

Blue Circle Manages Abrasive Slag with Basalt-lined Pipe

Blue Circle's Sparrows Point, MD. plant has been using a basalt-lined pipe for handling abrasive blast furnace slag for 17 years without needing to replace it.

Granulated blast furnace slag is extremely abrasive. Moving the granulated slag slurry wears pipes and elbows, resulting in downtime and higher maintenance costs. Blue Circle Cement's Sparrows Point, MD. facility is well aware of the problems that moving this abrasive material can cause. The company produces about 850,000 tons of slag cement annually.

A water granulating/grinding operation that turns slag left over from the production of iron into slag cement, the Blue Circle plant is the first and oldest of its kind to be built in the United States. It is the largest producer of the granulated blast furnace slag in one location in the country, producing 2,850 tpd of slag cement.

The slag cement produced by Blue Circle is called NewCem. Used as a Portland Cement additive, NewCem can replace as much as 70% of Portland cement in concrete mixes. The proportion is based on the specific job requirement, and the conditions and desired characteristics of

the concrete. NewCem provides specific concrete properties such as improved workability; permeability; resistance to sulfates and chlorides; and resistance to alkali-silica reaction. It has a greater strength potential and produces a lighter color product, say its makers.

Used in numerous general construction applications, NewCem is preferred by many engineers and concrete suppliers who produce high-performance concrete. The product meets ASTM 0-989, Grade 120, and AASHTO M-302 standard specifications of ground granulated blast-furnace slag for use in concrete and mortars. In the last decade, NewCem has been used in an estimated 40 million cu yd of concrete.

The slag cement production plant at Sparrows Point was designed specifically to handle slag produced by Bethlehem Steel's huge "L" blast furnace and went online in March 1981. One of the largest producing blast furnaces in the western hemisphere, the "L" furnace produces about 8,000 tpd of iron. The furnace runs continuously 365 days a year. To keep pace with the furnace, Blue Circle also runs 24 hours a day, three shifts a day. The Blue Circle plant and the steel mill plant are located near each other on the Chesapeake Bay.

Prior to the construction of the Sparrows Point plant, some of the slag produced by the steel mill was used as a fill material, but the majority of the slag was considered unusable waste material. Today, using the water granu-

lation system, Blue Circle consistently converts all of the "L" furnace slag into the high-quality slag that is used to make cement.

Engineers who designed the Blue Circle slag cement plant wanted to avoid blown pipe, worn elbows, and other problems that might result in downtime and high maintenance costs. They were well aware of the problems associated with moving the high volume of slag produced by the blast furnace. The slag, composed of a chemical combination of lime, silica, alumina, and magnesia, is extremely abrasive. It would take a special type of product to handle the high volume and the harsh nature of the slag.

Engineers found the answer in a basalt-lined pipe manufactured by Abresist Corp., Urbana, Ind. They specified 19-in.-diam Abresist pipe for the new plant and eliminated many of the problems caused by the harsh slag.

Approximately 2,000 ft of the basalt-lined pipe is used to move the slag through the processing system. For nearly two decades, the basalt-lined pipe withstood the abrasion from the slag and still does not need to be replaced. In addition to the pipe, Blue Circle also lined its agitation tanks with the basalt. It was installed in the tanks in 1989 and did not need to be reworked for a decade.

Converting iron/slag to NewCem

The production of slag cement at Blue Circle begins after the blast furnace finishes producing iron. During iron production the iron/slag mixture is drawn from the blast furnace at four tap holes—two located on the east side of the furnace, two on the west. Only one hole per side may be opened



At Blue Circle's Sparrows Point, MD plant, Abresist basalt-lined pipe runs along the bridge from the agitation tanks to the filter beds. Hydraulic variable-speed, 1,000-hp pumps move the abrasive slag to the filter beds. The basalt pipe, after almost two decades of use, showed little to no wear and did not need to be replaced.

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at any one time, and they are alternated every 28 days. The molten iron has a greater density than that of the slag and is drawn off using a dam structure as it flows from the tap hole down a runner in the cast house floor. The molten iron is collected for further processing while the molten slag flows over the dam, down the hot runner, and out of the furnace building.

At this point, Blue Circle takes over and the conversion of molten slag into cement begins. The granulating system was constructed as close to the blast furnace as possible to ensure a good flowing product. As molten slag cools, its viscosity increases, making it more difficult to granulate. All pipe used to convey the abrasive slag is lined with Abresist basalt wear-resistant linings.

Blue Circle maintains four hot runners and four blow boxes. The molten slag flows from the furnace at 3 to 10 tons per minute to the blow boxes. Based on the condition of the molten slag, it is diverted to a pit for air-cooling or is granulated. The hot runner channels the molten slag into the blow box.

Here the molten slag is quenched under high-volume water sprays. A water/slag ratio of 10-to-1 is maintained to assure rapid quenching. The shock cooling instantly vitrifies the molten slag into a glassy sand-like material that has a glass content of 95% to 98%. The slag is monitored to ensure that no iron carryover enters the blow box. If molten iron is detected, it is diverted to the pit before quenching to prevent explosions.

From here, the granulated slag and water slurry flows from the blow box to agitation tanks in steel, refractory-lined channels called the cold runners. Blue Circle has two cold runners and two agitation tanks on each side of the furnace. Each agitation tank is serviced by two 15,000-gpm slurry pumps.

The slurry enters the agitation tank tangentially, inducing a swirling action while more slurry is added. The agitation keeps the slag suspended in the slurry so it can be easily pumped from the furnace area via 1,000-hp hydraulic variable-speed pumps to one of five

filter beds on site. The system is designed to ensure that a constant level of slurry is maintained in the agitation tank.

From the agitation tank, the slurry line, which is lined with Abresist basalt lining, empties into the distribution box. The distribution box constructed with a ceramic tiled lining and a series of gates allows the operator to select which filterbed receives the slurry. Blue Circle has five 2,580-cu-ft capacity filter beds. In the filterbeds, a gravel filter is used to separate the slag from the water.

A series of drainage pipes collects the process water and channels it from the filterbed leaving the slag granules behind. The process water returns through three collector pipes to the main collection pipe. The granulated slag from the filterbeds is removed by a bridge crane and transported via conveyor to the storage silos. From there, the raw slag goes to the grinding plant for processing.

During the grinding operation, fineness is closely controlled on an hourly basis to ensure that the hydraulic activity of the slag is uniform and exceeds the stringent strength requirements of ASTM-C-989 specifications. After grinding, NewCem is stored in two 20,000-ton-capacity silos. From there, the product is distributed along the eastern seaboard to construction industry customers. It is shipped via truck, rail and class A ocean barges to markets as far north as Boston, Mass., and as far south as Jacksonville, Fla.

17 years and still going

In 1999, Bethlehem Steel shut the Sparrows Point steel mill plant down to reline its "L" blast furnace and relocate the slag runners. Because of the changes at the steel mill, Blue almost two decades was replaced. The rest was still in good condition.

Bill Sanders, Blue Circle's operational maintenance coordinator, said, "Much of the pipe was good. But we replaced it anyway. Especially in the areas that might cause us problems in the future if they would blow during operation. We replaced the pipe in the critical areas that are hard to get to and that take the most pounding. The pipe was not in bad condition, we just took the opportunity to replace it."

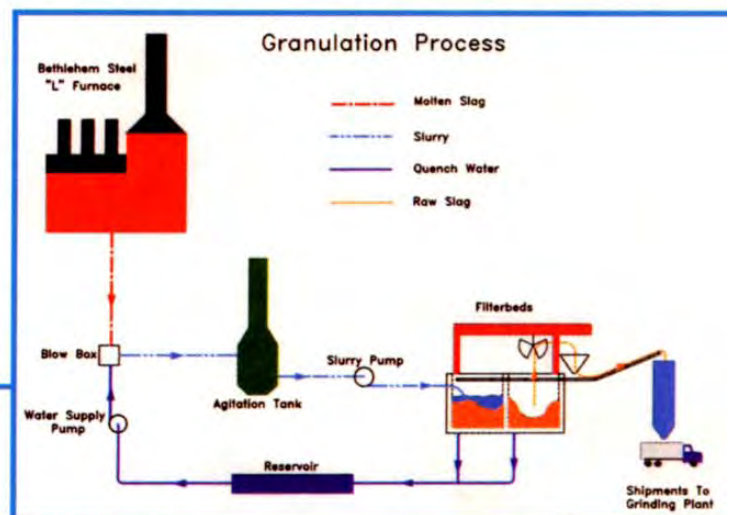
The company also examined the straight pipe on the bridge to the filters. Sanders said, "The pipe bridge piping is not a critical area like elbows and bends, but it needed to be looked at. We pulled the bridge pipe out, checked it, and decided it showed little to no wear. It could last another five to seven years, if not longer, based on the blast furnace output. We didn't need to replace any of the Abresist basalt-lined pipe on the bridge."

The company did not consider using another brand of pipe. Erin Altemos, plant process engineer, remarking on the longevity of the pipes, said, "We specified the best in 1981. The reliability we need is there. It lasts. Why change? You can't get much better customer service when you have a problem and the president of the company comes in and directs the repairs."

Agitation tanks

Like the pipes that crisscross the compound, the sides of the agitating tanks at Sparrows Point were basalt lined as well. In 1999 the company decided to address the few issues they were having with the lining in the tanks.

This schematic of the granulation process at Sparrows Point shows the movement of the slag from the "L" blast furnace to the filter beds through basalt-lined pipe.



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Once again, the company went to Abresist for the solution.

The basalt lining on the tanks had been installed in 1989 and was not originally specified when the plant was built. The corrosive

nature of the atmosphere at the plant eroded the tanks from the outside. "The basalt lining did not completely withstand the impact, but it had a longer life than anything else," Sanders said. "The Abresist panels were not worn out. Some of the tiles were being knocked off of the panel due to impact."

Altemos added, "Impact is a big problem with the tanks. We had to replace sections of the tank lining that were damaged. We had experience with Abresist. Joe [Accetta, president of Abresist] and Ray [Albertson, Abresist sales representative], helped us get around the problem and solve it."

The Abresist team advised the company to use Alresist high-density alumina ceramic tiles that were manufactured into curved

panels. Rated 9 on the Mohs scale of hardness, they provided the level of abrasion and impact resistance needed to withstand the impact of the slag. The Alresist plates were installed in the tanks in 1999 with the help of Jeff Howard, Abresist technician.

Summing up Blue Circle's longtime relationship with Abresist, Sanders said, "The reason we keep coming back to Abresist is the product performance and their customer service."

This article was adopted from material submitted by Blue Circle Cement/NewCem, (+1) 410-388-1177, www.bluecircle.co.uk; and Abresist Corp., (+1) 800-348-0717, www.abresist.com



Molten slag flows from the "L" blast furnace at the rate of 3 to 10 tons per minute. Depending on the condition of the molten slag, it will be channeled to a pit for air-cooling or is granulated.

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