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PNNL-33677

Methane Pyrolysis for CO2-free H2 and Carbon Nanomaterials (Abstract)

CRADA 576 (PNNL 80519)

November 2022

Robert A Dagle

C4-MCP, LLC
Southern California Gas Company

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
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Abstract

We propose to continue to develop a new process for producing CO2-free hydrogen (H2) from inexpensive and domestically-abundant natural gas (NG), while simultaneously reducing H2's net production cost to $1.0/kg through the sale of valuable crystalline solid carbon co-product. Producing clean hydrogen at this price is a DOE Hydrogen Energy Earthshot goal. Cost effective production of clean H2 is also of commercial relevance to project partners Southern California Gas Company (SoCalGas) and startup company C4-MCP, who aim to further develop, demonstrate at scale, and ultimately deploy the new process technology developed on this project in order to meet regulatory demands in the State of California. In the current project we have focused on i) understanding the catalyst science for thermocatalytic decomposition of methane (TCD), which resulted in the development of a patent pending bimetallic catalyst offering favorable activity, stability, and selectivity under industrially relevant process conditions, ii) developing a novel, patent pending process to enable the separation of produced carbon and catalyst, and re-synthesis of the catalyst using recycled materials, iii) performing limited characterization of the produced carbon materials, and iv) performing detailed process modeling in order to perform techno economic assessment.

The additional scope proposed here will accelerate the commercial deployment of TCD for CO2-free H2 and valuable solid carbon nanotubes (CNT) co-product, by i) scaling up the production of CNT co-product using a scalable, fluidized bed reactor (25 g catalyst scale versus the 1 g catalyst scale demonstrated to-date), ii) producing at least 40 g of CNT product, produced via multiple cycles of TCD, carbon-catalyst separation, and catalyst re-synthesis, to enable the production of sufficient quantities of solid carbon so as to explore its market potential, iii) understanding the quality of the co-product CNTs, produced at larger scale, through advanced characterization, and iv) beginning to explore multiple promising high volume carbon product applications.

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