the ENERGY lab

PROJECT FACTS

ICCS - Area 2

Catalytic Transformation of Waste Carbon Dioxide into Valuable Products

Background

Many industrial processes contribute large amounts of carbon dioxide (CO_2) to the earth's atmosphere. In an effort to reduce the amount of CO_2 released to the atmosphere, the U.S. Department of Energy (DOE) is funding efforts to develop CO_2 capture and storage technologies. In addition to permanent storage of CO_2 in underground reservoirs, some CO_2 can be used to facilitate enhanced oil recovery and enhanced coal bed methane recovery. Limited quantities of CO_2 are also used in a number of commercial and industrial processes which could serve as niche markets for a portion of the captured CO_2. The DOE National Energy Technology Laboratory (NETL) has teamed with Novomer, Inc. to develop a new technology for the beneficial use of CO_2 by both building a demonstration pilot plant that will use captured CO_2 to produce polycarbonate plastics and completing the applications development work required to commercialize these polymers in useful end products for the manufacture of useable products.

Project Description

This project will demonstrate the commercial feasibility of using a waste CO_2 stream to produce poly(propylene carbonate) (PPC) and poly(ethylene carbonate) (PEC) in both high molecular weight (i.e., thermoplastic) and low molecular weight (i.e., polyol) forms. Novomer and its subcontractors will design and develop detailed plans for a pilot-scale plant to be constructed with all the required processing equipment, instrumentation, and infrastructure to synthesize these aliphatic polycarbonates (APCs).

During Phase 1, Novomer and its subcontractor developed a pilot process and design for producing APCs. This work included environmental and safety assessment and planning; developing a process design and engineering plan; performing economic analysis of the application and products; establishing raw material standards, in-process test parameters, and analytical methods to ensure repeatability; and defining a scalable process for manufacture of large quantities of catalyst required for the process. During Phase 2, the pilot plant will be constructed and operated. Phase 2 will execute the pilot process and design to produce approximately 25,000 pounds of material for product development, application testing, and customer qualification.

The team will construct and operate the plant and will qualify the product generated from the facility by using the analytical methods identified in the planning phase. Both in-process engineering data and final material property specifications will be used to optimize the process to produce a consistent polymer in a manufacturing environment. The pilot-scale facility needs to be of sufficient capacity to allow multiple iterations of testing for internal evaluation and customer qualification. At

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PARTNERS

Eastman Kodak Company

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PROJECT DURATION

Start Date
01/15/2010

End Date
03/31/2013

COST

This project is ARRA funded

Total Project Value
$25,657,361

DOE/Non-DOE Share
$20,525,889 / $5,131,472

Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

least three products of reasonable cost, which have satisfied material property requirements and have been tested in full-scale conversion equipment, will be qualified by customers.

Goals and Objectives

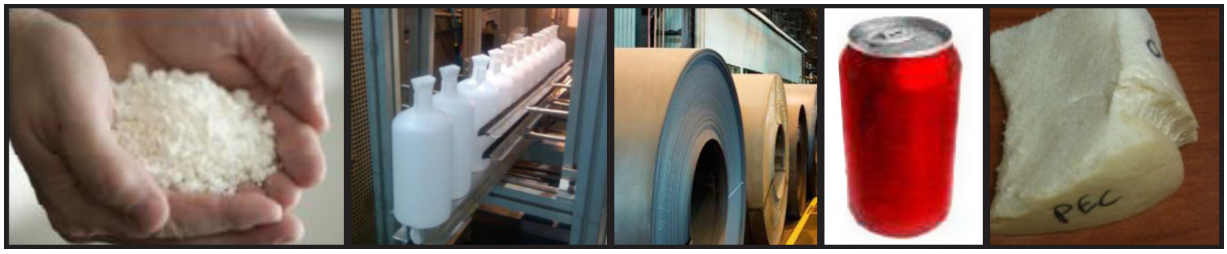
The overall goal of this project is to demonstrate a commercially feasible process and plant for the production of aliphatic polycarbonates by using a CO_2 waste stream. The primary objectives of Phase 1 were to design the manufacturing process including the best option(s) for recovering the final products, to provide a refined estimate of the cost per pound to manufacture the products at a full-scale polymer manufacturing facility producing 500 million pounds per year, and to map the physical and performance characteristics of the synthesized products with the customer application requirements to determine which applications are a best fit. Phase 2 objectives include constructing and operating a pilot-scale demonstration unit and verifying successful setup through three trials, qualifying the product generated using the analytical methods identified in Phase 1, producing multiple 2,000-4,000 pound batches of APCs, and qualifying at least three products with customers for subsequent commercialization.

Accomplishments

During Phase 1, Novomer demonstrated process feasibility by successfully scaling up manufacturing to ~100 pounds per batch. In parallel with this work, a broad set of physical property testing was completed to evaluate the properties of Novomer's APCs. In addition, a detailed economic model for commercial-scale manufacturing of these materials was built and a life cycle analysis was completed.

In the Design subphase of Phase 2, a significant amount of progress has been made in terms of both pilot plant design and applications testing. The preliminary design for the large-scale pilot has been completed, which includes selecting the specific equipment required for catalyst removal, solvent removal, and product recovery.

Applications testing work has progressed well. Coating resin formulations using Novomer PPC have been developed. Current focus in this area is on can & coil coatings, internal can coatings, 2-component coatings, and industrial wood coatings. In packaging, testing is currently underway to explore applications for PPC in mono layer films, multilayer films, paperboard coatings, and starch blends. Novomer has successfully produced proof of concept products for thermoset composite resin and polyurethane foam applications.

Benefits

The project, through the beneficial use of CO_2 waste streams, will demonstrate a method for replacing a portion of the carbon stream which would have typically been sequestered with useful products which can be sold in the marketplace. This will lower the cost of carbon capture and storage and contribute to efforts to decrease excess CO_2 in the atmosphere. In addition, the use of CO_2 in Novomer polymers displaces the petroleum used in existing materials, thus avoiding 40-50% of the petroleum production required to manufacture today's polymers.