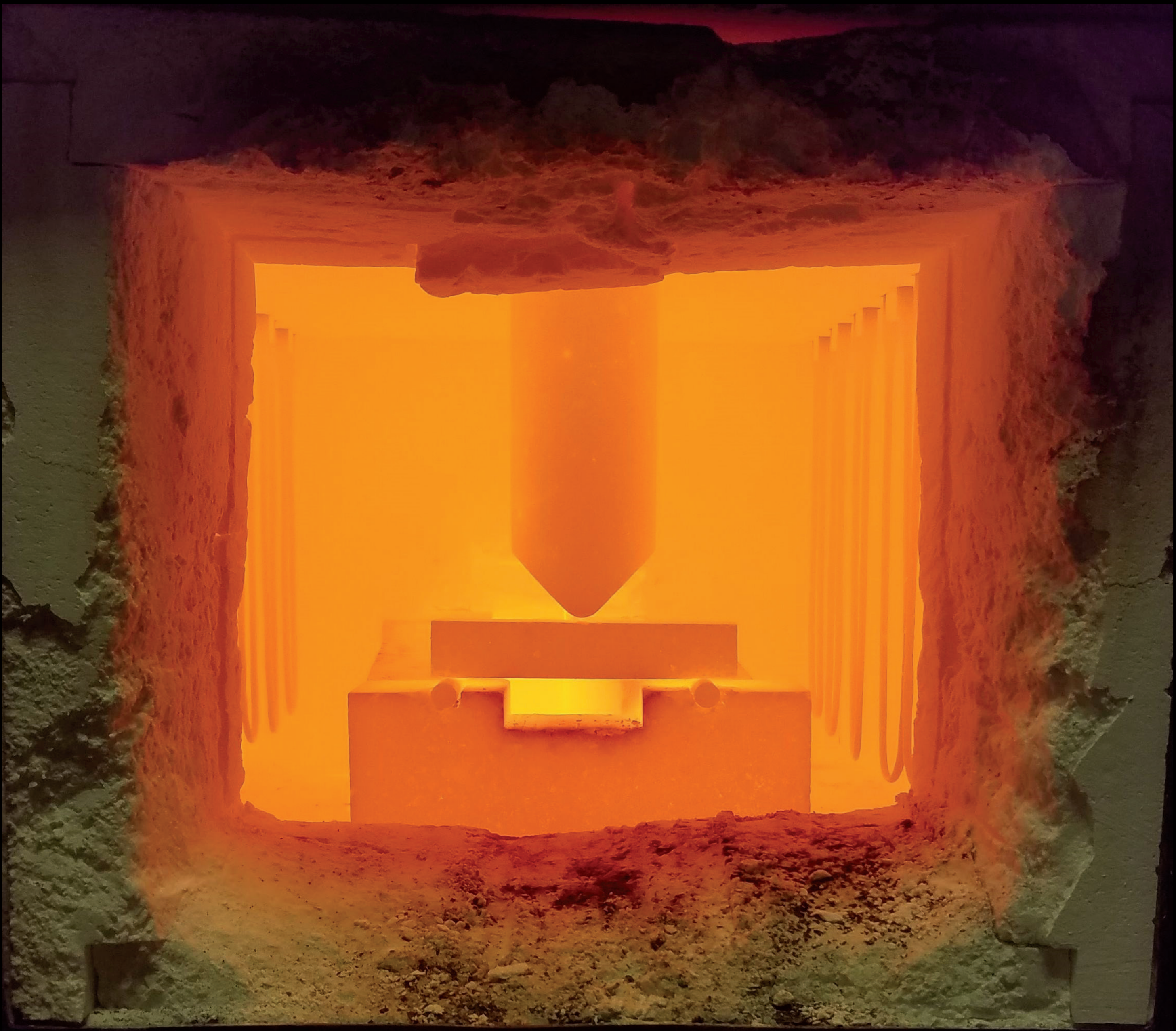
BIOMASS
MAGAZINE

SPOTLIGHT JANUARY/FEBRUARY 2020 Edition

www.BiomassMagazine.com



BIOMASS REFRACTORIES: ONE SIZE DOES NOT FIT ALL

Performing a process audit and understanding wear mechanisms can drastically maximize lining performance.

BY JIM CAPRIO AND BRENT BUCHCUSKI

Due to its versatility, value, overall economic impact and abundancy, biomass is becoming an increasingly popular fuel option for numerous processes. To better manage a biomass refractory lining system, we believe there are three key fundamentals:

• Variability, as biomass fuels and their effect on a refractory lining vary widely from one application to another.

• Understanding the four key wear mechanisms.

• Audit and design—installing a prescriptive lining based on a process audit that focuses on the key wear mechanisms to maximize performance and minimize overall costs.

Wear Mechanisms

Due to the different options of biomass fuels, and the various operating parameters of the units, it is important to understand the wear mechanisms of each biomass application.

Alkali attack. Relative to traditional fossil fuels, most biomass fuels contain high levels of alkalis (sodium, calcium and potassium). At temperatures as low as 1,500 degrees Fahrenheit, these corrosive compounds can disrupt refractories in two ways—slag corrosion, or expansive alumina reactions. For slag corrosion, the alkalis can combine with the silica and calcium in the refractory, forming a viscous slag at high temperatures that will deteriorate the lining. The alkalies in the fuel can also react with the excess alumina in the refractory, causing a shift from alpha to beta alumina. The beta transformation is very expansive, causing crack propagation in the lining.

Alkali cup tests serve to approximate the potential reactions. Comparative cup test can help predict a cost-effective solution.

Abrasion and erosion. Depending on the type of biomass fuel and ash hardness after combustion, various parts of the unit can be subjected to abrasion and erosion. To test and rank the abrasion resistance of different refractories, the ASTM C704 test is commonly used. Using a prescribed amount and type of silicon carbide grit, the refractory sample (heated to 1,500 F then cooled to room temperature) is eroded at a 90-degree angle. The subsequent hole is measured by its size in cubic centimeters (CC), with a smaller hole (and lower CC loss) indicating better abrasion resistance.

Thermal Cycling. Refractory materials are designed to be run at high temperatures with minimal thermal cycling. However, some units, and certainly some sections of many designs, are subjected to thermal cycling. Some refractories are more resistant to thermal shock and cycling than others. A popular test to determine thermal shock resistance is the prism spall test. Two-inch cubes of the refractory in question are heated to 2,200 F and then thermally quenched in water, to complete one cycle. After each cycle, the cube is examined for excess cracking. If the cube is not fractured in half, another cycle is run. This is done for up to 30 cycles. This data can then be compared to other refractory samples tested using the same method.

High-Temperature Strength. Most refractory castables are exceptionally strong at room temperature. The true test of a refractory, however, is strength at operating temperature. The most common method to test high-temperature strength is the Hot Modulus of Rupture (HMOR) procedure. The test performs a three-point modulus of rupture test on a refractory sample at furnace temperatures, often ranging from 1,500 to 2,800 F. The hot strength (psi) can then be compared to other refractory types. This test is critical with cement-bonded products, as higher amounts of calcium oxide in the refractory can cause a loss of strength at elevated temperatures, resulting in fluxing and premature wear.

Alkali cup tests serve to predict potential alkali reactions based on fuel sources, and this data can be applied to make a prescriptive product recommendation.
PHOTO: UNITED REFRACTORIES

Case Histories

The following are two examples where audit results, understanding wear mechanisms and installing a prescriptive lining pay off.

Midwest Gasification Unit

Audit results: The wood chip fuel will introduce excessive sodium and potassium, potentially causing fluxing and matrix disruption. The auger shaft area will be exposed to thermal shock and abrasion.

Products used: UNI-PUMP 55 ALK R has an excellent rating in various cup slag tests and is very conducive to the desired installation method. UNI-PUMP RF-FS-6 in the auger shaft shows shock data in greater than 30 cycles and excellent abrasion data.

Midwest Municipal Waste-to-Energy Unit

Audit results: The extremely variable fuel could introduce alkalis, and more importantly, chlorides that would severely disrupt any cement-bonded refractory. High strength is required, as the walls are routinely cleaned and scraped.

Products used: UNI-SHOT RF-60CF is a no-cement, gel-bonded system that shows excellent resistance to alkalis and chlorides. In addition, the "CF" products have good hot strengths in the operating temperature range to tolerate the cleaning process. The CF system is also easier to install and more cost-effective than competitive no-cement colloidal silica systems.

In summary, refractory linings in biomass units are subject to a variety of wear mechanisms. To expect optimal performance and results, a process audit should be conducted to consider the four key wear mechanisms and help design a prescriptive lining best-suited for a specific project.

Authors: Jim Caprio
Vice President, Customer & Product Development, United Refractories Co.
jimc@urc4u.com

Brent Buchcuski
Midwest Regional Sales Manager, United Refractories Co.
brentb@urc4u.com

URC | UNITED REFRACTORIES CO.

Refractory Solutions For Biomass

3 Steps To Success...

1 Perform a **Process Audit** with your URC representative

- *What's happening in your unit?*

2 Understand the **4 Key Wear Mechanisms**

- Alkali Attack
- Abrasion/Erosion
- Thermal Cycling
- Hot Strength

What wear mechanisms are present in your process ?

3 Design/Install a **Prescriptive Refractory Lining**

- *There is NO "one size fits all"!*
- *URC has numerous products to supply a cost effective lining based on your wear mechanisms*

For more details contact Brent Buchcuski:
906.221.7004 • BrentB@URC4U.com

URC|4U SERVICE

URC4U.com