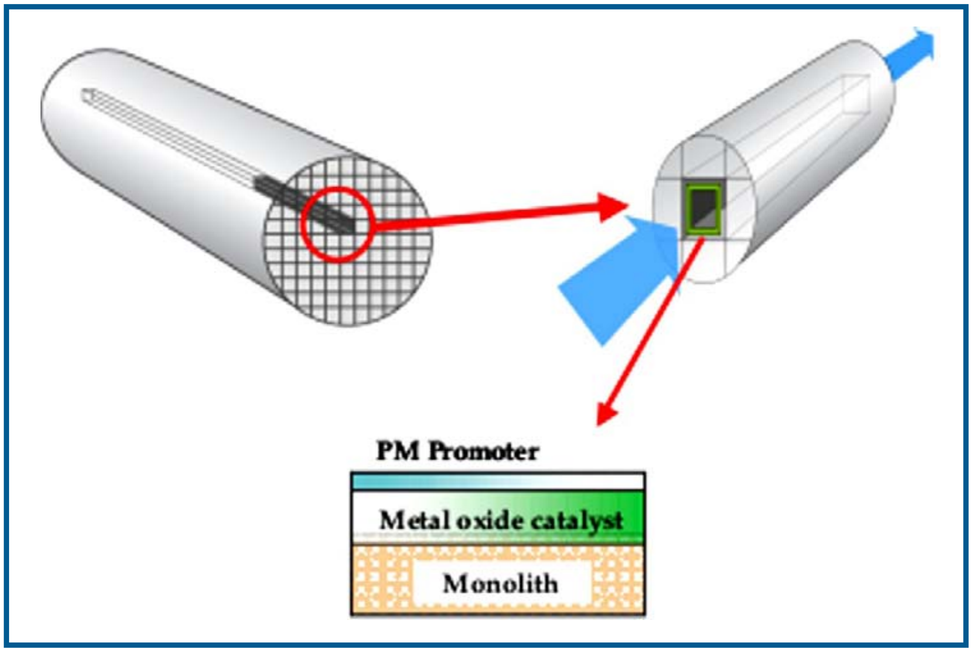
Industrial Technologies Program

Millisecond Oxidation of Alkanes

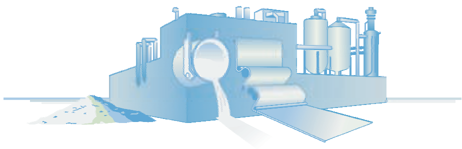
Novel Process Will Replace Conventional Acrylic Acid/Propylene Production Processes

Acrylic acid is one of the fastest growing commodity chemicals, produced at a rate of 7.5 billion pounds per year, with worldwide demand growing at 4 percent annually. It is derived from propylene, which is currently produced from naphtha and liquefied petroleum gas in energy-intensive steam crackers and fluidized catalytic cracking units. While researchers have investigated more efficient ways of producing acrylic acid directly, none as of yet have been commercially feasible.

Rohm and Haas, BASF Catalysts, and University of Connecticut seek to develop a novel millisecond oxidation process for conversion of propane to propylene and acrylic acid. This process combines highly active catalysts with an autothermal hybrid reactor at relatively short contact times for the selective oxidation of propane. Autothermal oxidation promises to reduce the energy intensity of conventional propylene and acrylic acid production methods. This new process will also reduce undesirable secondary reactions found in conventional processing such as the formation of hydrocarbons and carbon oxides.



Schematic of short contact time reactor: single monolith channel with layered catalyst structure



Benefits for Our Industry and Our Nation

Autothermal oxidation for conversion of propane to propylene and acrylic acid promises energy savings of 20 trillion Btu per year by 2020. In addition to reducing energy consumption, this technology will reduce manufacturing costs by up to 25 percent, and reduce CO_2, SO_x, and NO_x emissions.

Applications in Our Nation's Industry

Autothermal oxidation will find initial application in the conversion of propane to propylene and acrylic acid. Reducing the manufacturing cost of acrylic acid, a commodity chemical, will also positively impact a variety of downstream products, including coatings and sealants, super-absorbent polymer applications, and detergent additives.

Project Description

The overall objective of the project is to commercialize a production process for propylene and acrylic acid from propane using a catalytic auto-thermal oxydehydrogenation process operating at short contact times.

Barriers

Major barriers to be overcome include:

- Low reactivity of the propane vs. propylene;
- Poor catalyst properties including low or unstable activity and unselective active sites that degrade desired products or carry out competing parallel reactions; and
- Homogeneous gas phase oxidation reactions that are rapid, free radical-propagated mechanisms, which are highly unselective.

Pathways

The project team will address the technical challenges of propane oxidation to propylene and/or acrylic acid by developing catalytic systems using highly active catalytic materials operating at short contact time. Researchers will evaluate mixed metal oxide and nano-engineered catalyst systems to develop highly active catalytic materials and couple these novel catalyst s with an autothermal process for selective oxidation.

Progress and Milestones

- Setup high-throughput evaluation reactor unit and develop analytical method (completed)
- Demonstrate catalyst performance with a yield greater than 20% propylene without productivity constraints (completed)
- Demonstrate catalyst performance with a yield greater than 20% propylene with commercial feed conditions (completed)
- Meet break-even catalyst performance targets for propane to propylene (completed)
- Meet catalyst performance equivalent of 5 cents/lb incentive over current technology
- Establish minimum catalyst life

Commercialization

The project partners will collaborate to achieve the objectives of this project. Catalyst synthesis will take place at Rohm and Haas, BASF Catalysts and at University of Connecticut research facilities. The catalysts synthesized at these facilities will be evaluated in a high-throughput unit at BASF Catalysts, and the leading candidates will undergo a detailed evaluation at Rohm and Haas. A pilot plant unit will be set up at Rohm and Haas and will be used to identify safe operating conditions and investigate control issues.

Project Partners

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BASF Catalysts
Iselin, NJ

University of Connecticut
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A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable and affordable

February 2009