TECHNOLOGY LED GROWTH IN PERFORMANCE/SPECIALITY CHEMICALS: EMERGING OPPORTUNITIES

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Mumbai June 25, 2008

Introduction

The size of the global chemical industry is estimated at approximately US $ 1 trillion, consisting of three broad segments, namely commodities (US $ 950 billion), pharmaceuticals and agrochemicals (US $ 750 billion) and fine chemicals and specialties or performance chemicals (US $ 90 billion). Chemical industry occupies a significant share of every country GDP and is a major supplier to almost all sectors of the economy, producing more than 80,000 products. Chemical industry spans a wide range of manufacturing scales from small to very large and diverse value scales from a few cents a kg to hundred of dollars a kilogram.

The fine chemical industry globally is at a crossroad. Flat growth rates, endemic industry cycles, in terms of both operating rates and pricing, mergers, acquisitions and restructuring, low cost competition from emerging economies, such as China and India and excessive regulatory pressures related to environment, health and safety have characterized the fine chemical industry over the last decade.

Furthermore, specialty chemicals industry has been progressively demerged from commodity segment to fulfill the need of a differentiated business. Similarly, the life sciences and pharma segment of the chemical industry has also seen a separation into independent entities.

The future of the global chemical industry can be viewed from both a sense of optimism and pessimism. The sense of optimism stems from the fact that there are many emerging opportunities for specialty chemicals in high end applications, new technology platform awaiting to be exploited, opening of new markets in emerging economies and operational efficiencies one can realize through use of information technology. The pessimism originates from issues such as newer regulatory systems put in place by community of nations, increasing consumer concern for product safety, historic decline in innovation, continuously increasing energy and feedstock costs and frequent economic upheavals in countries around the world. Every company is striving to find a way to differentiate their offerings in the market place and responding with great agility to the process of faster commoditization of products.

Newer business models are being experimented with companies positioning themselves, either as low cost producers ("operators") or as those offering differentiated products or services ("solution providers").

A specialty chemical company needs to choose from one amongst the following six models to survive the future. These are a) new product developer b) application developer c) systems solution provider d) process technologist e) value chain integrator and f) low cost producer. These models have to be matched with the type of chemicals produced, the needs of the customer and the state of the segment's maturity.

Several potentially useful growth strategies can be applied to specialty chemical sectors. These are, increasing focus on service – based business models, development of new technologies, lower transaction cost of business through use of IT tools and entering new parts of the value chain.

The Indian Chemical Industry

The Indian Chemical Industry is one of the oldest industries in India. With the current annual turnover of around US $ 40 billion, it has emerged as a significant contributor to the economy. Indian Chemical Industry has a share of 6.7 % India's GDP and 10% of country's total exports. The Chemical Industry is ranked 12th in the World and 3rd in Asia. The industry exhibits a robust growth (CAGR) of 10-12% and is likely to reach a turnover of around US $ 75 billion by 2011. Although commodity chemicals still account for almost half of the industry output there is visible shift towards specialty and performance chemicals.

In this last decade, the Indian Chemical Industry has focused on either exports or positioning themselves as preferred low cost global suppliers, largely capitalizing on the cost arbitrage. In the process, the Indian companies have upgraded product and service quality, invested in new technologies and built new plant capacities. However, Indian companies have been beset with many weaknesses. These include poor investment on innovation, weak marketing and inadequate technical service to customers towards product formulation/applications. Globally India is seen more as an outsourcing destination rather than as provider of research based solutions. The industry is also confronted with increasing cost of petroleum derived feed stocks and intermediates, escalating energy costs and low priced competition from China in the global markets.

Yet India has several advantages that can propel it into a dominant player in the global markets. These are excellent process chemistry and engineering skills, low cost equipment manufacturing capabilities and large internal markets. If these advantages are leveraged with innovative R&D, improved process efficiencies and use of raw materials/building blocks where India possesses

unique advantage, then the Indian performance chemical industry can emerge as a force to reckon with in the global markets.

Technology Innovation Strategies

Technology is one of the important economic drivers for the survival and growth of the performance chemical industry. Our ability to use science to create economic wealth has historically increased at an exponential rate. However, proliferation of scientific knowledge also dramatically lowers competitive barriers. Apart from technology, use of sophisticated design and manufacturing tools reduce time-to-market for products. Consequently, a new high value product is likely to be obsolete or quickly commoditized by "me-too" products in the markets. Creating a high entry barrier to competition is thus a key strategy for innovation in performance chemical industry. Companies can create entry barriers, through enhanced manufacturing efficiency, a flexible and efficient R&D strategy and planning for uncertainty. In fact the ability to embrace and effectively deal with uncertainties will become an increasingly key competitive differentiator.

The performance chemical industry needs to set broad technology goals to stay competitive. Focus must be on reducing feed stock losses to waste and byproducts, reducing energy intensity, reducing emissions and effluents, shift to lower cost feed stocks, reduce time-to-market and increase number of new products and applications. In the process, the performance chemical industry must aim to become sustainable with reduced environmental foot prints and enhanced product safety in application.

Technology Platforms for Performance Chemicals

Several new technology platforms are emerging which can be of great significance to the future sustenance of fine/performance chemical industry. These are,

- Clean Technology
    - Solid catalysts
    - High specificity / atom economy
    - Green solvents
- Chemistry in Unusual Media
    - Supercritical CO_2 and water
    - Aqueous media
    - Ionic liquids
    - Reaction in dispersions, suspensions and emulsions
    - Solid state reactions

- Industrial (white) Biotechnology

    - Biocatalysis and biotransformations
    - Bio-based building blocks
    - Fermentation processes

- Chemistry Toolboxes

    - Chiral switches / single enantiomers
    - Microencapsulation
    - Synthetic chemistry tool boxes (e.g. Suzuki coupling, catalytic hydrogenation, metathesis, click chemistry etc.)
    - Crystal engineering and polymorphs

- Unusual Reaction Conditions

    - Photochemistry / photocatalysis
    - Electrochemistry
    - Microwave
    - Sonochemistry
    - Plasma

- New Processes and Process / Product Strategies

    - Chemical product engineering
    - Process intensification
    - Micro-reaction engineering
    - New reactor and mixer designs
    - Novel separation processes especially membrane based processes
    - Computational modeling, simulation and visualization

Success in developing these technology platforms and their application to specific products will require focused in-company research efforts, a deep understanding of customer's unmet needs, a sales team capable of growing new markets and developing new applications in partnership with customers and industries ability to partner with institutions of higher learning and research who develop new knowledge and insights through cutting edge research. Companies need to create internal benchmarks and metrics to measure the effectiveness of innovation. By today's standards, a business unit would need to see 5-10% of its sales derived from products introduced in the past five years for every 1% of its sales invested in product R&D. In process R&D, every 1% sales invested should achieve a 2-5% reduction in production costs. A recently global study of 27 companies drawn from North America, Europe and Asia showed that only 20% of companies succeeded in generating substantial returns on R&D investment and with over 60% of companies generating negative returns on R&D spend.

Many barriers for successful innovation have been reorganized. They are, poor targeting of research, lack of adequate risk capital to create new ventures and poor implementation skills resulting in longer time to market. An area of great concern globally is the inadequate number of skilled professionals in chemistry and chemical engineering. The chemical industry has also cut back on research leading to disruptive innovations. Instead, the focus has shifted predominantly to incremental, customer-led, innovations. Unless the chemical industry sector is more deeply engaged in pushing the boundaries of chemistry/chemical engineering and addresses the more risky unmet needs of the customer, it is unlikely to remain competitive for long.

R&D in Performance Chemicals at National Chemical Laboratory (NCL), Pune

NCL is the largest publicly funded R&D laboratory in India devoted to chemical sciences, engineering and technology. It has an established record of partnership with industry, both within India and globally. NCL has been addressing many of the key technology platforms need for fine chemicals industry. Some of these are clean technology through use of solid catalysts, reaction in supercritical water, development of globally competitive processes for performance chemicals, exploiting India's rich biomass resources for producing feed stocks for performance chemicals, chiral switches and single enantiomer processes, micro-reactor engineering and design of novel reactors and development of new membrane development processes. Specific examples will be discussed.

Conclusions

Driven by the compulsions of the three E's namely, energy, environment and equity, fine chemical industry faces great challenges. On the one hand feed stocks and energy based on fossil fuels are escalating in costs. On the other, society demands greater sustainability in the production and consumption of chemicals with concepts such as "carbon negative" or "neutral" technologies, "zero discharge", "total recycle", conservation of natural resources, safety in product use, etc. These competing demands put great pressure on the profitability of the chemical industry.

The chemical industry has to think out of the box if it has to meet these challenges. Chemical industry has been the beneficiary of seminal breakthrough in chemical technology and engineering. Technological innovation has shaped and transformed this business over the course of a century. We are now on the throes of the next wave of innovation. What remains to be seen is which companies will seize the opportunities offered by the new technologies, thereby, becoming more competitive and to some extent reinventing themselves. To succeed in the rapidly changing business environment companies must do

whatever they can to change their historic practices. Failure to do so will most certainly lead to the demise of the enterprise.