

PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Gasification Technologies
and Advanced Research

5/2006



HYBRID COMBUSTION-GASIFICATION CHEMICAL LOOPING COAL POWER TECHNOLOGY DEVELOPMENT

Description

Gasification technologies can provide a stable, affordable energy supply for the nation, while also providing high efficiencies and near zero pollutants. With coal expected to remain a major fuel source and the feedstock for gasification-based power systems, the issue for the power generation industry is how this will square with tougher carbon dioxide (CO₂) emission controls. ALSTOM is researching ways to meet these demands through chemical looping gasification technology.

ALSTOM is developing a hybrid gasification process using high temperature chemical and thermal looping technologies. The process is based on the oxidation, reduction, carbonation, and calcination of calcium-based compounds to chemically react with coal, biomass, or opportunity fuels in two chemical loops and one thermal loop.

An example of the integrated hybrid gasification process is shown in the following diagram. In this chemical looping process, calcium compounds are used to carry oxygen and heat between the various reaction loops. The first chemical loop uses calcium sulfide (CaS) and calcium sulfate (CaSO₄) reactions to gasify the coal. With the addition of steam, the syngas is converted to hydrogen (H₂) and CO₂. The CO₂ is then removed from the gas using another chemical loop based on calcium oxide (CaO) and calcium carbonate (CaCO₃). These compounds are then directed to another reactor where a "thermal" loop, using a bauxite heat transfer medium, drives off the CO₂ for use or sequestration. The overall system produces concentrated streams of CO₂ and H₂ without the need for a costly and energy intensive cryogenic oxygen production unit.

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PROJECT COST

Total Project Value:
\$3,994,095

DOE/Non-DOE Share:
\$3,195,276 / \$798,819

CUSTOMER SERVICE

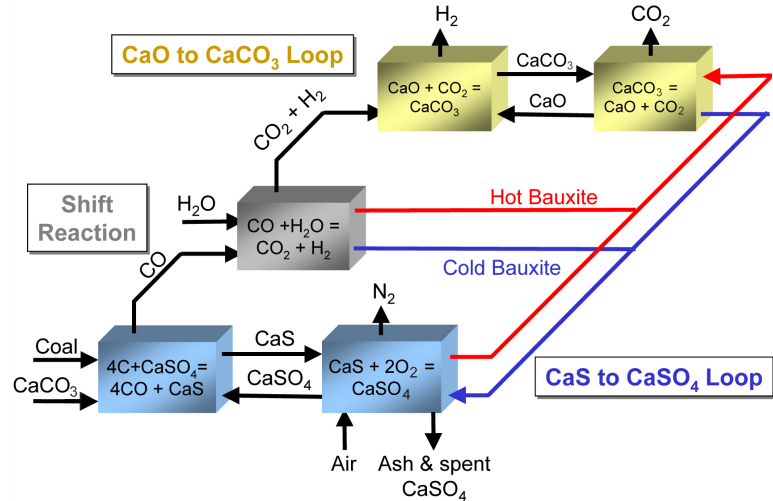
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WEBSITE

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Primary Project Goal

The primary project goal is to develop and verify the high temperature chemical and thermal looping process concept at a small-scale pilot facility. The pilot tests will enable ALSTOM to design, construct, and demonstrate a pre-commercial, prototype version of this advanced system.



Advanced Chemical Looping Process

Accomplishments

- ALSTOM has completed CaS/CaSO₄ testing to demonstrate syngas production from coal with the CaS/CaSO₄ loop.
- ALSTOM has completed pyrolysis and water gas shift testing demonstrating the formation of hydrogen via water gas shift with concurrent capture of CO₂ by chemically looping CaO/CaCO₃.
- ALSTOM has completed engineering studies and bench-scale tests on the chemical looping process and determined that this process has the potential to meet ultra-clean low emissions targets, including CO₂ capture, at a cost and efficiency that is about the same as today's power plants.
- ALSTOM has funded and built the required small-scale pilot facility at its Power Plant Laboratories in Windsor, Connecticut.

Benefits

This project will benefit the power industry by developing an efficient, cost effective integrated hybrid gasification process that will be capable of producing hydrogen for gas turbines, fuel cells or other applications, while also producing a concentrated stream of CO₂ for use or eventual sequestration.

Based on previously performed engineering and economic studies at ALSTOM, hybrid gasification chemical looping coal power technology has been shown to have the potential to capture all CO₂ emissions, while also exceeding all current environmental regulations (e.g. NO_x, SO_x, etc.). These studies also show chemical looping technology meeting or exceeding current integrated gasification combined cycle efficiencies and costing less than \$800 per kilowatt without CO₂ capture and less than \$1,000 per kilowatt including CO₂ capture for the world-wide power generation market.