DOE/PC/92112--T12

SRI International

Quarterly Report No. 12 • 1 December 1995

NOVEL CATALYSTS FOR METHANE ACTIVATION

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SRI Project 4069
Period Covering July 1, 1995, through September 30, 1995

Prepared for:

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Contract No. DE-AC22-92PC92112

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SUMMARY

Fullerenes are a recently discovered allotrope of carbon that possess unusual properties, some of which may be ideal for methane activation. This project is designed to evaluate these carbon-based materials for conversion of methane into higher hydrocarbons. The project is divided into three technical tasks. Task 1 deals with synthesis and characterization of the fullerenes and fullerene soots, Task 2 with testing of the catalysts, and Task 3 with evaluation of the results and technical reporting. Due to money constraints we have not done any technical work during this period. However, we hope to continue our work and produce a final report including recommendations for future research when funds are available.

PROJECT OBJECTIVES

GENERAL OBJECTIVES

Methane is one of the most abundant sources of energy and is found naturally in underground reservoirs and as a by-product of indirect liquefaction processes. Although methane is useful as a fuel, it is not easily stored or transported, and for that reason, the efficient direct conversion of methane to higher hydrocarbons is essential to provide an economical alternative energy source. However, because the C-H bond of methane is stronger than that of the higher hydrocarbons, high pyrolytic temperatures are needed, and the products tend to rapidly polymerize to coke and unwanted hydrocarbons.[1,2]

This project is designed to evaluate the feasibility of using fullerene materials as methane activation catalysts. Fullerenes are a new allotrope of carbon consisting of closed shells of sixty or more atoms.[3] The full scope of the reactivity of these novel materials is not yet known. However, SRI and others have demonstrated that fullerenes have unique properties, including the ability to stabilize methyl radicals, shuttle H atoms, and act as electrophiles.[4,5] Fullerenes have been found to act as "radical sponges" that readily accommodate organic radicals. Thus we expect that fullerenes or fullerene-based catalysts may be ideal for methane activation, and since these catalysts

are easily produced in soot, they can potentially be inexpensive catalysts and make the direct conversion of methane into higher hydrocarbons inexpensive and environmentally sound.

In this project, novel fullerene-based catalysts are being synthesized and examined for their ability to convert methane into olefins and other higher hydrocarbons. They will be examined using a short-contact-time reactor to minimize any by-product formation due to free-radical polymerization reactions. The primary objectives of this project are to synthesize and examine the reactivities of fullerene-based catalysts and to develop an understanding of these catalysts in terms of hydrogen activation, polymerization of methane into higher hydrocarbons, and minimizing of coke formation.