CHEMICALS

Project Fact Sheet

Short-Contact-Time Reactors

Benefits

- Reduced capital costs
- High conversion and selectivity
- Elimination of NOx production
- Significant reductions in CO_2 emissions
- Reduced fuel consumption

Applications

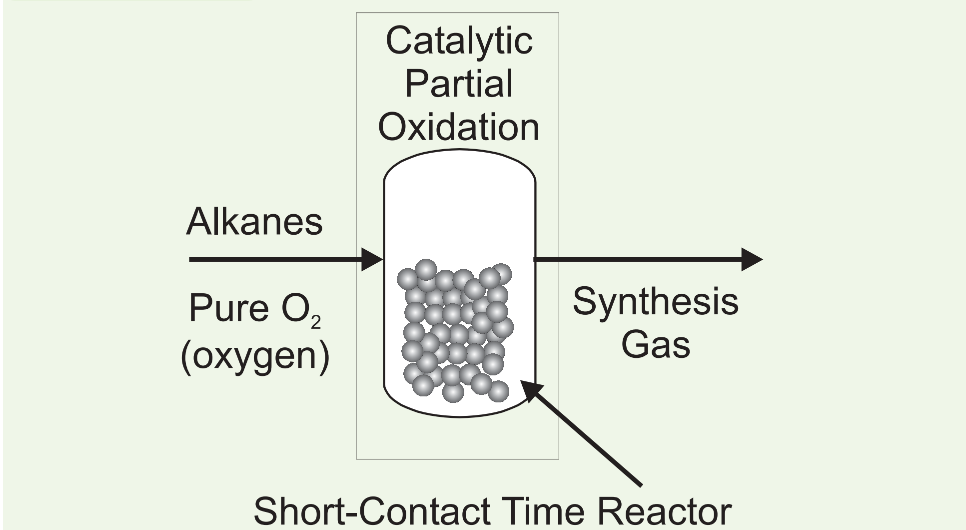
Catalytic partial oxidation can be applied throughout the chemical industry in processes that depend on synthesis gas as a feedstock. Over 2.5 billion cubic feet of synthesis gas is consumed per year in these chemical processes. Primary applications include methanol and acetic acid production, as well as gas to liquids conversion.

Catalytic Partial Oxidation in Short-Contact-Time Reactors Enhances Production of Synthesis Gas

Synthesis gas is used for the production of various chemicals such as methanol, oxo-alcohols, oxo-acids, acetic acid, bicarbonates, ammonia and for the conversion of natural gas to liquid fuels. Current production methods require significant energy inputs and result in substantial CO_2 and NO_x emissions. Selective oxidation of methane to synthesis gas, a process called catalytic partial oxidation, promises to significantly outperform other synthesis gas production techniques in use today.

Catalytic partial oxidation involves the use of a high temperature, non-equilibrium, short-contact-time reactor that combines alkanes, such as methane, ethane, propane and butane, with substantially pure oxygen to produce synthesis gas. This technology eliminates the formation of unwanted NO_x, cuts CO_2 emissions, reduces fuel consumption, and reduces capital costs. In order to optimize the process for scale-up purposes, a better understanding of the reaction kinetics is needed. Conservative estimates show that this technology will yield 28% reduction in capital costs, energy savings of 3.5 trillion Btu per unit per year, total elimination of NO_x emissions, and significant reductions in CO_2 emissions.

Short-Contact-Time Reactors



Oxygen is combined with simple alkanes (methane, ethane) over a catalyst at high temperatures to produce synthesis gas.

Project Description

Goal: To use computational techniques and catalyst characterization to enable the commercialization of a new process for making synthesis gas from methane.

This process will be based on a high temperature, non-equilibrium, short-contact-time reactor and will involve the selective oxidation of methane to synthesis gas (catalytic partial oxidation), an exothermic reaction. It overcomes the limitations reported in the short contact time reactors utilizing catalytic monoliths. These reactors have relied on conventional ways of reactant mixing, which make their reactor difficult to scale-up to industrially meaningful sizes. For an industrial system, appropriate care must be taken so that the hydrocarbon/oxygen stream does not react homogeneously before it reaches the catalyst. Efficient oxygen mixing with the hydrocarbon reactant is difficult due to safety and the possibility of initiating run-away reaction. The proposed technology addresses these mixing problems as well as provides for a safe catalyst ignition.

Progress & Milestones

Praxair has been working with this technology on a pilot scale since 1997. The pilot plant consists of a fully automated control and data acquisition system that allows for the quick and efficient testing of reactive systems. Presently, project partners are conducting experiments to better understand the primary gas reactions.

Future research will concentrate on:

- Developing a fundamental understanding of the kinetics of the three primary methane-to-synthesis gas reactions
- Identifying the surface versus gas phase contributions to the product formation
- Characterizing the catalyst used in this reaction in order to synthesize an optimum catalyst for the process.

Commercialization

Applications such as carbonylations and hydroformulations for the production of fine and specialty chemicals, such as oxo-chemicals, pharmaceuticals and agrochemicals, will be pursued for quick commercialization of this technology. The experience gained here will be used to develop large-scale commodity chemicals and gas to liquid fuel production plants.

Project Partners

Sandia National Laboratory
Albuquerque, NM

Praxair, Inc.
Tarrytown, NY

Reaction Design, Inc.
San Diego, CA

For additional information, please contact:

Brian Valentine
Office of Industrial Technologies
Phone: (202) 586-1739
Fax: (202) 586-1658
brian.valentine@ee.doe.gov

Please send any comments, questions, or suggestions to
webmaster.oit@ee.doe.gov

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Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585

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