CHEMISTRY INNOVATION IN ACTION

Advanced Catalytic Processes to Achieve Energy and Sustainability Goals

Background

Advancements in basic research in catalytic chemical processes can help solve a variety of fundamental technological and environmental challenges. The "shale revolution" has created a competitive advantage in feedstock that is revitalizing the U.S. chemical industry. Even greater benefits are possible through the discovery of more efficient ways to convert feedstocks into higher value products. **Federal agencies should work with academia, industry, and national laboratories to establish a sustained, interdisciplinary, cross-cutting research in catalytic processes.**

Beyond their efficiency benefits, catalysis is a fundamental driver for the economic contributions and environmental performance of the U.S. chemical industry. In fact, 90% of chemical processes employ catalysts.

There is an opportunity to achieve step-change advances in processes that use catalysts to convert shale-derived feedstocks into value-added products for the chemical industry and dependent sectors. Advances in catalysis can yield higher economic return, including opportunities for the next generation of practitioners in science, technology, engineering, and math (STEM), and a smaller environmental footprint (energy, GHGs, waste). **As a first step, support is needed for a multidisciplinary research partnership to achieve step-change improvements in the efficiency of small molecule (ranging from methane to hexane) conversion.**

Path to Innovation in Catalytic Processes

Direct activation of small molecules to selectively make products is a challenging area that offers enormous potential rewards. Since the hurdles are high and numerous, innovation in capabilities across multiple disciplines (chemistry, separations, engineering) is necessary. Recent cross-functional progress has renewed interest in R&D. Examples include:

- Retention of high conversion while avoiding over reaction (e.g., coke)
- Design and control of the catalyst reactive center using nanowires and other confined environments
- Oxidative coupling leading to a demonstration plant

Top Barriers/ Gaps

- Catalyst conversion and selectivity
- Economics relative to incumbent
- Chemical separations on molecules
- High-capital cost/process design
- Pilot demonstration, return on investment

Key R&D Areas to Reduce Gaps

- Catalyst structure/properties
- New materials research
- Kinetics/high throughput/in situ studies
- Separations/process/catalyst integration

Benefits of seeding R&D

- Value upgrade of natural gas & natural gas liquids, including market for flared gas
- Lower environmental footprint (energy, emissions, waste)
- Maintain advantaged, local cost position
- Spur innovation and create science, technology, engineering & math (STEM) jobs

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Understanding and applying catalytic concepts with knowledge across synthesis, advanced characterization, computation, reactor design, and separations offers can help narrow the gaps. The work should be guided by economic/technical feasibility analyses. It should also advance the science and implementation of scale-up and help bridge the project "valley of death." Renewed support for catalysis research would engage principal investigators to submit innovative proposals to lower hurdles and enable game-changing technologies.

Recommendations to Pursue Opportunities

Commit funding on an inter-agency basis for research on small molecules conversion from shale gas and natural gas liquids

Provide significant and durable funding, under guidance, to enable sustained progress

Support this endeavor with a dedicated institute/hub that promotes communication and innovation across fields