ICIS Chemical Business

ECONOMICS DRIVE NEW PETCHEM CATALYST DEVELOPMENT

CATALYST CREATIVITY

INNOVATIVE CATALYSTS PROMISE TO IMPROVE THE ECONOMICS OF CHEMICAL PRODUCTION

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CYNTHIA CHALLENGER

SPURRED BY volatility in the prices of oil, natural gas and the primary products of refining, chemical companies are improving the efficiency and productivity of catalytic processes, and developing new catalysts for the conversion of alternative raw materials.

Some of this activity has slowed in the recession, but the long-term trend is for spending on catalyst research to grow more quickly than GDP, says Clyde Payn, CEO of US-based consultancy Catalyst Group. The market for petrochemical catalysts, which totaled $3.1bn (€2.3bn) in 2007, will also expand faster than GDP, although by less than the 5-6% rate the firm expected a year ago.

COSTS ARE DRIVING CURRENT R&D

"A major trend at the present time is the pursuit of catalyst technology that will improve efficiencies, whether through the reduction of energy consumption, or waste production or by increasing yield and selectivity," says Payn.

For example, a new 300,000 tonne/year propylene oxide (PO) plant in Antwerp, Belgium, from Germany's BASF and US-based Dow Chemical, employs a hydrogen peroxide propylene oxide (HPPO) process that avoids major by-products, in contrast to traditional PO technology. Licensed from Italy-based EniChem, the technology relies on a zeolite TS1 catalyst.

German producer Evonik Industries and German engineering firm Uhde have developed their own direct HPPO process using a new heterogeneous nanocatalyst (precious metal on alumina) developed by US-based Headwaters Technology Innovation Group. South Korean producer SKC has commissioned a 100,000 tonne/year plant in Ulsan, South Korea, that will utilize the technology.

Japan-based producer Nippon Shokubai is building a pilot plant in Kanagawa prefecture for the production of ethylene oxide (EO) via vapor-phase oxidation of ethylene over a silver catalyst.

"This particular catalyst program is very interesting, because Nippon Shokubai is the first company to independently develop a catalyst for this process, rather than license technology from Dow Chemical, Shell or Scientific Design," notes Payn.

German producer Sud-Chemie has several development efforts aimed at reducing capital or operating costs.

"We fully expect that our customers will experience continued challenges with increasing feedstock costs. Only by continued, focused research efforts are we able to maintain our competitive position," says Scott Osborne, the company's director of sales and marketing for petrochemical catalysts in the Americas.

ROADS LESS TRAVELED

A second area of growing importance involves the use of alternative feedstocks such as synthesis gas (syngas) and natural raw materials such as castor oil and glycerin. "This area provides much opportunity, but also has associated with it a high level of risk because success is dependent upon the spread between the price of oil and the alternative feedstock of choice," notes Jeffrey Plotkin, a vice president with global consultancy Nexant ChemSystems.

Castor oil can be converted to polyols, unsaturated fatty acids and alpha olefins. BASF has developed a new catalyst for converting castor to sebacic acid, which it uses to make a polyamide and polyol designed for soft polyurethane (PU) foam applications. The new catalyst avoids odor-causing by-products.

French producer Arkema, which also converts castor oil to polyamides, aims to have more than 10% of its sales derived from products made with renewable resources. One catalytic process being developed by the firm uses a tungstated zirconia catalyst to produce acrolein and acrylic acid from glycerol, a by-product of biodiesel manufacture. A pilot plant should be built in two to four years, according to Jean-Luc Dubois, scientific adviser for catalysis and processes.

"Most of our work with catalysts concerns improving our existing processes, but the goal with this project is to create a renewable alternative for acrylic acid," he says.

A new partnership between Dow and German Sud-Chemie underscores the level of interest in syngas conversion. The companies expect significant results in five years but hope the timing can be accelerated.

"The goal of the project is to develop new catalysts for conversion of syngas to higher value chemical building blocks via more efficient and economical processes that could reduce the world's dependence on oil and help deliver sustainable solutions to global energy challenges," says Osborne.

BASF's Catalysis Research unit in Ludwigshafen, Germany, expects a new *Fischer-Tropsch (FT)* process for converting syngas into olefins to be commercialized within seven to 10 years. BASF researchers are focused on increasing selectivity for two to four-carbon alkenes.

Smaller companies are also active in this area. US-based technology developer Rentech has developed a high-alpha iron-based *FT* catalyst for production of fuels that also produce high-purity waxes (mostly normal paraffins), kerosene range n-paraffins, linear alpha olefins and alcohols. The process occurs at relatively low temperatures and is suitable for use with a variety of feedstocks, including coal, pet coke and even biomass.

The company plans to build a large, fossil synthetic fuel and chemical plant in Mississippi, US and a smaller biomass plant in the US that will use Rentech's iron-based catalyst. "We have found that chemical manufacturers want to have a feedstock source independent of oil and natural gas," says Rick Penning, executive vice president, technology and commercial affairs. "They also like the fact that our high purity *FT*-derived materials can be used to make desirable intermediates in fewer steps than typically required with petroleum-based feedstocks."

With the acquisition of the US microreactor firm Velocys, Oxford Catalysts has combined its catalyst capabilities with the latest microchannel process technology for the production of synthetic fuels and commodity chemicals.

Microchannel reactors can reduce capital expenditure, making them suitable for distributed production. They also enhance safety (see related story, page 24.) The company's carbide-based *FT* catalysts have increased activity and enhanced stability when compared with traditional metals such as nickel, molybdenum and cobalt, and are ideally suited for use in microreactors, according to Derek Atkinson, business development director at Oxford Catalysts.

USING CARBON DIOXIDE

Efforts to manage carbon dioxide (CO_2) emissions help drive catalyst development. "Industry is seeking alternative solutions that involve CO_2 conversion into commercial products that can sustain a full 'CO_2 life cycle' approach," observes John Murphy, president of Catalyst Group Resources, part of Catalyst Group. Such products include polymers, carbonates, acids, esters and ureas.

Catalysts are needed to activate the carbon-oxygen bond. Craig Grimes, professor of electrical engineering at the US's Pennsylvania State University has developed one such system based on titanium dioxide nanotubes, which converts CO_2 and water vapor into methane.

Supply/demand imbalances have also pushed development. "A great deal of current catalyst focus is now centered on novel or improved technologies that can use advantaged feedstocks or processes that produce optimized blends of olefins for subsequent manufacturing applications," Osborne observes.

Faced with a shortage of propylene, consumers are seeking alternatives, while C4 consumers face a shortage as crackers switch to C3 production.

Processes such as propane dehydrogenation and conversion of methanol and ethanol to propylene have been explored using materials such as solid acid catalysts and molecular sieves.

In the C4 area, Japan's Mitsubishi Chemical has demonstrated a new route to butadiene (BD) from waste butenes at pilot scale using a proprietary catalyst.