# Advanced Coal Conversion Process Demonstration

***Demonstration Operations Complete***

## Participant

Western SynCoal LLC (formerly Rosebud SynCoal Partnership; a subsidiary of Montana Power Company's Energy Supply Division)

## Additional Team Members

None

## Location

Colstrip, Rosebud County, MT (adjacent to Western Energy Company's Rosebud Mine)

## Technology

Western SynCoal LLC's Advanced Coal Conversion Process for upgrading low-rank subbituminous and lignite coals

## Plant Capacity/ Production

45 tons/hr of SynCoal® product

## Coal

Powder River Basin subbituminous (Rosebud Mine), 0.5–1.5% sulfur, plus tests of other subbituminous coals and lignites

## Project Funding

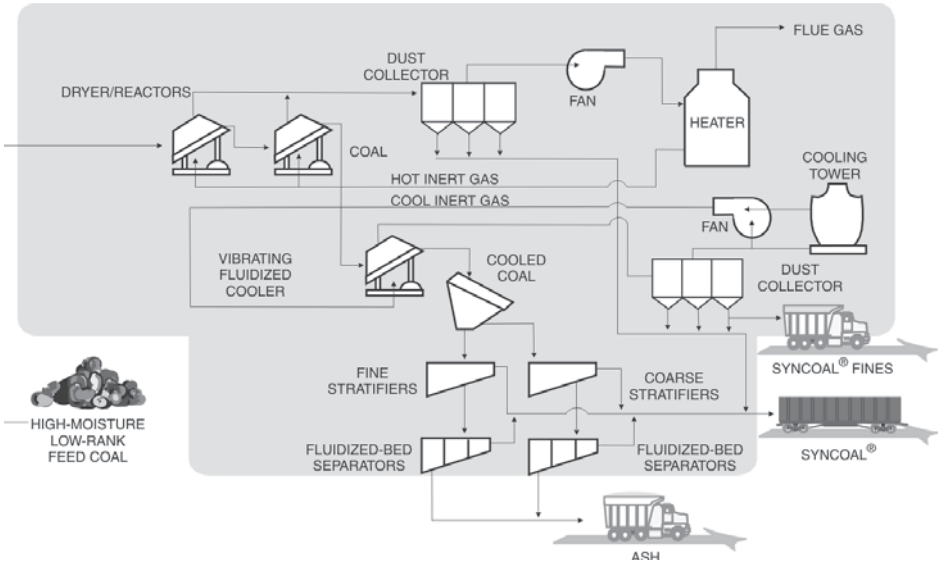
| | | |
|---|---|---|
| Total | $105,700,000 | 100% |
| DOE | 43,125,000 | 41 |
| Participant | 62,575,000 | 59 |

**CCTDP**

**Clean Coal Fuels**

**Upgrading** ■

**Conversion** □




## Objectives

To demonstrate Western SynCoal LLC's Advanced Coal Conversion Process (ACCP) to produce SynCoal®, a stable coal product having a moisture content as low as 1 percent, sulfur content as low as 0.3 percent, and heating value up to 12,000 Btu/lb.

## Technology/Project Description

The ACCP demonstrated in this project consists of thermal processing coupled with physical cleaning to upgrade high-moisture, low-rank coals to a SynCoal® product having high heating values and low sulfur contents. In the ACCP, the raw coal is screened and fed to a vibratory fluidized-bed reactor where surface moisture is removed by heating with hot combustion gas. Coal exits this reactor at a temperature slightly higher than that required to evaporate water, and flows to a second vibratory reactor where the coal is heated to nearly 600 °F. This temperature is sufficient to remove chemically bound water, carboxyl groups, and volatile sulfur compounds. In addition, a small amount of tar is released, partially sealing the dried product. Particle shrinkage causes fracturing, destroys moisture reaction sites, and liberates the ash-forming mineral matter.

The coal then is cooled to less than 150 °F by contact with an inert gas in a vibrating fluidized-bed cooler. The cooled coal is sized and fed to deep-bed stratifiers, where air pressure and vibration separate mineral matter including much of the pyrite from the coal, thereby reducing the sulfur content of the product. The low-specific-gravity fractions are sent to a product conveyor, while heavier fractions go to fluidized-bed separators for additional ash removal. The fines handling system consolidates the coal fines that are produced throughout the ACCP facility. The fines are gathered by screw conveyors and transported by drag conveyors to a bulk cooling system.

| Project Duration<br>129 Months | Period of Operation<br>108 Months | Status/Schedule<br><br>*Estimated date |
|---|---|---|

## Benefits

ACCP technology offers a means of converting vast low-rank western subbituminous and lignite coal reserves to high-energy-density, low-sulfur, low-ash fuels capable of enhancing boiler efficiency and reducing sulfur emissions. Increasing energy density of western coals also has the potential to significantly reduce transportation costs, assuming stability of the processed coals can be achieved, *i.e.*, control spontaneous combustion. Western coals typically cost less to mine than eastern coals because they reside in thick seams amenable to surface mining, whereas eastern bituminous coals are typically mined by underground methods. Thus, western coals start with a cost advantage that may be retained in distant markets if ACCP objectives were met. The consistent quality and high carbon and volatile content make the SynCoal® product: (1) an excellent fuel supplement to resolve flame stability and slagging/fouling problems experienced by boilers using raw low-rank coals, and to reduce sulfur emissions from plants using relatively high sulfur content coals; (2) a superior fuel for direct-fired applications, offering good ignition and a stable flame in cement and asphalt production, particularly when blended with petroleum coke; and (3) a good reducing agent for some metallurgical processing applications.

## Status/Accomplishments

Project operations ceased in June 2001, with the purchase of Montana Power (including Western SynCoal LLC) by Westmoreland Mining LLC. The final report has been issued and can be found on the Clean Coal Technology Compendium Web site at *www.netl.doe.gov/technologies/coalpower/cctc/cctc_main.htm*.

## Results Summary

### Operational

- During the life of the project, over 2.9 million tons of coal were processed to produce over 1.9 million tons of SynCoal® product shipped to a variety of customers.
- The SynCoal® product was very close to the design basis product chemically, but fell short of physical performance specifications with regard to resistance to spontaneous combustion and dust emissions upon handling.

| STATUS | | |
|---|---|---|
| Report | *Final Report Issued* | *9/04* |
| Operation | *Operation Completed* | *6/01* |
| Construction | *Operation* | *6/92* |
| Design | *Construction* | *8/91* |
| PreAward | *NEPA Completed (EA and FONSI)* | *3/91* |
| | *Award* | *9/90* |
| | *Selection* | *12/88* |

## Contacts


**Participant**

Harry Bonner, General Manager
(406) 494-5119

Western Syncoal LLC
120 North Parkmont
Butte, MT 59701

**NETL**

Joseph B. Renk III
(412) 386-6406
joseph.renk@netl.doe.gov

**Headquarters**

Joseph Giove
(301) 903-4130
joseph.giove@hq.doe.gov

*Western SynCoal's® Advanced Coal Conversion Process.*

- The SynCoal® product quality remained essentially constant for the life of the project.
- A water-based anionic polymer dust stabilization enhancement (DSE) product was applied to suppress dust emissions in SynCoal® handling and shipment, and to provide a heat sink to temporarily suppress spontaneous combustion. More extensive stability processes were investigated showing that stability could be achieved, but the required re-hydration and oxidation were costly and degraded the product.
- Test burns of 50 percent DSE-conditioned SynCoal®/raw Rosebud Mine coal blends at the 160-MW J.E. Corette power plant in Billings, Montana reduced $SO_2$ emissions 12 percent, and increased boiler efficiency 1 percent; a similar 79 percent/21 percent SynCoal®/raw coal blend reduced $SO_2$ emissions 23 percent, increased boiler efficiency 1.5 percent, and de-slagged the boiler, resulting in a 3-MW boost in power output.
- ACCP upgraded 6,800 Btu/lb North Dakota lignite (having 36 percent moisture and sulfur equivalent to 3.0 lbs of $SO_2/10^6$ Btu) to a 10,500–10,700 Btu/lb SynCoal® product (with 47–48 percent less sulfur and 7–27 percent less ash).
- Burning of the North Dakota lignite-derived SynCoal® product in the 250-MW Milton R. Young Power Station Unit 1 cyclone-fired boiler near Center, Montana resulted in release of slag buildup, a 13 percent reduction in boiler air flow requirement, an increase in boiler efficiency from 82 percent to 86 percent, and a 123 Btu/kWh increase in heat rate.
- SynCoal® heat inputs of 15–16.6 percent to Colstrip Energy Limited Partners Unit No. 2 boiler increased power output by an average 3.7 percent, increased heat rate 85 Btu/kWh, reduced $SO_2$ emissions 8 percent, and reduced $NO_x$ emissions 19 percent.
- In direct-fired cement and lime kiln applications, SynCoal® enhanced flame stability, improved product, and increased process efficiency.
- As a green sand binder additive in metal casting, SynCoal® served as a reducing agent and improved the "peel" quality of the casting.

#### Environmental

- The ACCP SynCoal® plant experienced no problems in meeting Federal, State, and local permitted emission limits.
- The SynCoal® product proved to be an effective fuel in enhancing efficiencies of both boilers and direct-fired industrial applications, and in reducing sulfur emissions in applications using baseline fuels with relatively high sulfur contents.

#### Economic

- Capital costs of $39 million were estimated for a 100 ton/hour reference plant design that integrates ACCP into a power plant, relies upon the plant for process energy requirements, and neither cleans nor stabilizes the SynCoal® product.

### Project Summary

Exhibit 3-6 provides an operational performance summary of the ACCP plant. Availability suffered in the early stages from stability problems experienced with the SynCoal® product. Spontaneous combustion problems limited storage and forced plant shutdowns when limits were reached. Also, SynCoal® produced during startup and

shutdown did not meet specifications and was rejected, which caused early production to fall short of the 2/3 of a ton of SynCoal® per ton of raw coal objective. After finding the means to extend storage, and finding clients for the SynCoal®, availability approached design targets of 75 percent and production goals were met. The SynCoal® product quality remained essentially constant for the life of the project.

In addition to stability problems, the SynCoal® product suffered from fugitive dust emissions when handled, as dust particles released upon impact had no receptive surfaces on which to adhere. After extensive research, a water-based anionic polymer dust stabilization enhancement (DSE) product was identified that suppressed dust emissions in SynCoal® handling and shipment, and provided a heat sink to temporarily suppress spontaneous combustion.

The DSE approach expanded test burn and special use possibilities, the results of which are summarized in the preceding Results Summary. In utility applications, efficiency was the primary benefit, which in turn reduced emissions, with direct sulfur reduction occurring in plants using relatively high sulfur baseline coals. In direct-fired applications, flame stability resulting from the product content and consistent quality was the primary benefit, which impacted product quality and process efficiency. In metal casting, SynCoal® proved to be an effective additive for molds.

More extensive stability processes were investigated, which included re-hydration and oxidation. While stability is achievable, the cost to build and operate such a process is not insignificant and the product is degraded.

Permitting an ACCP SynCoal® plant does not appear to be a problem, and the most likely application seems to be integrated with a power plant to take advantage of available heat and ash handling and to avoid expensive stability processing and added product ash removal. The estimated capital cost of a 100 ton/hour ACCP plant integrated into a power station is $39 million.

*Coal feed system to ACCP to produce SynCoal®.*

**Exhibit 3-6**
**ACCP Annual Production Rates**

| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Raw Coal Processed (tons) | 28,686 | 157,421 | 370,789 | 479,621 | 370,389 | 395,450 | 163,272 | 419,296 | 441,380 | 112,931 | 2,939,240 |
| Availability (%) | 18 | 53 | 65 | 78 | 65 | 66 | 28 | 70 | 73 | 54 | 58 |
| Forced Outage Rate (%) | 70 | 40 | 26 | 13 | 21 | 26 | 8 | 15 | 14 | 35 | 23 |
| Avg. Feed Rate (ton/hr) | 21.1 | 34 | 64.7 | 70.1 | 64.4 | 68.0 | 66.0 | 68.4 | 69.0 | 73.1 | 63.3 |
| SynCoal® Shipped (tons) | 5,566 | 57,528 | 205,447 | 315,688 | 238,766 | 413,175 | 97,574 | 268,650 | 291,604 | 86,281 | 1,980,279 |