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Prospects of Green Ammonia for Fertilizer Production

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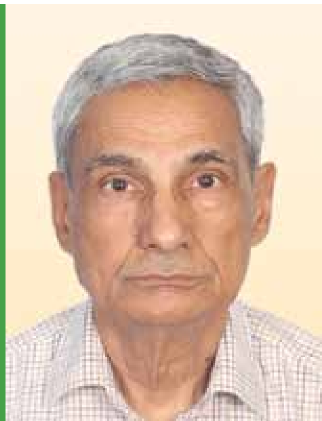

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India has done well during last five years by achieving an installed power generation capacity of 110 GW from renewable resources. There is target of achieving 500 GW installed capacity by 2030. There is now focus on utilization of green power for decarbonization of economy in consonance with our commitment in meetings of COP-25 in Paris and COP-26 in Glasgow. There are issues in utilization of green power due to variation in generation and connecting with the grid for transmission to consumption centres. Utilization of the stranded green power for production of hydrogen is a promising option. Hydrogen then can be used as source of energy and also as feed for production of a variety of chemical products. At present, hydrogen is generated using fossil fuels mainly natural gas. This is called grey hydrogen. Generation of hydrogen with renewable energy is called green hydrogen. Green hydrogen will play an important role in reducing carbon footprint of our economy. Hon'ble Prime Minister launched the National Hydrogen Mission on India's 75th Independence Day.

There are various industries like refineries, fertilizers, steel, etc. which can use green hydrogen. Fertilizer industry is one of the largest user of hydrogen for production of ammonia. Ammonia is the essential input for production of all nitrogen containing fertilizers *viz.* urea, ammonium sulphate, ammonium chloride and various grades of NP/NPK complex fertilizers. Hydrogen required for production of ammonia at present is derived mainly from natural gas. This also generates carbon dioxide both as feed and fuel. Carbon dioxide generated from feed gas is completely converted to urea-the most popular fertilizer used in India. Only carbon dioxide generated from fuel natural gas is let off to atmosphere. About 2 MT of carbon dioxide is generated in production of 1 tonne of ammonia. Of this, 1.4 MT carbon dioxide is converted to urea. It may also be clarified that pure hydrogen is nowhere present and it is always present in a mixture alongwith carbon dioxide and nitrogen. However, technology for production of ammonia from pure hydrogen is well established.

Storage and transportation of hydrogen still has various challenges including that of safety and infrastructure. But storage and transportation of ammonia though requires elaborate arrangements, has been well established. Large quantities of ammonia are transported by road or rail tankers and ships throughout the world. Therefore, ammonia can not only be used as feed in chemical industry but can also work as energy carrier. Energy density of ammonia being thrice that of compressed hydrogen makes it better option as source of energy.

In India, we produced 15.3 million tonnes (million MT) of ammonia in 2020-21 which was mainly used for production of urea. Production of urea requires captive production of ammonia and carbon dioxide. About 2.6 million MT of ammonia was imported to produce various grades of complex fertilizers in the country where carbon dioxide is not required.

There are two possibilities of replacing grey hydrogen with green hydrogen in fertilizer production. From technology point of view it is quite feasible to utilize green ammonia in production of complex fertilizers and ammonium sulphate. These products consume yearly about 3 million MT of ammonia equivalent to about half a million tonne of hydrogen. Ammonia can be procured from any source to produce these fertilizers. But economics of use of green ammonia has to be worked out. The second option is to use green ammonia for production of urea. In case of production of grey ammonia, carbon dioxide is generated in situ and its recovery from

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feed gas mixture is part of ammonia production. Since there is no co-production of carbon dioxide in production of green ammonia, one has to recover carbon dioxide from other sources *viz.* furnace or boiler flue gases. Needless to mention that it will be additional cost. Such a source should be available on the same site because compression and transportation of carbon dioxide will require new infrastructure and will add to the cost of carbon dioxide significantly. It means one has to necessarily have fossil fuel based utilities at the site.

The existing ammonia- urea plants are highly integrated and involve multiple processing steps for production of ammonia and urea. It is often suggested that green hydrogen can partially replace the grey hydrogen for production of ammonia in the plants. This will reduce urea production due to non-availability of sufficient carbon dioxide. Recovery of carbon dioxide from furnace flue gases will increase the cost of production of urea. But the more important aspect is that partial use of green hydrogen will require modifications in equipments and operation of the plant affecting the energy efficiency of ammonia production. Therefore, one has to be extremely cautious while implementing any scheme of use of green hydrogen in existing integrated ammonia-urea plants.

As far as economics of production of green ammonia is concerned, there are three distinct elements; delivered cost of green electricity, production cost of green hydrogen and finally cost of production of green ammonia. Government of India has already notified Green Hydrogen Policy on 17th February, 2022. The policy provides for 'waiver of inter-state transmission charges for a period of 25 years to the producer of green hydrogen'. This alongwith other concessions provided in the policy will reduce the delivered cost of green electricity for green hydrogen producers. Production of hydrogen through electrolysis route is highly capital intensive. It is hoped that government will take steps to encourage domestic production to reduce cost of electrolyzers. Finally, production of green ammonia will require installation of air separation plant for generation of nitrogen for synthesis of ammonia from a mixture of hydrogen and nitrogen. If the cost of hydrogen is competitive with grey hydrogen, cost of ammonia will also be competitive with ammonia produced from natural gas.

The other important consideration in production of both green hydrogen and green ammonia is steady availability of green electricity on 24 hour basis in all seasons. Since there will be huge fluctuation in availability of power, downstream electolyser and ammonia plants will have to be carefully designed. In case of ammonia, the plant has to be so designed that it can operate at wide range of designed capacity. Another solution is that plant can operate in hybrid mode i.e. using mixture of green and grey hydrogen. Storage of green electricity and hydrogen are the other options. Obviously, one has to utilize combination of all these options to improve the techno-economic viability of green hydrogen/ ammonia projects.

In view of steep increase in cost of energy from conventional sources, green energy offers an opportunity not only to decarbonize the economy but also provide substitution to imported energy, imported ammonia and imported fertilizers. To begin with, green ammonia can be utilized for production of complex fertilizers. Further policy support will be required to make production and use of green hydrogen and green ammonia a viable proposition. Production and use of green ammonia both as feed and source of energy will help India to be 'Aatma Nirbhar' for her need of energy and fertilizers.■