How to go green?

Nitesh Mehta of **Newreka Green-Synth Technologies** and **Krishna Padia** of the **Green ChemisTree Foundation** look at the barriers to implementation of green chemistry

Green chemistry is now moving into a phase where most people are not asking whether to implement it or not but how. Relevance is no longer the question. Most chemicals industry stakeholders are clear that green chemistry is a powerful tool for a sustainable future.

As industry grapples with shrinking margins and increasing pressure to comply with environmental norms, it has started seeing green chemistry as a tool that can enable it to achieve both economic and environmental competitiveness. Academic and research institutions see it as an area for research where they can do meaningful work and contribute towards solving problems.

Teachers, meanwhile, are beginning to see the relevance of teaching green chemistry to equip students better deliver on the expectations of industry and society. Students now see it as a very promising and growing field with potential to provide great career opportunities. Government and regulatory bodies have realised the role that green chemistry can play in improving the quality of air, water and soil.

The next question for all of them is 'How we can go about it or how we can accelerate the inclusion of green chemistry in our domain or in our area of accountability?' Various barriers to implementing green chemistry are being encountered, which must be identified and confronted before we can accelerate past them.

Newreka GreenSynth has engaged with industry to develop, scale up and commercialise green chemistry-based technologies, as well as working with its non-profit organisation, the Green ChemisTree Foundation, to expand the awareness of green chemistry. Thus both have had first-hand experience of some of these barriers.

To overcome them barriers and to accelerate the implementation of green chemistry in industry, initiatives need to be taken on multiple fronts simultaneously. Such issues will be addressed at the forthcoming Industrial Green Chemistry World (IGCW) in Mumbai on 6-8 December.

Among the most important barriers is the **availability** of green chemistry-based technologies. The green chemistry toolbox - that is, a set of platform technologies, based on the principles of green chemistry and engineering, which offers an alternative to conventional synthetic chemistry-based processes and chemistries - is still quite empty.

We still do not have viable green routes for many chemistries and processes, like, for instance, nitration, sulphonation or Friedel-Crafts reactions. Industry still carries out these chemistries using huge quantities of acids, alkalis and other reagents. Low conversion, poor selectivity, low yield and huge effluent generated makes these processes undesirable but there is no other viable option.

IGCW returns to Mumbai in December

This is one barrier which academic and research institutes can make significant contributions to overcoming. Creating some fundamental innovation in these areas is a very relevant problem on which these institutes can work.

The **scale-up and commercialisation** of green chemistry-based technologies is another major issue. Many inventions and innovations have already been developed by various academic and research institutes and are potential solutions for some of the environmental challenges faced by the chemicals industry. However, for whatever reasons, these have not been pursued beyond lab-scale.

This is a barrier, because it calls for both academic and research institutes as well as industry to stretch themselves beyond their boundaries. The former need to make extra effort to customise systems and demonstrate their technical and commercial viability at a reasonable scale, in order to gain industry's confidence. The latter needs to take the risk associated with the scale-up and commercialisation of new technologies.

A related problem is **connecting** green chemistry solution providers to industry. Many such solutions, the proverbial low-hanging fruit, are ready and proven but remain unused because the industry and the solution providers are in different parts of the world, or because there is a communication gap between them. Often, there is insufficient marketing by the solution provider, as is usually the case with academic and research institutes who do not proactively market themselves to industry, while industry may not be putting enough effort into finding new solutions.

More fundamental is the **limited understanding** of green chemistry and engineering principles among chemists and chemical engineers. It is critical to ensure that a team has a working knowledge of these principles and also to introduce green chemistry into academic curricula so that the next generation of chemists and chemical engineers is shaped to 'think green'.

Certain common **myths about green chemistry** are also a barrier to the implementation of green chemistry. These include the view that green chemistry is good in theory but not practically feasible, difficult and complex, not viable for SMEs, or that it requires huge resources.

Newreka has commercialised many green chemistry-based systems, ever for SME pharmaceuticals and fine chemicals companies, that involve hardly any capital investment and break-even periods as low as three months, though some may take longer to develop and may require more resources. We have many case studies that prove that the perceptions are myths.

Regulatory barriers are also a major challenge for the pharmaceuticals industry and others where any change in process has to go through validation trials and changes in documentations and filings, as well as approvals from the internal regulatory affairs team, customers and, finally, external regulatory agencies like the US FDA. Beside the time invested in the tedious process of making these changes in DMF filings, this also involves significant costs.

Hence, only when the green chemistry-based alternative offers returns that justify the investment of time and money does it see the light of the day. Nonetheless, many pharmaceuticals companies have now started exploring green chemistry-based routes of synthesis right during the initial phase of development of the molecule.

Looking at the vast number of generic drugs being manufactured through synthetic chemistry processes with high E-factors, it is worth considering the possibility of creating a fast track for the regulatory approval of process changes involving green chemistry and engineering, without, of course, compromising on any other aspects of evaluation procedures of FDA. It is also worth considering offering some discount on the costs involved for filing such changes. These would offer encouragement to the pharmaceuticals and other industries to implement green chemistry.

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