



# Product / Application Update

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## Boilers

With a wide variety of boiler designs and fuels, the types of refractories used can vary considerably. Careful consideration of the type of fuel and firing method is needed before a refractory material can be made. The destructive conditions present must also be identified before refractory materials are selected. Typical boiler destructive service conditions are:

### Chemical Attack

Typical boiler fuels can contain reactive elements such as sodium, potassium, or vanadium. Reactions between these products of combustion and the refractory lining can alter the properties of the refractory lining resulting in spalling, corrosion, and/or erosion.

### Abrasion & Erosion

Airborne particulate can cause abrasion as it impacts the surface of a refractory. Erosion can be introduced as a fluid slay flows over the surface of a refractory lining.

### Thermal Shock

Rapid temperature fluctuations, caused by variability in the fuel (either in BTU content or volatility) or from water washing in ash hoppers, can lead to spalling.

The types of fuels and firing methods are frequently the source of many of these destructive service conditions.

**Gas**-These fuels typically burn very clean. When gas fired boilers are running properly (ie, clean fuel and good burner control), they provide a consistent and mild environment for refractories.

**Fuel Oil**-In general, light oils such as #1 and #2 fuel oil usually cause few problems for refractories. As the quality of the oil decreases, impurities such as sodium and vanadium increase which can cause chemical attack. Fuel oil flames are more difficult to control. If the boiler is fired with oil heavier than #2, refractories in contact with the ash must be upgraded.

**Coal**-The primary destructive condition is abrasion. In stoker fired units, the grate lines are subjected to rubbing of the coal and ash. In pulverized coal burners and cyclone burners,

the burner throats are subjected to high air velocities carrying coal particles. Ash hoppers can be subjected to a combination of impact and abrasion as well as thermal shock.

**Wood and Agricultural Waste-** Firing with these fuels can cause problems with refractories depending on the nature and condition of the fuel being burned. Wood fuels commonly contain high levels of alkalis and salt that can cause chemical attack. Glues and coatings from processed wood waste burn exothermically and can result in very high firing temperatures. Firing sawdust in suspension burners generally use large amounts of excess air that creates high temperatures.

**Black Liquor-** The smelt used as fuel in black liquor boilers has very high sodium contents. Refractories in contact with smelt slags must be capable of withstanding severe chemical attack.

General refractory selections for boiler areas not subjected to ash or slag are:

## **BOILER AND PENTHOUSE WALLS**

The two primary types of walls found in boilers are:

### TUBE AND TILE WALLS

Tube and tile walls have tubes normally on approximately 6-7.5" centers with refractory tile and insulation behind the tubes. The brick tile, CLIPPER, VARNON AIR HAMMER, KX-99-BF, or ARCO 50 are typically 2-3" thick and are backed up with mineral wool block insulation, INSBLOK-19. To insure a tight seal with the casing, ½-1" thick INSWOOL-HP ceramic fiber blanket can be attached to the back of the INSBLOK-19 to provide a compressible layer next to the casing.

### TANGENT TUBE OR WATER WALLS

The second type of wall found in boilers is the water wall. Here tubes can be adjacent to each other (tangent tube) or may be separated slightly by a flat bar or round stud. In either case, the "scallop" between the tubes is filled with a pliable refractory mastic. H-W products such as GREENPATCH 421 or KS-4T have been successfully used in this application. When the lining extends beyond the face of the tubes, a wide variety of castables and gun mixes such as HPV GUN MIX, KS-4GR PLUS, or EXPRESS-27 PLUS castables have been used. Sometimes these walls will have an inner casing between the refractory and insulation to reduce air infiltration. Seal boxes around penetrations such as soot blowers, doors, or observation ports can be filled with H-W products such as KS-4 PLUS.

## **FURNACE SECTION OR COMBUSTION CHAMBER WALLS**

The refractory linings here are exposed to the inside of the boiler and are subjected to the full range of destructive conditions. Depending on the severity of the destructive conditions, products ranging from super duty fireclay to extra high alumina and alumina-chrome refractories can be found.

Gas or light oil fired boilers generally use super duty to 60% alumina linings. The linings can be brick such as CLIPPER DP, KALA, or ARCO 50. Other linings can be castable such as MIZZOU CASTABLE PLUS. Plastic linings suggestions have been SUPER HYBOND or SUPER G.

In units fired with heavier oils than #2, upgraded brick linings such as UFALA or DV-38 brick have been used. Monolithic upgraded hot face plastic linings have been SUPER HYBOND 70, H-W Bull RAM, GREENPAK-85-P, GREENGUN-85 P. Monolithic upgraded dense castable linings have been ULTRA-EXPRESS 70 or VERSAGUN 70 ADTECH.

In boilers utilizing stoker or grate systems to burn coal or wood, the tubes must be protected against abrasion. Brick linings have been UFALA, NIKE 60 AR or KRUZITE 70 with upgrading to GREENAL-90 or KORUNDAL XD. Typical monolithic linings such as GREENPAK-85-P PLUS, GREENGUN-85-P PLUS, or GREENPAK-90-P PLUS are used. In situations requiring silicon

carbide monolithics, NARCOGUN SIC 80 AR, GREENGUN ECLIPSE 73P & 85-P, ECLIPSE 70 P PLUS, and THOR 60 ADTECH are used.

## **FURNACE SECTION OR COMBUSTION CHAMBER WALLS –Continued**

In boilers with wood waste or agricultural wastes, high levels of alkalis or salts may occur. Products such as VERSAFLOW 55/AR ADTECH, ULTRA-GREEN 57A, or VERSAFLOW 57A can be used for moderate fired temperatures. At very high temperatures, alumina chrome brick such as RUBY SR or alumina chrome plastics such as RUBY PLASTIC or RUBY PLASTIC AMC may be required.

## **STOKER PIERS, DIVISION WALLS, AND BRIDGE WALLS**

Brick have historically been the primary construction material although the use of refractory castables is gaining in popularity. These structures carry high heavy loads requiring a lining to resist high temperature creep. In mild conditions, super duty firebrick such as CLIPPER DP have been used. Coarse grain castables such as MC-25 PLUS, VERSAFLOW 45 C ADTECH, or VERSAFLOW 55-AR ADTECH are also suggested. For more severe operations, upgraded brick linings such as ARCO 50, UFALA or NIKE 60 AR can be used. For more severe operations, upgraded castable linings such as ULTRA-EXPRESS 70 or VERSAFLOW 70 C ADTECH can be used.

## **BAFFLE WALLS AND BOILER SEALS**

For many years, CLIPPER DP tile has been used to form baffle walls in boilers. If the particulate load is very heavy, an upgrading to UFALA , NILE 60 AR, or KRUZITE 70 brick may be required. Casting baffle walls has become common with H-W castables such as KAST-SET PLUS or KS-4 PLUS. Enhanced flow dense castables such as EXPRESS-27 PLUS and ULTRA-EXPRESS-45 has reduced installation difficulties but care must be taken to ensure a tight seal between the tubes and the form when pouring.

Filling boiler seal boxes has been accomplished with KS-4 PLUS castable. For corner seals, refractory mastics such as GREENPATCH 421 or KS-4T have been successfully used.

## **BOILER FLOORS**

Boilers firing gas or light oil typically have a floor consisting of 2-3" CLIPPER DP, KX-99-BF, or ARCO 50 tile. If heavy oil, wood, or agricultural waste is being fired, a typical brick upgrading is UFALA or KRUZITE 70 tile. Based on the boiler design, these tile may be placed directly over the tubes or they may have insulation under them. Insulating firebrick such as G-23 LI or insulating castables such as KAST-O-LITE 22, GREENLITE CASTABLE 22 or GREENLITE 23 LI PLUS DS can be used for the floor insulation. The insulation material depends on the ease of installation and the maximum use temperature.

Hot face floors have occasionally been totally cast. For this construction method, H-W dense castables such as VERSAFLOW 45 PLUS or EXPRESS 27 PLUS are suitable.

For coal fired units with wet ash bottoms or slag taps, silicon carbide plastics or castables such as ECLIPSE 70 P PLUS, GREENGUN ECLIPSE 73-P PLUS, or NARCOGUN SIC 80 AR are used.

## **BURNERS**

Linings for burners & burner throats vary considerably depending upon what is being burned.

In units burning gas or light oil, H-W plastics such as SUPER HYBOND 60 or SUPER HYBOND 80 are used.

For units firing heavy oil, phosphate bonded plastics such as H-W BULL RAM PLASTIC, GREENPAK-85-P PLUS or GREENPAK-90-P PLUS are used.

For units firing sawdust or pulverized coal, upgraded linings to alumina-chrome or silicon carbide may be required. These H-W materials are RUBY PLASTIC, RUBY PLASTIC AMC, ECLIPSE 70 P, and ECLIPSE 80 P. If the burner is very large, a gunning plastic such as GREENGUN ECLIPSE 73P, GREENGUN ECLIPSE 80 P, or GREENGUN JADE is preferred.

For cyclone burners in pulverized coal fired power plants, premium gunning monolithics are gunned over studded tubes. These H-W materials are NARCOGUN SIC 80 AR, GREENGUN ECLIPSE 73P, GREENGUN ECLIPSE 80 P, or GREENGUN JADE.

## **ASH HOPPERS**

Refractory dense castables or gun mixes are the material of choice. The material selected will depend upon the preferred installation method (pouring, pumping, dry gunning, wet shotcreting) and the degree of thermal shock it is subjected to.

Dry ash hoppers usually have little to moderate thermal shock and H-W products such as NARCO GUNCRETE AR, MC-25 PLUS, VERSAFLOW 45 PLUS, VERSAGUN 57A, or EXPRESS 27 GT are used.

For wet ash hoppers, much more severe thermal shock occurs. H-W products such as HPV ESX, PNEUCRETE THERMAX, EXPRESS THERMAX, VERSAGUN THERMAX ADTECH or VERSAGUN 57A will work.

Brick linings for ash hoppers are still used for some designs. H-W brick such as CLIPPER DP or KX-99-BF brick are suggested.

## **DUCTS AND STACKS**

Castables and gun mixes are most commonly used for ducts and stacks. The material selection depends upon the amount of expected abrasion, hot face temperature, and any potential for acid gases present in the process gases.

For moderate temperatures with no abrasion, H-W lightweight gun mix products such as GREENLITE 45 L GR PLUS, GREENLITE 23LI PLUS DS, KAST-O-LITE 20-45 G, or KAST-O-LITE 23 LI PLUS are suggested.

For more abrasive conditions, H-W TUFSHOT LI, NARCO GUNCRETE AR, or VERSAGUN ABR ADTECH will work well.

For low temperatures below 1200F, GREENCAST-12 GR PLUS will resist high particulate loading and abrasion at an economical price.

## **BLACK LIQUOR RECOVERY BOILERS**

Black liquor recovery boilers present a special situation due to the corrosive smelt. Droplets of black liquor sprayed into the boiler fall to the floor to form a char bed. Standard practice in these boilers is to use composite tubes eliminating the need for refractory except as a seal between the tube panels. Before composite tube availability, a chrome refractory gun mix was used to cover the floor and lower walls to protect the tubes. This material is H-W MAGSHOT.

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