◉ THE TIME IS NOW

Biofuel alliance must turn to tech to tame costs

KEY FACTOR. For rapid adoption of biofuels, costs must come down drastically. This can only happen through breakthrough technology

M Ramesh

The world wants to switch over from fossil fuels to biofuels, but there is a problem: biofuels derived from non-edible feedstock are expensive. Unless costs come down, initiatives such as the Global Biofuel Alliance may not take off.

A litre costs around ₹110, compared with ₹65 of the first-generation biofuels (derived from edible items like corn and soya).

Since we cannot afford to divert agricultural lands meant to grow food for the production of biomass for biofuels, the need of the hour is the 2G biofuels. However, for rapid adoption of these biofuels, costs must come down drastically. The only way that can happen is through breakthrough technology. Broadly, there are two ways technology can help. One, by developing better catalysts that can increase yield and two, by finding ways of making other chemicals from biomass.

Biomass is essentially 'lignocellulosic'. It contains three elements—lignin, hemicellulose (branched polymer molecules) and cellulose (long chain polymer molecules).

Cellulose is the one that gets converted into biofuels. This is where catalysts will help. Scientists are working on developing better catalysts.

Hemicellulose can be made into valuable chemicals, called 'platform chemicals'—mainly into furan dicarboxylic acid (FDCA), which can replace the petroleum-derived terephthalic acid used in the manufacture of PET bottles.

Lignin, a glue-like substance that binds cellulose and hemicellulose together in plants, is generally considered to be a waste and the joke among chemical engineers is that you can make anything from lignin, except money. Lignin is used as fuel for industrial boilers, but researchers say that the high-carbon content biochemical can be mixed with bitumen for surfacing roads, locking-in carbon. Research is also happening in valorising hemicellulose and lignin. Valuable by-products from these can bring down the cost of the main produce—biofuels.

CHALLENGES GALORE. The biofuel industry needs governments' support to confidently bet on new technology

But, the critical research is in developing catalysts—chemicals that do not participate in the reaction but enable them.

Researchers have only recently begun exploring various catalyst candidates for biofuels. "Till now, only a few catalysts have been explored, which can break these strong polymers into useful chemicals and biodiesel," says a January 2023 paper by researchers Tripti Chabbra and Venkata Krishnan of IIT Mandi, published in the journal, *Fuel*.

In another scientific publication titled 'Nanotechnology based technological development in biofuel production: Current status and future prospects', the authors, Zaheer Ud Din Sheikh, et al, of the Central University of Jammu, J&K, note that "in biofuel production, nanoparticles can be broadly categorised into carbon based, metallic, ceramic and semiconductors." The paper delves into the merits of each.

The conversion of cellulose into (sugar monomers such as glucose and xylose, and then into) biofuels is by a process called 'enzymatic hydrolysis'. Nanoparticles, especially magnetic nanoparticles, can assist in making the biomass conversion process more economical, the paper argues. It notes that nanoparticles of metal oxides are good, as they "enhance electron transfer and boost enzymatic activity and thereby increase biofuel production." Further, nanoparticles of silver and gold promote the growth of microbes, which again help increase biofuel yields.

Scientists are taking nanoparticles a step further, tweaking their composition, size, shape and properties—a branch of science called 'nanoarchitectonics'. Chabbra and Venkat Krishnan have worked the nanoparticles of a metal oxide, called niobium pentoxide (Nb_2O_5) into a flower-like structure (florets) to further enhance its properties.

Prof R Vinu of the Department of Chemical Engineering, IIT Madras, has developed a 'lignin-first approach', which stands the biorefinery on the other leg. In this, the lignin is first separated and converted into phenols for use in some industries such as perfumery. The rest of the biomass, rich in cellulose and hemicellulose, is a better feedstock for the biorefineries, says Vinu.

LAB TO INDUSTRY

So, the biomass is there in the agricultural fields—India produces 750 million tonnes every year. The technology is there in the labs. However, technology, especially the new generation catalysts, are miles away from commercialisation. Dr Milind Patka, President (Biofuels), GPS Renewables, a 11-year-old Bengaluru-based biofuels manufacturer, told *Quantum* that no technology provider has offered the company any yield-enhancing nano catalyst. Vinu points out, it is one thing to develop a catalyst in the lab but quite another to mass-produce it.

The Ministry of External Affairs' statement announcing the launch of the Global Biofuels Alliance, speaks of "facilitating technology advancements". Technology is there; but it needs the governments' support to journey from the labs to the industry. The jump from the labs to the industry is fraught with challenges. The industry needs to be given confidence to bet on a new technology. Patke feels that the government can help by mandating the oil marketing companies like IOC and BPCL to buy some amount of 2G biofuels from the market.

We value your feedback.
Do send your comments to
quantum@thehindu.co.in