Plibrico's Anti-Spalling Additives Provide Faster and Safer Dry-Outs

Ensuring Proper Dry-Out and Maximum Refractory Strengths

Removing moisture from refractory castables and precast shapes is a critical part of the refractory installation. Pressures on the heat processing production department to minimize downtime can lead to rushed dry-out procedures. Usually, these ill-advised shortcuts have the opposite effect and quickly compound delays by causing thermal damage to refractory linings, and in some instances can lead to injuries.

Dry-outs fail due to imprecise management of water extraction from refractory linings. At the boiling point of water, the pressure of steam is less than 1 psi. However, at 700°F, saturated steam reaches 3,000 psi, and possesses enough energy to destroy the most resilient refractories. Too much heat, rapid ramp ups, vapor lock, poor curing and surplus water can contribute to potentially hazardous situations.

A vital method to minimize the susceptibility of refractory castables to explosive spalling and structural damage during dry-out is with the use of anti-spalling additives, such as burnout fibers. The channels formed by the elimination of burnout fibers increase permeability, providing faster and shorter paths for steam to escape. This accelerated water extraction from refractory linings allows refractory dry time, and by extension heat processors downtime, to safely be reduced by 10% - 15%, depending on application.

What Is Kwik Kure and How Does It Function?

Kwik Kure is a type of organic bake out fiber (OBOF), or burnout fiber, which is added to refractories to specifically increase the permeability of the castable or plastic during initial heat up. Organic bake out fibers used in the refractory industry vary in composition. Synthetic fibers such as plastic, both solid and hollow, and natural fibers such as jute, have been used in the industry, as well as plastic shavings. Size also varies within the different OBOF's, where fiber lengths can range between 3mm to

Plibrico®

8mm, and thicknesses from 15mm to greater than 100mm. Typical commercially available OBOF used in refractories are listed in figure 1.

OBOF Types

	Jute	Polyester	Polypropylene	Acrylic
Length (mm)	3 - 5	3 - 6	3 - 5	4 - 8
Thickness* (mm)	>100	20 - 40	15 - 20	15 - 20
MP (°C)	-	2500	1620	-
Shrinkage (% @~150° C)	-	.50	-	.10

** For comparison, a human hair ranges between 80-120 microns in diameter.*

Figure 1

Like some monolithic refractory manufacturers, Plibrico offers an organic fiber called Kwik Kure as an optional or standard addition in its refractory castables. This fiber acts as a dry-out aid especially in applications where heat up procedures may be in question, or where an added dry-out safety factor may be required.

Kwik Kure is a polyester based fiber of approximately 3mm in length. Microscopic examination of the surfaces of refractory castables containing the Kwik Kure anti-spalling additive, reveal a fiber density of between 15 to 30 fibers/cm^2. The shrinkage and melting of Kwik Kure fibers increases castable permeability prior to the start of cement dehydration (Figure 2) and helps reduce internal pressure in the castable when high temperature steam is released during the dehydration process.

Kwik Kure Bake Out Mechanics

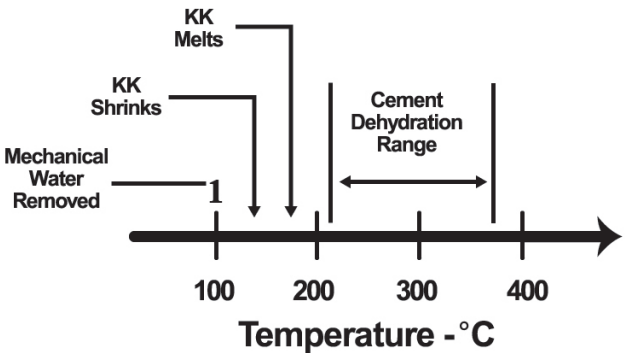

Figure 2

Does Kwik Kure Increase Porosity and Weaken the Castable?

Kwik Kure additions do not increase castable porosity to any significant degree. Their main purpose is to increase the permeability of the castable during dehydration. Porosity is simply a measure of the amount of holes in the castable. These holes may be isolated, or sealed, and may be connected to varying degrees. Permeability is the ability of a refractory to transport or release gas through the pore network, and can be considered a measure of the pore network connectedness. Kwik Kure fibers bridge the pores and open up the porosity structure. In achieving an open and connected pore structure, the fiber's contribution to porosity is negligible, approximately 0.2% - 0.5% additional porosity.

The addition of Kwik kure by itself does not weaken the castable. However, refractory castables with Kwik Kure additions, or any other OBOF for that matter, can exhibit a slight strength decrease due to the necessity to use extra water over the required amount of an equivalent castable without Kwik Kure to achieve an equivalent apparent flow. Kwik Kure inhibits the apparent flow of the castable

leading to the use of additional water to place the castable in the field. However, with the use of a wand vibrator the apparent "stiffer" Kwik Kure containing castable can generally be placed at normal water additions. Figures 3 and 4 illustrate these points.

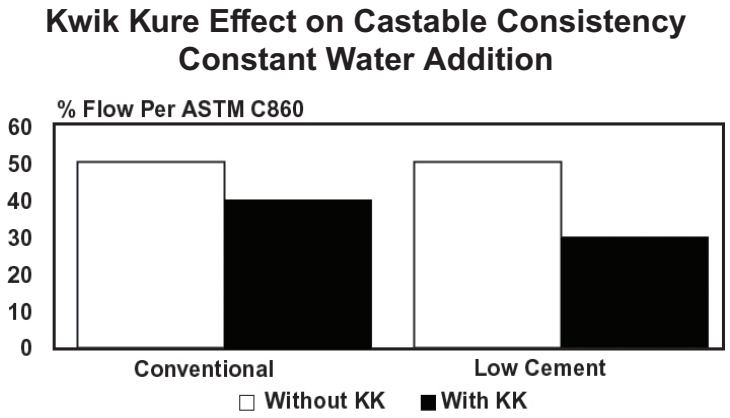

Figure 3

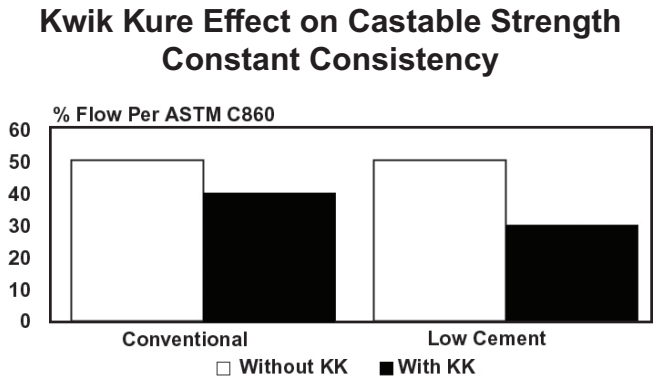

Figure 4

How Fast Can Kwik Kure Castables Be Heated

As a consequence of refractory castables possessing different physical characteristics due to formulation, particle packing, cement type, and such, there are no set standards as to how much of an increase in heat up rates a refractory castable can tolerate with Kwik Kure. While Kwik Kure does increase permeability in all castables, it does so to varying degrees because of textural differences both between and within various product classes (Figure 5) as well as the installed surface (Figure 6). Kwik Kure additions do not guarantee that dry-out spalls will not occur, rather it provides an extra margin of safety to reduce the possibility of steam spalling.

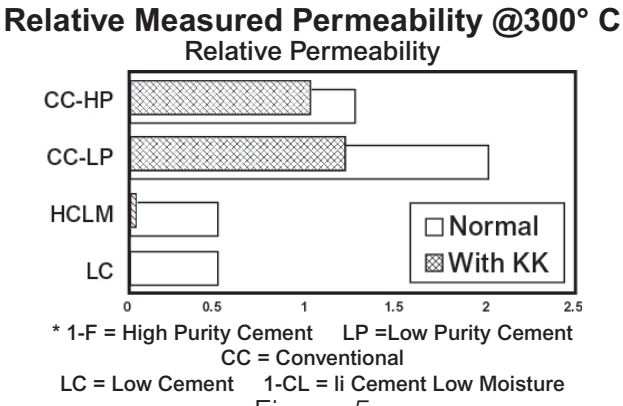

Figure 5

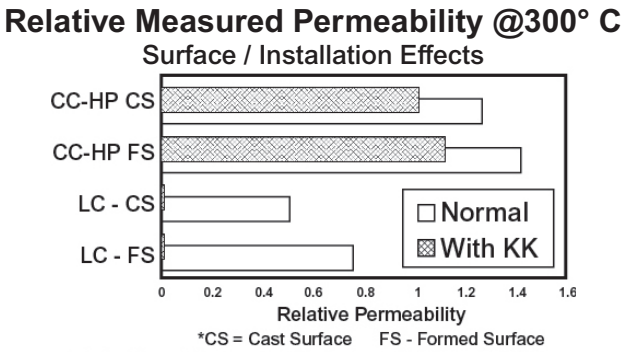

Figure 6

Plastic refractories do not benefit much from OBOF additions. Plastic refractories, both clay/air bond and phosphate bonded, lose the majority of their water at low temperature (100°C). Their permeability relative to castable refractories is much greater. In the extreme case, that of a fine grained, phosphate bonded plastic refractory, the permeability of this material at the dehydration point is 5-times lower than that of a conventional castable refractory.

Figure 7 compares the permeability of clay/air bonded and phosphate bonded plastic refractories with and without Kwik Kure additions to that of a conventional refractory.

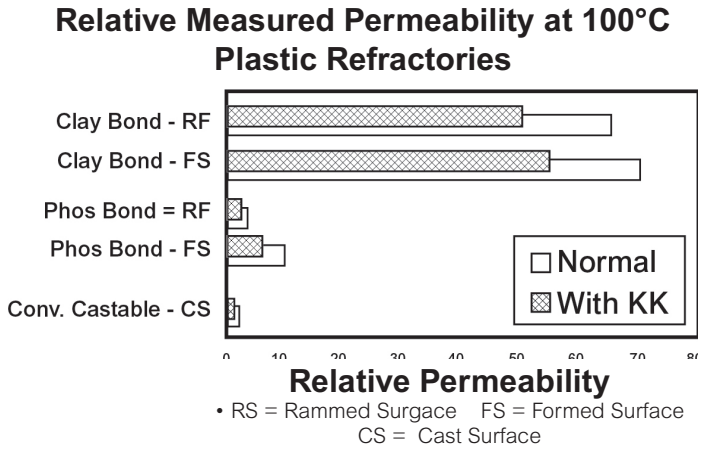

Figure 7

The Benefits of Anti-Spalling Additives

A proper dry-out is as important to a monolithic refractory lining as are the material quality and a proper installation. Fast heat up rates thermally stress refractory linings, causing micro cracking, reduction of strength, and ultimately, reduce lining longevity.

The use of anti-spalling additives in refractories can be a safe and effective way to quicken water extraction and reduce the time required to dry-out refractories. Anti-spalling additives help to efficiently increase the permeability of the refractory structure by allowing steam to safely escape at an accelerated rate during the dry-out process. Plibrico uses anti-spalling additives in its conventional castable refractories to add a layer of protection against steam spalling and structural damage, in addition to reducing dry-out times by an estimated 10% - 15%. The reduction in refractory dry time helps heat processors decrease expensive downtime and aids refractory installers by increasing scheduling flexibility.

For more information or to talk to a knowledgeable expert with genuine experience, please contact Plibrico at contact@plibrico.com, or 312-337-9000. You can find additional resource online at www.plibrico.com