

# Refractory Gunning Material Precertification by Correlation Testing

By Robert J. Jenkins

In spite of advancements in cement technology, and research and development efforts on the part of refractory manufacturers to develop the ideal gunning mixture, pneumatic placement of refractory castables remains more of an art than an exact science. The quality and service life of an installed refractory lining is largely dependent on the skill and dedication of the gunning crew and the inspection and quality control programs implemented during lining application. It is also directly dependent on the quality of the refractory materials used.

This article addresses one issue related to pneumatic gunning—that of precertifying refractory materials before installation where certification is conducted in a manner that predicts refractory properties on the wall, where it counts. If refractory properties on the wall are unacceptable, the cost incurred to correct the problem or possibly the cost to live with the problem could be severe. Accurately predicting gunned properties on the wall is of the utmost importance.

Historically, refractory material precertification has been based on the physical properties of refractory samples that have been cast, not of refractory samples that have been gunned. While historical data relating cast properties to gunned properties have been used to predict refractory properties on the wall, the relationship between historical data and what is on the wall is tenuous at best and should not be relied on.

## Physical Property Variations: Cast versus Gunned

To understand why the physical properties of refractory materials installed by casting vary from those installed by pneumatic gunning, it is necessary to compare certain aspects of the two installation processes.

When a refractory material is installed by casting, the proportions of the material components within the mixture remain the same as the material manufacturer's original blend. No portions or parts are lost. When that same material is gunned, however, a certain percentage of the material,

primarily the coarse aggregate, is lost through rebound. Rebound is that portion of the refractory material that bounces away from the refractory surface during lining installation and is lost, thereby affecting the structural nature of the material. In addition, the amount of water required to reach optimum gunning consistency is generally less than the amount of water required to reach optimum casting consistency. For any given material the gunned concrete tends to have more cement and refractory fines, and less coarse aggregate and water than the cast concrete, and the physical properties may vary considerably. The cast properties may not accurately reflect the gunned properties that will be achieved on the wall—where it counts.

For insulating refractories, gunned samples tend to be denser and stronger than cast samples because the water content has been reduced, the proportion of cement has been increased, and the insulating aggregate has been compressed. By-products of increased density frequently include increases in compressive strength and thermal conductivity, and decreases in porosity and permanent linear change. Some changes can be significant.

For dense gunned refractories, a loss of dense coarse aggregate can lead to higher percentages of cement and refractory fines, and decreased density. By-products of decreased density frequently include increased porosity and permanent linear change, and decreased strength, abrasion resistance, and thermal conductivity. As previously mentioned, some changes can be significant.

If these changes are significant, it is critical that it be known before refractory installation. After installation is no time to discover there is a problem.

## Refractory Material Precertification by Correlation Testing

Refractory materials to be pneumatically gunned should be precertified by gunning. However, if the entire certification process involves only gunning, the cost to do so can be significant

because the cost to prepare a refractory sample by gunning tends to be far greater than the cost to prepare a refractory sample by casting. In addition, a gunned sample requires far more material than does a cast sample, adding more cost to the gunning process.

Gunned correlation testing is a reasonable solution to this problem. Correlation testing provides a realistic relationship between cast and pneumatically gunned materials for any given lot of refractory material, while remaining reasonable with respect to testing costs.

Correlation testing consists of first testing the refractory material by casting in the normal fashion followed by partial testing by gunning. What makes correlation testing work is that each gunned test duplicates a cast test. The gunned sample is in addition to, and not in place of, the standard lot of cast samples required by the project specification. It is the relationships between the physical properties of the duplicated tests that project physical properties on the wall.

## Correlation Testing: Procedure

The frequency of material recertification testing by casting would be controlled by the project specification and would be performed in the normal fashion.

For each lot of five or less cast samples prepared, the pallet or super-sack from which the center sample (usually the third sample) was prepared would be resampled and tested by gunning. The cast and gunned data from that center pallet or super sack would be used to calculate the correlation factors applicable to that sample lot. The correlation factors determined would then be applied to the cast properties of the other cast tests within the sample lot, thereby projecting gunned properties on the wall. This

represents an 80% reduction in gunning cost as compared to the cost of gunning each and every sample. The additional cost to prepare correlation samples by gunning, as compared to the cost of preparing all samples by casting where the results are of doubtful value for predicting gunned properties, would be minimal considering the value of the engineering data obtained.

When performed properly, correlation testing provides a realistic projection of gunned refractory properties on the wall—where it counts—for density, strength, and abrasion resistance, and helps to keep testing costs in check. Correlation testing is not an effective tool for projecting gunned permanent linear change.



**Robert J. (Bob) Jenkins** is the President and founder of Robert J. Jenkins & Company, a Texas Corporation and provider of refractory quality control services. Jenkins founded Robert J. Jenkins & Company in February 1977 based on a new concept, which was to provide refractory inspection services whereby inspection would be performed by personnel whose hands-on experience in the application of refractory lining systems would be of such a degree as to enable them to perform the actual work they inspect. Under his leadership, Robert J. Jenkins & Company has become the leading independent provider of refractory quality control services worldwide. He received his BS in civil engineering from the University of Houston, Houston, TX.