade in ambient conditions.

4) Methane Decomposition to Value Added Product

Refinery's prime utility, hydrogen (H_2) is being majorly produced from steam methane reforming (SMR) which causes huge greenhouse gas emissions. An alternative route for producing hydrogen without CO_2 emission is viable where, Natural gas / methane is thermo-catalytically decomposed to hydrogen and carbon nanotubes (CNT). Current catalyst systems based on Ni, Cu and alumina for decomposition of natural gas are capable of generating multi walled CNT (MWCNT) of 50-100 nm diameter and length of 5 micron along with 85 vol.% H_2 in off gas. The yields of CNT is limited to 2 kg CNT/kg catalyst in continuous mode of operation.

However, the MWCNT demanded by market are < 20 nm diameter and > 10 micron in length. To make the process economically attractive, after CNT separation, the catalyst should be recycled back into the process. Innovative ideas are required to develop novel catalyst for high quality and high yield CNT with optimal conversion of natural gas to hydrogen. Catalyst should be preferably recyclable and cost effective.

5) Hydroprocessing

Hydroprocessing is one of the important refining processes to improve the quality of fuels (diesel and gasoline). It is known that the requirement of hydrogen is pertinent in any hydroprocessing units. The economics of the plant is significantly influenced by hydrogen consumption. Several technologies are being studied to reduce or eliminate hydrogen for desulfurization. One among them is Adsorption based desulfurization of Naphtha, Gasoline and Diesel. Though the desulfurization to less than 10 ppm sulfur is achievable, the regeneration of adsorbents and reuse is not effective. From the reported literature, the adsorption capacities are in the range of 20 to 70 mg/g of adsorbents. The effectiveness of regenerated adsorbents is also limited. It is envisaged to identify novel adsorbents using minimal hydrogen consumption and novel and easier regeneration techniques to achieve Ultra Low Sulfur hydrocarbons. Innovative ideas are required to address the above problem statement.

6) Carbon dioxide (CO_2) Capture

- Carbon dioxide (CO_2) sequestration & capture is of primary concern due to growing global emissions in recent history. Conventionally, CO_2 removal at industrial scale is carried out by absorption process using amines as solvents (such as MDEA, DEA, MEA, etc.) and then regenerating the solvent by heating (energy intensive process). Current hybrid solvents have 0.5 to 1.5 mol CO_2 / mol solvent capacity. Innovative ideas are required to develop a novel solvent with different chemistry which shall have higher absorption rate and capacity than solvents reported so far in literature, with lowest specific heat demand for desorption of CO_2 from solvent during regeneration.
- CO_2 removal from flue gas / natural gas using membrane separation is also a key research area. Commercialization of membrane technology for this application has bottlenecks of durability, cost, selectivity of the membrane system. Development of compact and cost effective membrane separation unit for CO_2 removal which has 95% recovery of hydrocarbon gas and > 98% removal of CO_2 with high selectivity of CO_2/CH_4 is a requirement for successful commercialization. Innovative research ideas required on the novel and cost effective material combinations for high CO_2 selective membrane preparation and process development.

Ideas are invited in the following categories: (Contd.....)

7) Carbon dioxide (CO₂) to Chemicals

Global warming caused by remarkable increase of Carbon dioxide CO₂ emission in the atmosphere is the recent age problem throughout the world. CO₂ valorization to value added products is the way forward to mitigate the issue. The research progressed mainly in the areas of CO₂ to di methyl carbonate, methanol and hydrocarbons. Currently best reported processes in literature are limited to the 30 to 40% conversion of CO₂ to methanol, or syngas which are building blocks for petrochemicals or fuels. To commercialize any of these technologies, high CO₂ conversion with low energy intensive process is required. Innovative catalyst systems and processes are required to produce bulk chemicals including methanol, synthetic fuel, etc. from CO₂.

8) Heat Stable Salt

Industrial level acid gas treatment (removal of CO₂ / H₂S) is achieved by amine treatment units, using amines such as MDEA, DEA etc. One major operational problem related to the amine treating unit is the accumulation of impurities in the amine circuit. These contaminants include metals from other units / equipment, and contain specific ions that interfere with the absorption, amine degradation products and amine by products in the form of heat stable salts. These heat stable amine salts (HSAS) in the solvent / solution reduce the amount of amine available for gas treatment, thereby reducing the unit's productivity, also causes operation problems such as excessive foaming, corrosion, solvent loss etc. Currently removal of HSAS are done by using ion exchange resin methods which are expensive and complicated.

Innovative ideas are required to (a) develop simple method / process which can be employed at industrial level for the removal of HSAS ions from the amine system, (b) Additives which can be used to prevent the formation of HSAS ions, (c) Additives which can be used which will react / compound with HSAS ions and can easily be removed from the amine circulation system.

9) Water Security

The topic of water security has become alarmingly relevant in recent times due to widespread water scarcity throughout the world. There can be several causes to water scarcity including rapid industrialization, deforestation, urbanization, low rainfall, climate change, high population density, and over allocation of a water source. Much of scientific research to ensure water security tried to mitigate the problems by developing purification, decontamination, preservation and recycling technologies. In this regard, Innovative ideas are required in the field of:

- Water purification technologies specifically focused on desalination of sea water and decontamination of ground water through membrane filtration, nanoparticle aided photo decomposition and other relevant methods
- Restoration and preservation of ground water through the use of absorbent materials such as porous clay, Super-Absorbent Polymers etc. or other relevant technologies.

10) E-Mobility

Electric mobility symbolises a promising trend for the future of mobility by reducing the dependency on fossil fuels. Government of India has announced plans to promote e-vehicles on a huge scale by 2030. Its realization is mainly determined by which energy storage technologies are in the research and development stage, and when these will be available for the industry. Currently, Lithium –Ion technology has been most widely used in E-mobility and is popularly believed that additional improvements in energy density can utmost be 30% for this technology. Accordingly, other chemistry and systems are required to achieve targeted capacity of 500 Wh/kg and cost less than \$100/kWh and the potential candidates are metal- air batteries, supercapacitors and their combination.

- a) Metal – Air Batteries:** The most favourable among metal-air battery is Zn-Air which has theoretical voltage of 1.65 V and Theoretical Sp. Capacity~1352 mAh/g while practically achievable is ~ 500 mAh/g.

Novel ideas are required for addressing the following challenges in Zn/metal-air batteries:

- Poor energy efficiency & cycle life.
- Development of suitable Cathode material and cyclable metal anode.
- Zn dendrite formation
- Inert passive layer on Electrodes
- Hydrogen evolution during Charging.

- b) Super Capacitors:** Pseudocapacitors are different from electrostatic or EDLS. When a potential is applied to a pseudocapacitors, fast and reversible faradaic reactions (redox reactions) take place on the electrode materials and involve the passage of charge across the double layer. This faradaic electrochemical processes not only extend the working voltage but also increase the specific capacitance of the supercapacitors.

Novel ideas are required for addressing the following challenges in pseudo capacitor:

- Suitable electrode materials (TMO.TMN, conductive polymers, composite materials etc.)
- Increasing cycle life and energy density.

11) General

Apart from the above mentioned specific areas, we also welcome innovative ideas in the area of resid upgradation, fuel oil upgradation and energy optimisation in petroleum refinery, oxidative desulphurisation, chemical desulphurization, membrane based desulphurization, yield improvement in petrochemical feed stock productions from existing refining processes or using novel processes, energy optimization in petroleum refinery, cost effective hydrogen production and hydrogen storage processes etc.



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Who Should Participate?

Competition seeks participation from students & researchers of different Institutes, Universities and Colleges across India.

How to submit the ideas?

Participants shall submit the ideas through e-mail to ngi@mail.hpcl.co.in on or before **19th August, 2019** in the following format:

- Title of the idea
- Category Name & Number
- Name of the Author(s), Institute, E-mail for correspondence
- Abstract
- Introduction
- Review of literature (Optional)
- Innovation statement with Objective
- Methodology followed:
 - Explanation of method, tools, etc. for the study (If the proof of concept has been established) (OR)
 - Basis of the idea including citation of relevant documents (If the proof of concept has NOT been established)
- References

Instructions

- Total write-up should be limited to 1500 words excluding references.
- One participant can submit multiple entries through separate e-mails.
- The write-up shall be sent in PDF format (< 5 MB).
- Write-up shall be originals and plagiarism is strictly prohibited.
- Ideas will be evaluated based on its Novelty, Applicability, Clarity, Scalability and Integration potential.

Prizes for the Winners

- 1st Prizes worth Rs. 50,000/-
- 2nd Prizes worth Rs. 25,000/-
- 3rd Prizes worth Rs. 15,000/-
- Consolation Prizes worth Rs. 5,000/-



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