

PROJECT facts

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

Gasification Technologies

06/2008



WILSONVILLE POWER SYSTEMS DEVELOPMENT FACILITY

Description

The Power Systems Development Facility (PSDF) is a unique research and development center designed to test, evaluate, and accelerate the deployment of advanced coal-based power system components and technologies. The facility is a highly flexible test center where developers evaluate precommercial innovative system components in an integrated process at commercially relevant process conditions. The PSDF is large enough to produce commercially representative data while remaining sufficiently small for economic operation and has the following primary components:

- 1) a coal preparation facility
- 2) a KBR Transport Reactor designed to operate as either a two ton-per-hour coal gasifier or combustor in either air-blown or oxygen-blown operating modes at pressures of 150-230 psig and temperatures of 1500-1900 °F
- 3) several convective gas coolers

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- 4) a Siemens high-temperature particulate control device (PCD) to remove fine solids from the nominal 20,000 pounds-per-hour of fuel/flue gas at higher process temperatures
- 5) a heat-recovery boiler
- 6) a 50 pound-per-hour fuel/flue gas slipstream for evaluating processes for carbon capture, gas contaminant cleaning, fuel cells, gas separation technology, and/or instrumentation
- 7) a four MW combustion turbine
- 8) a syngas combustor

The facility also houses a stand-alone cold-flow test unit, with subscale versions for additional study of the transport reactor, coal feeders, and PCD (filter element and failsafe screening). Researchers can use data from the PSDF to identify and guide further R&D needed for the tested technologies or to confirm the readiness of the technology for scale-up to commercial operations. The PSDF has an infrastructure (staff/utilities) to support a range of testing scales and conditions.

Primary Project Goal

The U.S. Department of Energy’s goal is to accelerate the development and deployment of advanced coal-based power systems components, technologies, and processes. The Wilsonville PSDF serves as a proving ground for performing integrated systems, process, and component testing at an industrially relevant scale of operation via a government/industry partnership.

Objectives

- Conduct tests and collect performance data for high-moisture lignite, high-sodium lignite, bituminous, and sub-bituminous coal feedstocks.
- Install and commission an offline high-pressure fuel feed testing system.
- Provide host site for testing and evaluation of advanced power systems technologies such as fuel cells, gas cleaning, membranes, etc.
- Evaluate CO₂ capture testing needs and develop a design for modifications needed for a flexible CO₂ capture test facility.
- Develop and evaluate advanced syngas cleanup technologies to meet “near-zero” emission goals, including the evaluation of new particulate control devices, high temperature sorbents, new contacting devices, etc.

Accomplishments

- In record time, the PSDF and DOE's private/public collaboration efforts have introduced to the commercial marketplace the new transport reactor integrated gasification process, which is focused on low-rank coal. The data generated at the PSDF provided information required for scale-up of the transport gasifier for full-scale demonstration.
- Researchers at the PSDF fabricated, commissioned, and operated a transport reactor that is suitable as both a coal combustor and a coal gasifier. Transport reactor operations have become extremely reliable for typical test campaigns of 250-750 hours duration.
- Between 1996 and 1999, the transport reactor was successfully operated as a combustor for a cumulative 4,985 hours. These operational hours were accumulated during nine test campaigns during which five different fuels (three bituminous coals, one sub-bituminous coal, and petroleum coke) and four in-bed sulfur sorbents (three limestones and one dolomite) were evaluated.
- Between 1999 and the 2007, the transport reactor was operated as a gasifier, generating syngas for a cumulative 10,500 hours. These operational hours were accumulated during 24 gasification test campaigns during which 9 fuels (4 bituminous, 1 sub-bituminous, and 4 lignite) and 2 in-bed sulfur sorbents (limestone and dolomite) were evaluated. After redesigning and reconfiguring a portion of the gasifier, carbon conversions of up to 99 percent have been realized.
- High-sodium lignite, a difficult fuel to process, was successfully tested at PSDF on behalf of the Lignite Energy Council. The test concluded with 300 hours of operation. The addition of kaolin was effective in preventing agglomerate formation.
- The PSDF supported the development of filter elements and fail-safe technology for hot gas cleanup, ash depressurization and removal systems, sensor development, and high-pressure coal feed systems, all of which are being further developed and commercialized.
- The PSDF tested filter elements for 1,000 hours to provide support data to Westinghouse for use on the city of Lakeland Clean Coal Technology project.
- Two particulate removal devices and over 30 different filter element types (e.g., monolithic ceramic, ceramic composite, sintered metal powder, sintered metal fiber) have been tested at the PSDF. Results showed the commercial impracticality of a PCD ceramic tube sheet design for certain applications.
- The PSDF supported Stamet, Inc., in testing their dry-feed coal pump for 500 hours—the longest testing yet achieved. Testing revealed the need for several design modifications for the pump to perform reliably at high pressure.

PERIOD OF PERFORMANCE

9/14/1990 to 9/30/2008

COST

Total Project Value

\$441,541,425

DOE/Non-DOE Share

\$380,900,815 / \$60,640,610

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- Two test campaigns were successfully completed on 0.6 kW solid oxide fuel cells (SOFC) marking the first time an SOFC had been operated on coal-derived syngas. PSDF identified certain design improvement recommendations in testing a developer's fuel cell under DOE sponsorship.
- As of January 17, 2008, the PSDF employees have worked 4,550 days without a lost time accident (i.e., zero lost time work days recorded).

Benefits

To meet the growing demand for electricity, coal will continue to supply at least half of the Nation's electricity needs. Yet, future coal systems must become increasingly clean and more efficient for the United States to fully realize the potential of its most abundant fossil fuel. The PSDF gives U.S. industry the world's most cost-effective, flexible test center for evaluating the critical components of tomorrow's coal-based power-generating systems. When compared with the costs of building each of the technologies in use at the PSDF at stand-alone facilities, construction at one site saved more than \$32 million. In addition, the transport gasifier technology developed at the PSDF has been selected for commercial-scale development under a Clean Coal Power Initiative Round 2 award.

Planned Activities

- A test campaign on Mississippi lignite (TC25) is scheduled for the 4th quarter FY08 time frame.
- Continue exploratory evaluation of solvents for CO₂ capture with testing at batch reactor scale and use results to evaluate prospects of continuous capture system.
- Initiate preparation of infrastructure at the Syngas Cleanup Unit for larger capacity slipstream testing.