GreenFields Develops New Techniques for Recovering Coal Fines

Using a dry process and a new binder, GreenFields recycles waste into high-Btu briquettes

BY STEVE FISCOR, EDITOR-IN-CHIEF

GreenFields Coal Co.'s bruquetting facility is located on the former U.S. Steel Gary property.

To some, coal fines are a nuisance, while others see potential. Throughout Appalachia and the Illinois Basin, thousands of refuse impoundments hold billions of tons of coal fines. Gold and diamond miners have made a fortune reprocessing tailings. Could coal miners do the same? Or more realistically, could they make money while reclaiming abandoned sites. Technology and improving prices has made the processing of materials discarded by previous generations more viable today.

The engineers at GreenFields Coal Co., which is based in Beckley, W.Va., have developed a new patent pending technology to bind and briquette coal fines. They are converting high moisture, fine coal refuse into briquettes that maintain their integrity and inherent energy properties through processing, transport, weather, etc. The possibilities are site-specific, but in some cases the low-cost process recycles nearly 100% of coal waste into a high-Btu product for power generation or steelmaking applications. The technology can be deployed alongside any prep plant.

The coal industry has seen its fair share of binders and briquetting processes over the years. Few have succeeded. The problem usually lies with the binder. In the past, binders either altered the characteristics of the coal (increasing ash or reducing the calorific value) or they simply could not withstand the rigors of transportation including the long-term exposure to weather.

Knowing this, GreenFields developed a proprietary binder and set out to produce an economically and ecologically viable briquette from coal fines. it has permitted a refuse site at the former U.S. Steel Gary prep plant, built a pilot plant, and is now moving into full-scale production. The briquettes coming from the pilot plant retain the same, or possibly better, petrographic value as the coal from which the fines originated.

Independent laboratories and researchers from Virginia Tech have confirmed the effectiveness of the GreenFields technology on samples from three different U.S. coal regions. In fact, researchers from Virginia Tech have co-authored two papers about GreenFields technology for the International Coal Preparation Conference, which is being held in conjunction with Coal Prep 2010 (See Coal Prep Preview, p. 30). One paper discuss the briquetting process and the other evaluates a dry cleaning process, differential hardness separation (DHS). The labs determined that the moisture content of the samples, which was 18% to 30% prior to processing was consistently reduced to 5% or less, substantially increasing the calorific value (Btu's per lb). The tests also confirmed the handling durability and the weather resistant nature of the briquettes.

During its search for a method to process the fines, the engineers at GreenFields discovered the DHS process, which is waterless and emissions free. The process captures the solids that report to the coal product, not to the surrounding environment. The process is also chemical-free. Separation is based on particle size and specific gravity. Using heat and air, rather than just the heat from a thermal dryer, the DHS process is relatively energy efficient. The byproducts can be marketed to the concrete and brick making industries as well as a number of other industries.

GreenFields Earns Its Stripes

GreenFields was formed as a clean coal technology company by partners with years of experience in the coal and alternative energy industries. "The company was founded originally to pursue what we determined to be a revolutionary binder for briquetting coal fines," said Rory Cutaia, CEO and founder. "We spent two years testing a product that had been developed and determined it was indeed revolutionary. It reduced moisture rather dramatically in the several hours during the curing process after the briquettes were made."

The briquettes really do hold together and act in every way as deep-mined coal would act, Cutaia explained. "They could be loaded into railcars without breaking and left out in the rain for an extended period of time without disintegrating," Cutaia said. "We decided to bring this product to market and design a briquetting system around the use of the binder.

"One aspect of our binder that is unique is that it is not petroleum based," Cutaia said. "It can be safely burned in

coking ovens and coal-fired boilers. That's revolutionary. It's not something simply sprayed onto the briquettes as they come out of the machine. In fact the binder consists of ingredients that are completely environmentally safe—so safe it could be ingested."

When GreenFields began to contact potential customers, mine and prep plant operators, it learned about the industry's past experiences with companies that claimed to have a binder that worked well, but really did not. "What we found was resistance, not necessarily to the binder, but to trying the process," Cutaia said. "Every operator asked the same question: Where are you doing this now? We weren't doing it anywhere yet. We were fresh out of the lab with it." GreenFields decided the best way to bring its product to market would be to acquire a site with coal fines and build a facility, make briquettes, and sell them.

The company purchased the abandoned U.S. Steel Gary prep plant in southern West Virginia. The facility was, at the time, the largest prep plant in the U.S. Over the course of 40 years, the plant deposited extremely high-quality metallurgical grade coal fines. The site holds an estimated 15 million tons of fines and another 50 to 60 million tons of gob material.

The Gary site would become the GreenFields showcase. It took the company two years to obtain an Article 3 permit. "That was a very difficult process, because the site had a history of problems," Cutaia said. "A previous owner went into bankruptcy. It was also the site of a disaster, where the runoff from after a 100-year rain storm caused tremendous damage to a local community. The state had to reclaim it and placed a lien against the property." GreenFields had to clear up all of these issues and go through a full formal permitting process.

Last summer the company started construction after the permits were issued. Today GreenFields has established a pilot plant and is about to go into full production at the site. "It's been quite an extraordinary journey," Cutaia said. "Since then, we have also acquired the exclusive worldwide rights to the DHS waterless process."

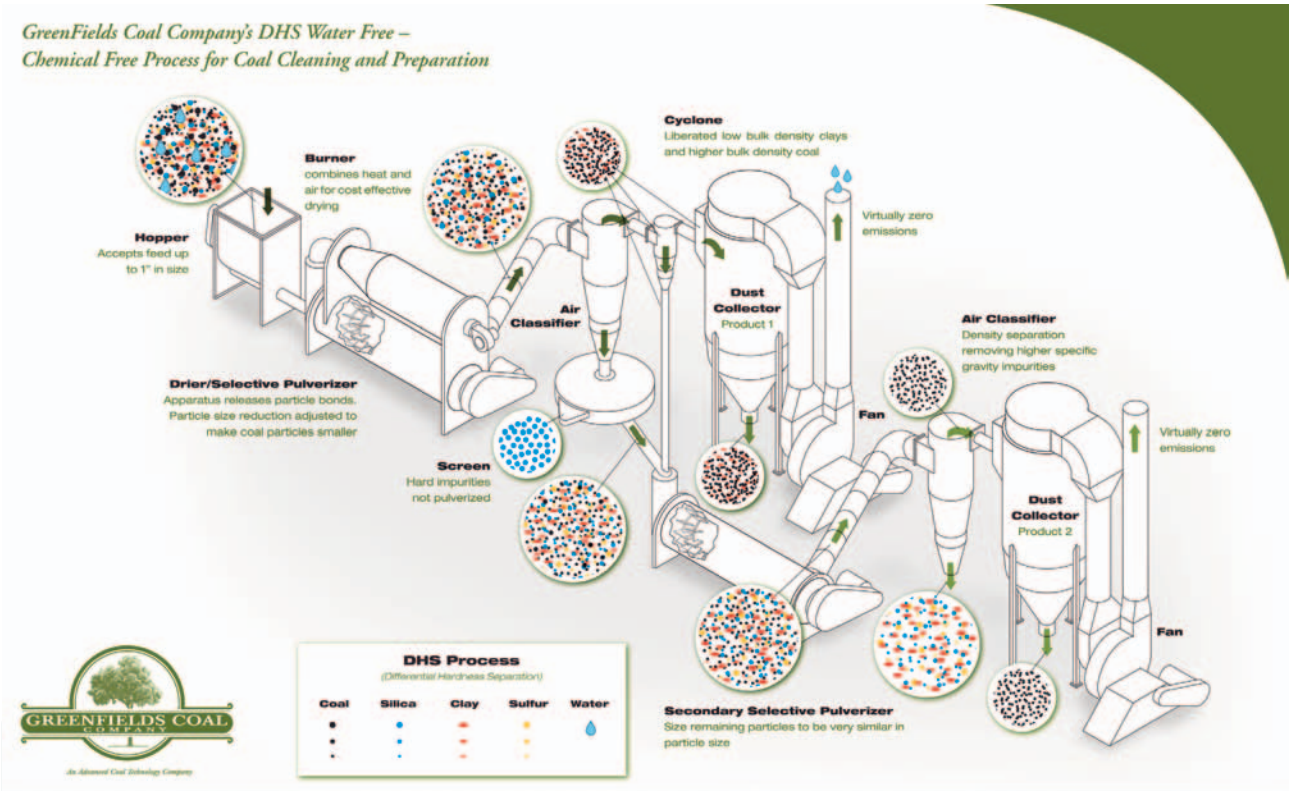
Waterless Processing

During the briquetting process, a screw conveyor feeds materials from a hopper to a pug mill where the binder is mixed with the coal—no water, just a binder. Once the coal is mixed, it's fed by conveyor to the briquetter rolls. As the briquettes are pressed, they fall onto another conveyor via an angled discharge. A curing process begins while the briquettes travel along the conveyor. "We accelerate that curing process through a hot-oil drying system along the entire length of the belt,"said Henry Kasindorf, principal, GreenFields Coal. "At the midpoint of the belt, the briquettes are flipped using a tripper system and the other side of the briquettes is dried.

A chemical reaction takes place with the binder that begins a self-drying process. "We watched as the briquettes dropped in weight on the scales during the first hour after they were pressed while we sat with researchers from Virginia Tech," Kasindorf said. The moisture is further reduced during the hot-oil drying time.

While the company was evaluating the material at the Gary site, it was originally considering a conventional 200 tph raw feed prep plant with traditional coal-washing circuits, explained Greg McGraw, chief mining engineer, GreenFields Coal. "During our search, however, we came across a facility originally designed to clean kaolin clay," McGraw said. "We found the process interesting because kaolin clay has same high moisture and fine particle constraints."

GreenFields moved the facility from Georgia to the Gary site and converted the pilot plant from kaolin to coal processing.



The Differential Hardness Separation (DHS) process is a waterless and emissions-free system.

Using a proprietary binder, GreenFields produces a very durable briquette from fine coal.

"To the best of my knowledge, we are the only company that can take a high moisture ultra-fine coal product and reduce it to 1% moisture coal and generate several marketable byproducts," McGraw said.

The DHS process upgrades the calorific value of the coal by reducing the moisture and ash. If GreenFields is working with a metallurgical coal, the process maintains those characteristics. "The most amazing thing about the DHS process is that the byproduct, which would be refuse for a typical facility, is also a marketable high Btu product," McGraw said. "We can ship it with the steam orders or produce a clay byproduct by burning the remaining carbon out of it." The clay byproduct could be used in place of flyash in concrete mixes.

The DHS system relies on air and heat as the processing medium. "With the DHS process, we dry bituminous coal to 1% to 2% moisture," said Riley Robbins, director of engineered minerals, GreenFields Coal. "We separate and sort the coal and non-coal mineral products based on hardness and specific gravity. We are developing markets for all of the materials so that they are completely recycled."

The coal material consists of minus 28 mesh coal with a lot of clays. The material is transferred by auger to a dryer/selective pulverizer. Air enters the process in the pulverizer. At the Gary facility, the dryer/pulverizer uses natural gas. The pulverizer breaks up the gob material and then using mostly air and some heat it dries the material. The crushing forces in the pulverizer are set in such a way that it breaks up the coal, but not the hard impurities.

By air, the whole dry particle stream reports to the first air classifier. A large fan pulls air through the dust collector, air classifier, and pulverizer. The lighter coal moves toward the top, while the heavy silica particles drop to the bottom. A set of screens and cyclones are used to further remove more of the hard impurities.

Coming from the top of the air classifier, the mostly coal mixture goes through a dedusting cyclone and then into a dust collector (See Product 1 in Figure 1). That is a combination of coal and clay with the particle size of smoke. "The lower discharge of the air classifier is coal and we have the option of grinding it again to remove the fine impurities," Robbins said.

Taking it through the second grind, the finer heavy particles can be removed. "Now we are simply making a density separation," Robbins said. "The light coal heads toward the top and heavy coarse impurities slide toward the bottom. The second dust collector produces another coal product."

"We are taking advantage of the nature of the particles in feedstock to design a solution to dry and size them," Robbins said. "It's an emission-free process because the dryers run on natural gas. By opening the material with the pulverizer, it's a very efficient and environmentally friendly process."

The heavy material dropping out of the air classifier is fine clay and silica. The material screened out of the first step can be used as feedstock for the brick industry. "One of the biggest factors in brick production is drying clay," Robbins said. "We often try to apply those materials toward a dry mineral application. It's not a big financial driver, but it helps with the recycling process."

It varies with each application, but the size fraction on the second dust collector in the case of the Gary deposit is a minus 100 mesh coal. "For people that use pulverized coal, we can meet their needs," Robbins said. "If the customers don't want to deal with fines, the product can be pressed into briquettes."

"We also have a unique situation with regards to the use of the coal-clay mix," Robbins said. Post combustion the coal-clay mix yields an ash product that has similar cementitious properties of flyash, but 1/8 the bulk density. We are applying it in some high-end products."

Deploying the Technology

The Gary facility recycles 100% of the materials on the 1-mm x 0 size fraction. "We have 25% to 35% moisture feed into the system that results in a 1% moisture product," McGraw said. "There are some transportation constraints handling minus 100 mesh coal. It could be transported pneumatically or by covered railcars. Using our binder, however, we are able to produce very durable briquettes from the 1% moisture fine coal. Those briquettes are easily transportable."

McGraw believes it to be the only technology currently viable for large production scale. "We can build the briquetting facilities 80-tph modules," McGraw said. "They are mobile and can be easily placed on site." The DHS units would require two to three men to run a 200- to 300-tph facility and a natural gas or a propane source.

GreenFields would need to perform a detailed evaluation (size fraction analysis, moisture, ash, etc.). Once they test the coal waste material, they can develop the design criteria and determine the appropriate configuration. "We would take four 55-gallon drums of samples to the Gary test facility and run the material through the pilot plant," McGraw said. "We would be able to evaluate the site-specific conditions and tell mine owners what we can and can not do with their materials."

GreenFields is currently in the process of acquiring other sites. "We have added two more sites and we are looking at several more," Cutaia said. "We are looking to expand as rapidly as possible. Not only in acquiring sites and operating them ourselves, but also in licensing the technology to other mine operators." Now they can bring a prospective licensee to the Gary site to see the equipment in operation.

GreenFields believes it has developed a revolutionary way to clean up coal refuse impoundments. Some older impoundments are environmental hazards, leaching toxins into rivers and streams. The system removes and recycles 98% of the materials.