Biotechnology

Emerging opportunities

The application of biotechnology in a wide range of applications has led to both economic and environmental benefits. It has also opened the possibility of decoupling economic growth from environmental impacts. As the technology continues to be developed and diffused through a wide range of industries, the economic and environmental benefits are predicted to grow. Of late, paints & coatings manufacturers as well as users are placing more emphasis on ecological compatibility, and are therefore demanding raw materials with ecological benefits. An insight…

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The global economy today depends to a large extent on energy, chemicals and materials derived from crude oil. Petroleum has provided fuel for transportation and heating, and it is also used in manufacturing of a wide range of products - from synthetic chemicals to plastics, adhesives, and paints.

The age of crude oil has resulted in massive pollution and the emission of greenhouse gases responsible for climate change. The price of crude oil has shown great volatility and a few months ago, it was priced at over $ 135 per barrel, compared to $ 15 per barrel 10 years ago. The present level of energy consumption, production and industrial growth is not sustainable because they are using a resource that is finite and diminishing. There is realisation that both the management and usage of natural resources need to change. It needs to become more sustainable.

Industrial sustainability

According to Organization for Economic Co-operation and Development (OECD), an industry is sustainable when 'it produces goods and services in such a manner as to meet the needs and aspirations of the present without compromising the ability of future generations to meet their own needs'.

In the Shell Report 2000, sustainability was captured as follows: 'Excellent environmental performance is meaningless if no wealth is created. Wealth in a destroyed environment is equally senseless. No matter how wealthy, a society fundamentally lacking in a social equity cannot be sustained.' What this statement implies is that for industry to be sustainable, it must meet the following three conditions:

- It must be economically viable by creating wealth and profits through the use of natural, financial & human capital
- It must be compatible with the environment by using eco-friendly products and processes to preserve biodiversity
- It must be socially responsible by managing the impact of its productions

Technology as a key driver

Technology is a key element in achieving cleaner production and sustainable growth. Sustainable means clean enough to meet the needs of the present without compromising on the ability of future generations to meet their own needs. There are already some technologies available to help achieve this objective, and the UNEP International Cleaner Production Information Clearing house has provided information on some of them.

Further, as production doubles, the environmental impact doubles. In the case of sustainable growth, as production increases, so should the environmental performance, or 'eco-efficiency'. The expectation should be that new technologies introduced to bring production improvement must also bring eco-efficiency.

Since there is a lag between technology development and the point where this becomes an industry standard, the R&D work being performed today should target a quite significant achievement in environmental performance. The level and target of R&D must take into account the current situation. If the current environmental impact of existing productions is not sustainable, then the environmental performance targets for new technologies to address this will have to be raised even higher.

For a technology to be adopted, it must provide a significant net positive value in terms of its economic and/or environmental performance. It takes 25 years for a technology, which is now being introduced into the industry to become an industry standard. Technologies at the R&D stage today will take an average of 10 years to be developed to the 'market ready' stage, ie, where it is attractive for the industry to begin adopting them.

Technology that is ready to be introduced into the market today should have an environmental performance at least three times better than the current industry average (that is the emission will be only 33 per cent of what it is today). Technologies that are at the R&D stage today should have an environmental performance at least four times better than the current industry average (that is emission will be only at 25 per cent).

A continued use of conventional processes that are not eco-friendly in combination with non-renewable resources will result in continued pollution and exhaustion of resources. However, if conventional methods are used with renewable resources, then they may lead to depletion of those resources as the global economy grows and demand increases. When cleaner processes are used with non-renewable resources, they will extend the life of those resources by postponing their inevitable exhaustion. Sustainability is most likely to be found where renewable resources are utilised through eco-efficient cleaner processes.

A paradigm shift

It is difficult to achieve a four-fold improvement in environmental performance through incremental improvements in conventional production technologies. Improvements of this magnitude will call for a major paradigm shift. This shift is due to products and processes found in natural ecosystems and organisms. One technology that has enabled this shift is biotechnology. Advances in biotechnology have also enabled improvements in environmental performance.

Biotechnology has evolved (over the past 20 to 30 years) into

a set of powerful tools for developing and optimising the efficiency of bioprocesses and the specific characteristics of byproducts. The increase in efficiency and specificity achieved with biotechnology has great potential for moving the industry along the path to sustainability. Increased efficiency allows for greater use of renewable resources without depleting them. Biotechnology has the potential to allow greater economic growth while preserving the environment. It allows the design of processes and products whose performance cannot be achieved using conventional chemistry or crude oil derivatives.

Biotechnology offers tremendous growth opportunity for the industry. Chemical companies have strong manufacturing skills and distribution networks, and can thus exploit biotechnology. Those skills would need to be complemented with specific biotechnology skills, alliance management skills and effective financing & risk management skills. For chemical companies, product development times are long (from five to ten years), the technology is complex, and it is dynamic. Every few years, a new technology arises that makes the existing ones redundant. The market risk is often seen to be high. Consumer acceptance for agro products is limited in some areas because of doubts about the long-term impact on health and the environment. The risks of moving into biotechnology are much smaller in chemical businesses other than the agrochemicals sector. And, for those businesses, consumer acceptance is often high because of the environmental benefits, besides the R&D costs being lower because of the shorter replication cycles in microorganisms & fewer regulatory hurdles.

Transforming chemical processes

Modern biotechnology has the potential to fundamentally transform chemical processes and products. Its application is likely to grow more than tenfold over the next decade. Companies with vision and aspiration will drive the speed of development. There are a number of examples of biotech-based processes and products involved in the manufacture of paints & coatings that are already available. Biopolymers as substitutes for synthetic polymers, enzymes and modified additives in specialties and modern fermentation as a production process for basic & intermediate organics are some that can be cited. They have to be seen within a much larger evolution of biotechnology in its applications. This evolution includes fine chemicals, (where some of the first applications of biotechnology happened) and intermediates chemicals.

Ecological manufacturing approaches

Polymers and resins commonly called binders by the coating industry are the main vehicles for the coatings. The main types include alkyds resins, polyesters resins, isocyanate (polyurethane), drying oils and acrylic emulsions. Due to increasing environmental regulations on volatile organic compounds (VOCs), the industry has been focussing on how to reduce VOCs in paints formulations, and seek ecological manufacturing approaches. Biotechnology is offering this opportunity for feedstocks and formulations with non-petrochemicals components.

Polymers

Cargill Dow (USA) uses biotechnology to produce polylactic acid (PLA), a biopolymer that is energy efficient and uses renewable feedstocks. In some applications, it can replace nylon, polyethylene terephtatate (PET), polyester and polystyrene. The biotechnology-based process requires 20 to 50 per cent less fossil fuel energy. The production of polyesters by the conventional methods requires either titanium or tin based catalyst with solvents at a temperature of about 200°C. The company is also building a

$ 22-million, renewable polyols plant in Chicago, scheduled for startup in November. The world-scale facility will produce Cargill's proprietary soybean-based polyols, which can replace petroleum-based chemicals for production of polyurethane products. Cargill currently supplies customers with its renewable polyols through toll processing agreements. Baxenden Chemicals (UK) has developed a process that uses the enzyme lipase to catalyse the polymerisation reaction at a temperature of only 60ºC. This biotechnology-based method eliminates the use of organic solvents and has resulted in considerable energy savings.

Bio-based powder coatings

Researchers from Battelle, the Ohio Soybean Council (USA) have pulled together to develop a bio-based powder coating technology based on soybeans and corn. These are renewable resource feedstocks. The bio-based powder coating technology also enables low-temperature curing, which leads to lower overall energy costs, although it can also be used on high-temperature substrates, such as metals. There is great interest in the replacement of some petrochemical feedstocks with bio-based feedstocks for use in a wide range of applications. Hexion intends to take advantage of this new technology.

Conclusion

Biotechnology is an answer to the problem of sustainability that the chemical industry is confronting. The advantages that have enabled the use of biotechnology in some industries is applicable to many chemical industry segments and allied industries such as paints and coatings:

- Biotech-based processes have substantially lower capital and manufacturing costs. These are cost-effective
- It allows for greater flexibility because the minimum plant size to achieve economies of scale is much smaller
- It is more eco-friendly because there is less wastage and less energy consumption, and the resulting products are often biodegradable
- It is more sustainable because it relies more on renewable resources
- It is potentially revolutionary because it holds out the promise of features unknown in existing synthetic materials

Chemical companies have a good basis for moving into biotechnology. They have strong manufacturing skills and distribution networks, but they do need to complement these with specific biotechnology skills, management skills, and effective financing & risk management skills. This also opens opportunities for the paints and coatings industry. Biotechnology offers hope to both developed and developing countries.

It gives the developed countries an opportunity to shield themselves from the fluctuations in the price of energy and availability of petrochemicals. It also helps them diversify. As far as developing nations are concerned it gives them a chance to leapfrog (at least in part) from fossil fuels and petrochemicals to the age of bio fuels and biochemicals. These are less toxic and more biodegradable than their petrochemical counterparts and can be derived from locally grown feedstocks, leading to an improved economy and better quality of life. CW

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