the ENERGY lab

PROJECT FACTS

Gasification Systems

National Carbon Capture Center – Long-term Filter Element Tests (Transport Gasifier)

Background

In cooperation with Southern Company Services, the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) established the National Carbon Capture Center (NCCC) at the Power Systems Development Facility (PSDF) in Wilsonville, Alabama. The center will bolster national efforts to reduce greenhouse gas emissions by developing cost-effective technologies to capture the carbon dioxide (CO_2) produced by fossil-fueled power plants.

The PSDF is a unique test facility. It is large enough to provide commercially relevant data yet small enough to be cost-effective and adaptable to testing a variety of emerging technologies. The facility is a test-bed capable of evaluating advanced technologies at multiple scales, thus allowing results to be scaled directly to commercial application. This capability gives the PSDF the flexibility to develop and demonstrate a wide range of advanced power generation technologies that are critical to developing highly efficient power plants that capture CO_2.

In developing a cost-effective advanced coal power plant with CO_2 capture, the NCCC also evaluates opportunities to reduce cost for the entire plant in order to optimize the plant processes with the integration of the CO_2 capture processes. One of these reduction opportunities includes particulate control in the syngas from a gasifier. Since 1999, the PSDF has been demonstrating the use of filter elements to remove ash from the syngas prior to it being utilized in a gas turbine or fuel cell. The elements are arranged in columns called "candles" and contained within a vessel referred to as a particulate control device (PCD). This dry particulate removal technique eliminates the blackwater stream associated with wet cleanup and by maintaining higher syngas temperature increases process efficiency. Also, the PSDF has greatly contributed to innovation for failsafes, which consist of a back-up filter located on the clean side of each primary filter element. A failsafe filter prevents solids leakage in the event of filter element failure, thus preventing transmission of particulate to the turbine.

Project Description

The Transport Gasifier operating at the PSDF is a circulating fluidized bed reactor designed to operate at higher circulation rates and riser densities than conventional circulating bed units. The higher circulation rates result in better mixing, higher mass and heat transfer rates, and higher carbon conversion. Since the gasifier uses a dry feed system and does not slag the ash, it is well-suited for high ash fuels such as sub-bituminous and lignite coals, but can also process some higher-rank coals.

CONTACTS

Jenny Tennant
Gasification Systems Technology Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4830
Jenny.Tennant@netl.doe.gov

Morgan Mosser
Project Manager
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4723
Morgan.Mosser@netl.doe.gov

Roxann Laird
NCCC Director
Southern Company and Services, Inc.
Highway 25 North
Birmingham, AL 35291-8060
205-670-5863
rfleonar@southernco.com

PARTNERS

American Electric Power
Arch Coal, Inc.
Electric Power Research Institute
Luminant
NRG Energy, Inc.
Peabody Energy
Rio Tinto

PROJECT DURATION

Start Date	End Date
10/01/2008	09/30/2013

COST

Total Project Value
$251,454,148

DOE/Non-DOE Share
$201,163,318 / $50,290,830

PROJECT NUMBER

NT0000749-NCCC-Transport Gasifier (Filter)

U.S. DEPARTMENT OF ENERGY

Filter element testing at the PSDF is conducted during gasification runs with Powder River Basin sub-bituminous coal, or one of several bituminous and lignite coals. After certain test runs, selected filter elements are removed for detailed inspection, flow tested to check for any change in pressure drop characteristics, and bubble tested to identify any media or weld problems. Scanning electron microscopy with energy-dispersive x-ray analysis is used for detailed examination of corrosion and ash plugging in selected filter element sections.

Goals/Objectives

The primary goal of the filter project is to enhance the understanding of filter performance and transfer this knowledge into improved filter elements for future applications. Specific objectives in support of this goal are to test and evaluate commercially available and newly developed filter elements and failsafes for their particulate collection efficiency, process performance, mechanical integrity, corrosion behavior of metal filter media, and lifetime prediction.

Accomplishments

Extensive testing with ceramic, composite, sintered metal powder and sintered metal fiber elements has shown that the mass concentration of gasification ash can be reduced from 10,000–30,000 parts per million by weight (ppmw) at the filter inlet to less than 0.1 ppmw at the filter outlet. Experience at the PSDF has shown that ceramic filter elements are prone to crack and fail during thermal excursions associated with coal feeder trips and other system upsets. To avoid these failures, recent testing at the PSDF has focused on metal filter elements.

Since initiating gasification operations in 1999, multiple test campaigns, each 250 to 1,500 hours in duration, have been completed. During this time, the PCD candle filters have been consistently reliable and available for testing, demonstrating collection efficiencies greater than 99.999 percent.

To date, iron aluminide sintered metal powder elements and Haynes HR-160 sintered metal fiber elements have the longest exposure times. Progressive corrosion and an increase in pressure drop have been noted in the iron aluminide elements although the corrosion has not had significant impact on mechanical integrity of the filter media. Less corrosion or plugging has been found in the HR-160 elements, but they also have much less exposure time than do the iron aluminide elements.

Accomplishments at the PSDF in failsafe development include the following: (1) new types of failsafes were developed; (2) the failsafe concept in the PCD for Integrated Gasification Combined Cycle technology was promoted and vendors were motivated and supported to develop new failsafes per PSDF test results and specifications; (3) failsafes, from PSDF's own design and from vendors, were tested systematically under actual gasification operating conditions; and (4) failsafes were eventually incorporated into the commercial PCDs as a standard and required item.

Benefits

The corrosion resistance of filter elements will increase as filter element materials are improved. This enhancement will also result in longer element life, resulting in lower operating costs, and ultimately a lower cost of electricity.

Type of Element	Material	Exposure Hours
Sintered Metal Powder	Iron Aluminide	15,995
Sintered Metal Powder	HR-160	4,541
Sintered Metal Fiber	HR-160 (Coarse)	8,064
Sintered Metal Fiber	HR-160 (Fine)	6,036
Sintered Metal Fiber	Inert Coated Fecralloy	5,018
Sintered Ceramic Powder	Silicon Carbide	519

Accumulated syngas exposure for various element types through March 2013.

Haynes HR-160® (Haynes International, Inc.) is a nickel-cobalt-chromium-silicon alloy.

Fecralloy® (U.K. Atomic Energy Authority Statutory Authority) is an iron-chromium-aluminum alloy.

Candle Filter System.
Courtesy of Southern Company and Services, Inc.