Wet Shotcrete for Refractory Applications...Where It Has Been and Where It Is Going

by Jim Farrell

Refractory producers and contractors have a history of trying to put themselves out of business. The hook in selling refractories has always been to make them last longer, install faster, and lower the cost to the end user.

Monolithic refractories include materials that are manufactured using calcium aluminate cement rather than portland cement. Monolithics, either cast or spray-applied, have gained significant market share over the use of fire brick and mortar, gunning materials, plastics, and ramming materials outside China and India in recent years.

In the early 1990s, Ralph Allison and his son Eric of Oak Mountain Industries (OMI), working with Reno Refractories, and Harbison Walker Refractories (now known as part of the ANH Refractory Group), independently developed low-cement/low-moisture monolithic materials that were installed using the wet process. These low-cement/low-moisture materials performed much better than traditional dry gunning materials, but the problem was the set time was too long.

"We knew we had something special," remembers Eric Allison. "It just took too long for the material to set. I will never forget, it was on October 10, 1993, at Armco Steel (now AK Steel) in Ashland, KY. We decided to use hydrated lime as an accelerator and the material immediately froze on the walls of a torpedo ladle as soon as it made contact. I knew then that we had it." The Allisons called their system "Wet Set."

2200 lb (998 kg) bulk bags are loaded into a mixer and ultra-high-pressure pump for wet shotcrete process

Harbison Walker resolved their problem using sodium silicate as an accelerator. Both OMI and Harbison filed for process patents and both patents were issued. Fortunately, no serious dispute ever arose from either side.

"After we resolved the problem of the set time," Ralph Allison recalls, "we continued to improve the materials and work with equipment manufacturers to improve the equipment. We needed smaller but higher-pressure pumps than were on the market, and larger, more efficient mixers. Allentown and Whiteman initially, and later Blastcrete, came up with smaller, higher-pressure pumps. We worked with Blastcrete to design a mixer that would keep up with the pumps and mount the mixer and the pump on a single trailer. Now there are ultra-low-cement and no-cement products on the market, all of which have been improvements. Now many are in the game."

George Stoupis, Sales Director, Linings for Iron and Steel, for Vesuvius USA, thinks the area that has been best served by the low-cement/low-moisture process is the steel industry, which consumes 70% of all refractory materials. "From our perspective, the areas that have been best served are the iron making and finishing sectors of a steel plant" Stoupis says from his office in Carnegie, PA. "Blast furnace operators have embraced the wet shotcrete process in all areas where refractories are used. Many brick laying jobs have been lost to attrition; however, we continue to see a need for brick. Shotcrete certainly extends the service life of the brick, reduces refractory cost and increases the speed of making repairs."

The wet shotcrete process has played a significant role in ladle maintenance according to Stoupis. "Where in past years ladles were constructed with commodity-type brick and the

ladle life was between 60,000 and 100,000 tons (54,000 and 91,000 metric tons) poured," explains Stoupis, "the use of the wet shotcrete process has extended the ladle life up to 1,000,000 tons (910,000 metric tons) poured."

MINTEQ International's Shotcrete Applications Technology Manager, Robert Harmon of Slippery Rock, PA, is another who recognizes the importance of wet shotcrete to his business. "Recent improvements to mixer energy, as well as improved wear part life of the equipment, allows for much more uptime," says Harmon. "We see the greatest advancement, however, in technology from the material side. We anticipate more exotic materials will replace more labor-intensive applications that we see today. Regarding the equipment, we anticipate the trend to be more mobile and instantaneous. That appears to be the trend in Europe at the moment and likely will continue in the U.S."

North American Refractories, who is part of the ANH Refractory Group, also uses the wet process in combination with a robotic applicator at their ladle maintenance facility in Gary, IN. Ladles up to 220 ton (200 metric ton) capacity are maintained at this facility.

Industrial applications using wet shotcrete include OSB plants, cement kilns, coal-fired power plants, petro chemical plants, and large foundries.

The world's largest producer of steel is China, producing over 440 million tons (400 million metric tons) in 2006, compared with approximately 110 million tons (100 million metric tons) in the U.S. This trend is expected to continue through 2010. Monolithic refractory usage in Japan, Korea, Europe, and the U.S. accounts for 44% of all refractory usage. Monolithic refractory usage in China accounts for only 25% of all refractory usage. Dr. Charlie Semler, former Head of Ceramics Engineering at the Ohio State University and owner of Semler Materials Service in Phoenix, AZ, is of the opinion that the Chinese, and eventually India, who manufacture just over 1/10th of the steel produced in China, will see their monolithic usage increase in the future. "I feel the future of monolithic usage in China and India is bright," says Semler, "because of the proven practical and economic benefits for diverse applications."

Vesuvius' Stoupis, however, is more cautious about China and India. "It is difficult to predict with any certainty what level of growth for the wet shotcrete process we will see there," continues Stoupis. "The cost of investment in equipment required to accommodate the process will certainly be weighed against the abundant labor and very low labor costs in these areas." The recent announcement recently that there are more than 300 million workers in China who still earn approximately $1.00 per day certainly supports Stoupis' position.

Ralph Allison (left), author Jim Farrell (center), and Eric Allison discuss how the wet refractory shotcrete process developed. The Allisons and Harbison Walker Refractories were pioneers of the wet process in the early 1990s

Robotics are used for spraying ladles with wet shotcrete at North American Refractories' ladle maintenance facility in Gary, IN

Throughout the 1980s, steel-buying customers demanded clean steel. Refractories were blamed for most inclusions in steel that resulted in structural failure to parts made with steel. As a result, refractory materials became more sophisticated, such as low-cement/low-moisture wet shotcrete materials. Like the fuel used to melt iron and steel, refractories are a large consumable

and refractories will eventually burn away. It will be interesting to see if the pressure for clean steel placed on Western producers will prevail on large steel producers like China and India.

It is likely that the future for monolithics and the wet process will continue to grow in the U.S., Europe, Japan, and Korea. The jury is out on the fate of monolithics in China and India, but as is always the case, the market will dictate the rules of the game.

A typical setup lining a cement kiln with wet shotcrete refractory material

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