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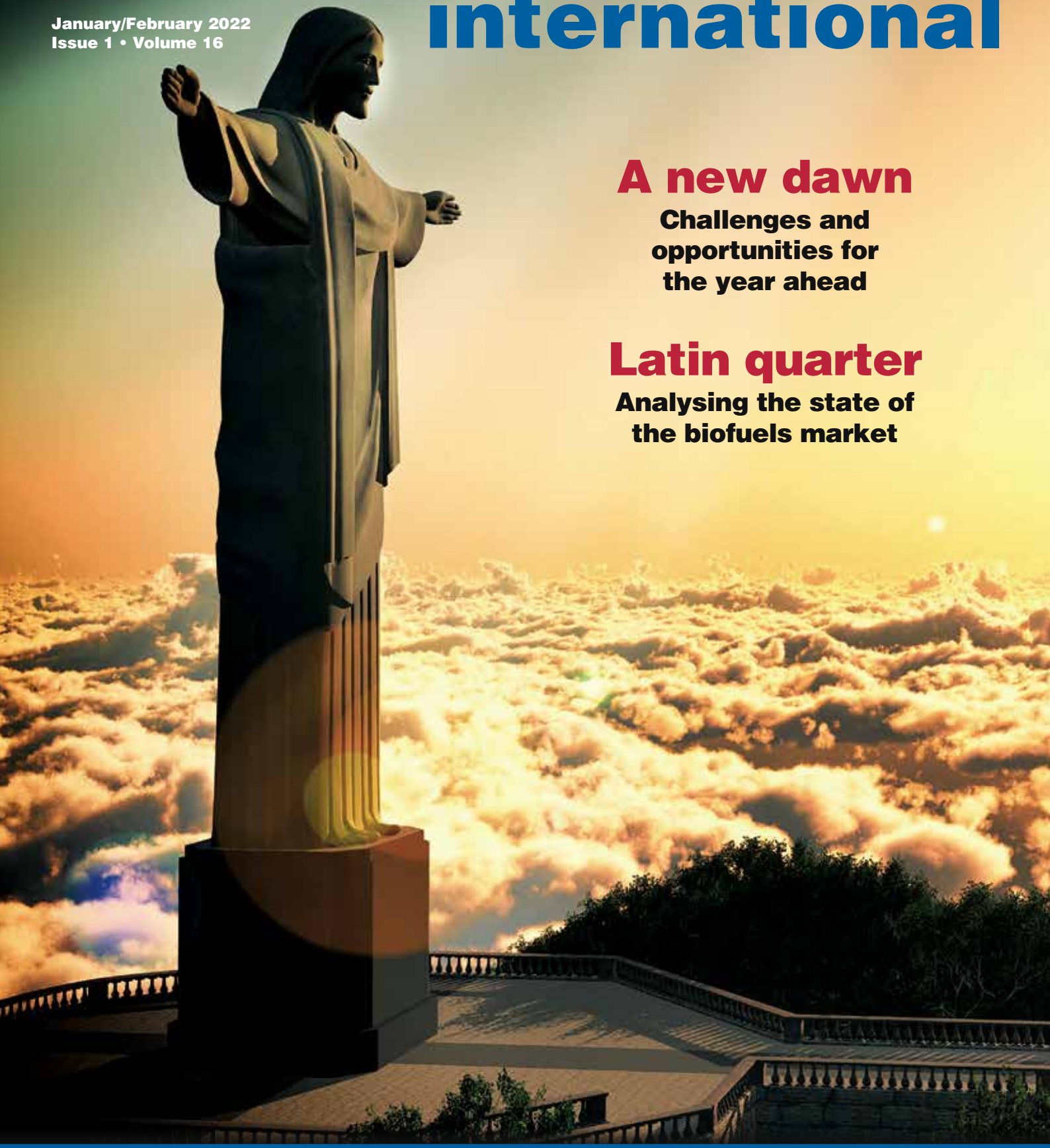


A new dawn

Challenges and opportunities for the year ahead

Latin quarter

Analysing the state of the biofuels market

Regional focus: South America

Mallikarjun Navalgund, president, advanced biofuels and chemicals at Praj Industries, sheds light on cellulosic ethanol technologies Enfinity and Celluniti™ for agricultural and forestry residues

Cellulosic ethanol: A path towards sustainable Bio-Mobility™

With many climate action plans being implemented, additional immediate actions are needed to ensure the climate impacts do not become more dangerous and unpredictable. Some hard-to-abate sectors (e.g. cement, steel and transport) have proven to be particularly recalcitrant. Current climate mitigation efforts are merely reducing the rate of GHG emissions. While taking carbon out of the environment will require technologies that are still under development, it is necessary to deploy all the currently available technologies. For a video link to the pre-treatment process visit: https://www.youtube.com/watch?v=PdDJx5cR3ek

How would you characterise the present cellulosic ethanol landscape?

The enormous environmental and social benefits of ethanol produced from cellulosic feedstock are undeniable. Cellulose is the most abundant molecule on the planet; it does not compete with food or feed, and has a high GHG avoidance potential.

The use of cellulosic ethanol is also being incentivised by favourable government regulations and policies in the US and the EU, amongst others. With these drivers in place, the potential to reduce GHG emissions is in the millions of tonnes, conservatively.

However, it is common knowledge that the industry has yet to break the shackles and realise its true potential, and one of the significant roadblocks for this is perceived to be is the maturity of the underlying technology.

What, in your opinion, needs to be done to improve confidence in cellulosic ethanol technology?

Now, the conventional ethanol (1G) technology is quite well established and has delivered millions of tonnes of carbon abatement and continues to reduce its carbon intensity.

The pre-treatment process step distinguishes the 1G ethanol technology from the advanced cellulosic (2G) ethanol technology. Recent experience has revealed that this stage has posed some difficulties for certain technology demonstration projects, leading to concerns about the technology's development.

As a result, it stands to reason that focusing on pre-treatment process technology will help ensure that technical risks are kept

to a minimum. This can be accomplished by leveraging 'experience' gained from resolving similar challenges.

What have been the key challenges encountered by the first few technology demonstration projects?

From the information available in the public domain about the various projects so far, the challenges encountered in the first few cellulosic ethanol technology demonstration projects include:

- Inefficient pre-treatment system
- Hurdles in bioprocessing
- Difficulty in synchronised operations.

How has Praj overcome the pre-treatment inefficiency challenge?

The pre-treatment step has presented some challenges owing to the presence of extraneous components like soil and debris, clogging of the reactor, and reduced efficiency.

As the cost attributed to the feedstock is the most important element in the cost stack and impacts project economics, gaining higher process efficiency is paramount. How well the pre-treatment step runs largely affects the efficiency of the overall process.

Praj's enfinity technology under the Bio-Mobility™ portfolio utilises multiple strategies in the design and operations of the pre-treatment system based on insights gained from our long and varied experience. These strategies have been validated and ensure the pre-treatment system remains clog-free. As a result, improved process efficiency impacts project economics positively.

"While taking carbon out of the environment will require technologies that are still under development it is necessary to deploy all the currently available technologies"

You appear to place a high value on experience. Why?

Let me use an illustration to show how we have leveraged the bioprocessing experience from 1G technology to make the 2G technology robust.

'Bio-processes' and 'chemical processes' differ on two counts: in bioprocessing, because the feedstock is of natural origin, one finds variations due to the climatic and geographical diversity of the cultivating region. Secondly, microorganisms, which are living beings (fraught with idiosyncrasies like human beings), are responsible for the processing. Hence the experience of bioprocessing in 1G technology is very valuable.

We've learned a lot from developing and deploying 1G ethanol technologies, where we've handled a lot of starch and sugar-rich feedstock over the last 38 years and have literally hundreds of references.

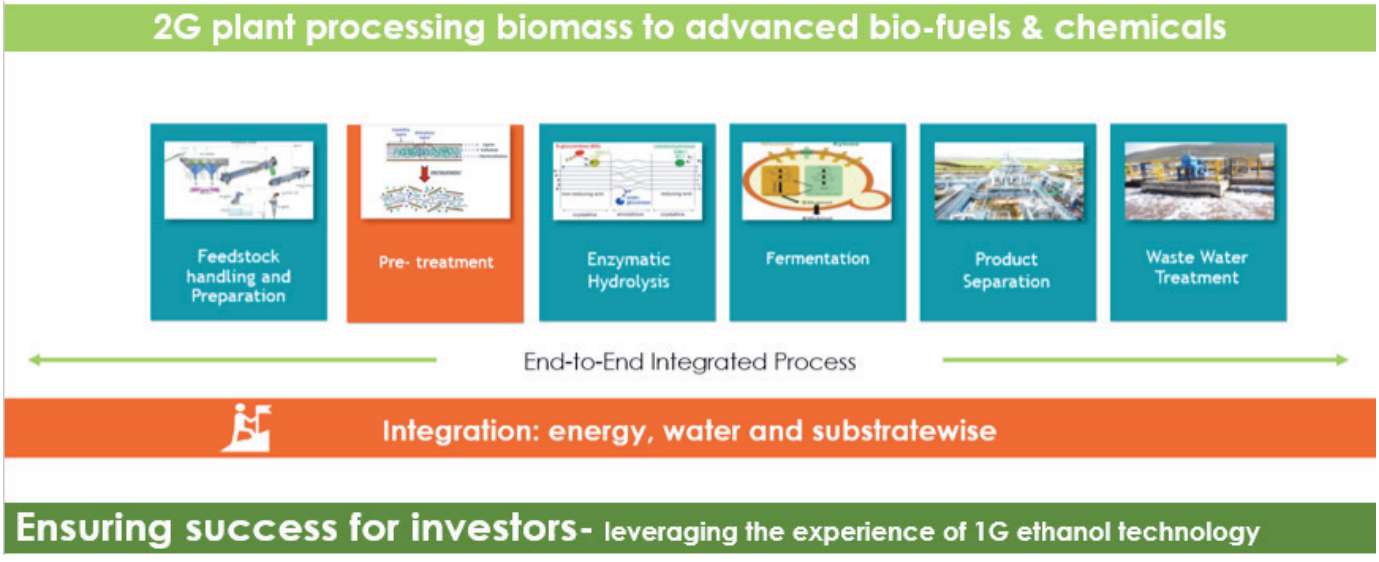
Many of the bio-processing challenges posed by lignocellulosic feedstock are similar to those posed by cassava, (a tuberous starch-rich feedstock) due to similar physical characteristics.

In terms of the sheer number of constituents that are present, no other feedstock comes even close to molasses, which is one of the feedstocks used for producing ethanol. Many of these constituents are inimical to biological processes like fermentation. The number and toxicity of the constituents in the substrate after the pre-treatment step in the cellulosic ethanol technology are similar to molasses. Praj is using the numerous lessons learned from tackling challenges posed by the physical and chemical complexity of feedstock while processing first-generation feedstock to make the cellulosic ethanol technology robust. So, leveraging the vast bioprocessing experience can help minimise risks and improve the maturity of the 2G ethanol technology.

Could you explain what exactly you mean by challenges in synchronised operations in 2G technology?

End-to-end integration of all the process units like pre-treatment, enzymatic hydrolysis, fermentation, product separation steps like distillation and ethanol dehydration, and at times evaporation of the stillage is essential for ensuring the smooth operation of the complete plant at the lowest GHG footprint. This involves two important aspects:

a) **Energy and water integration:** to achieve the lowest GHG footprint possible it is essential that the technology uses the lowest net energy. There are many opportunities to cascade energy used in one unit operation again in other unit operations. This obviously results in lower overall net energy use. The same concept is used to reduce net water use by recycling. All in all, 'good physical integration'



To get insights into Praj's pre-treatment process step CLICK HERE

"Praj is using the numerous lessons learned from tackling challenges posed by the physical and chemical complexity of feedstock while processing first-generation feedstock to make the cellulosic ethanol technology robust"

is necessary to ensure a low GHG footprint.

b) **Process integration:** removal of the constituents causing harm during bioprocessing would obviously be capital and operating costs intensive. Strategies like directed evolution will ensure robust and economic performance.

We utilise our experience in 1G technology to tackle the problems that arise during start-up and under certain exigencies to ensure synchronised operations of all the process units and deliver on the agreed outcome.

How would you see the prospects for Praj's cellulosic ethanol technology going forward?

Praj has been a valued partner to clients all over the world for innovative, sustainable bioenergy solutions for almost four decades. With the apparent risks of cellulosic ethanol technology having been mitigated with enfinity and Celluniti™, Praj is confident of licensing to many others around the world.

Three Fortune 500 energy companies have already shown their confidence by signing licenses for Praj's enfinity technology for their commercial-scale projects. The first project is expected to be completed by the middle of this year, with the other two projects following in the course of the year.

Can you give us a glimpse of other focus areas for Praj within the bioeconomy?

In addition to the abundance of agricultural lignocellulosic feedstock, a huge amount of forestry residues are available in Europe and the Americas. Harnessing these residues to produce biofuels and biochemicals is of interest to the bioeconomy.

Praj has partnered with Sekab of Sweden to deliver Celluniti™ technology, which harnesses forestry residues to produce cellulosic sugars, biofuels & chemicals. By providing Bio-Mobility™ solutions for the transportation industry in the form of advanced biofuels derived from softwood, the Praj-Sekab alliance will help to achieve long-term carbon reduction.

Sustainable aviation biofuels in partnership with Gevo, Inc. and technologies for an array of biochemicals under development are some of the other focus areas towards which significant resources have been deployed. ●

For more information:
Visit: praj.net
Mr Navalgund will be speaking at our Biofuels International Conference and Expo in Brussels on 5-6 July.
Visit: biofuels-news.com/conference/biofuels/biofuels_index_2022.php