AGC

THERVEK

AGC Plibrico Monolithic Refractories

AGC Plibrico Co., Ltd.

AGC Plibrico Monolithic Refractories

Since starting out as the first company in Japan to manufacture monolithic refractories in 1954, AGC Plibrico has developed into a specialized monolithic refractory manufacturer.
The company name “Plibrico” is an acronym of the words **Pli**able Fire**bri**ck **Co**mpany (pliable firebricks = monolithic refractories).

Characteristics of Monolithic Refractories

In contrast with shaped refractories, which are formed into a particular shape before shipping, monolithic refractories are shipped in a powdered or granular clay-like product, and can be shaped on site to match the specific needs of customers.

No Need for Skilled Workers
Application of monolithic refractories does not require skilled workers, as in the refractory lining application using shaped refractories.

Shorter Construction Period
The refractory lining applications can be completed faster using monolithic refractories than using shaped refractories.

Monolithic Structure
Using monolithic refractories it is possible to reduce the number of joints in comparison with shaped refractories, thereby minimizing falling off and joint corrosion.

Reduced Workload
With monolithic refractories there is no need to carry heavy bricks.

Complex Shapes
With monolithic refractories it is possible to form complex shapes, such as a boiler walls and around burners.

Characteristics of AGC Plibrico Monolithic Refractories

- AGC Plibrico delivers superior **quality** to customers by conducting strict raw material acceptance inspections and traceability management.
- AGC Plibrico caters to small-lot production orders and short-term delivery deadlines and promises greater security and **peace of mind** for customers.
- AGC Plibrico’s Chigasaki Plant has Manufacturing and Product Development divisions that cater to customer needs in a timely manner, and help to **resolve customer issues**.

AGC Plibrico Gunning Materials

AGC Plibrico considers the gunning application method to be the most economical application method for monolithic refractories, and has a particular preference for this method. Through the development of methods that were conventionally considered impossible, such as dry gunning of low cement castable refractories (THERVEK AD) and gunning of plastic refractories (THERVEK HR), AGC Plibrico is pursuing greater efficiency in refractory application methods.

As of July 2019, AGC Plibrico will unify and consolidate its THERVEK™ product brand. The name THERVEK™ is an acronym for **THER**mal **V**alue supported by **E**xperience and **K**nowledge, which expresses the brand concept of catering to customer needs and contributing to the resolution of customer issues by offering value, backed by experience and knowledge, to customers in thermal (i.e. high-temperature) industries.
AGC Plibrico will continue to contribute to customer’ s needs and resolution of customer issues more than before with THERVEK™.

THERVEK
(THERVEK)

AGC Plibrico Monolithic Refractory Lineup

Contents

Classification		Installation method	Bonding system	Product name	Page
Cement castables	Refractory castables	Casting/ trowelling	Hydration bonding	**THERVEK C**	3
	Light weight insulating castables				
	Refractory castables	Dry gunning		**THERVEK G**	3
	Light weight insulating castables				
Low cement castables		Vibration casting	Coagulation bonding	**THERVEK V**	4
		Free-flow casting		**THERVEK F**	4
		Wet gunning		**THERVEK PTG**	4
		Dry gunning		**THERVEK AD**	5
Plastic refractories		Ramming	Clay bonding	**THERVEK RM**	5
		Plastic gunning		**THERVEK HR**	5
		Patching	Phosphate bonding	**THERVEK PAT**	6
Specialized castables		Acid resistant castable refractories		**THERVEK AR Series**	6
		Abrasion resistant castable refractories		**THERVEK ABR**	6
		Abrasion resistant plastic refractories		**THERVEK CYMIX**	7
		Other monolithic refractories		**THERVEK PX**	7～8

Cement castables

THERVEK C (Casting / Trowelling)

Easy installation and excellent general-purpose characteristics

Refractory castables

- Powdered product consisting of carefully selected refractory aggregate and alumina cement.
- Can be prepared simply by adding an appropriate amount of water and mixing using a mixer, and applied easily by either casting or trowelling. When applying by casting, prepare suitable forms.
- The requisite degree of strength can be achieved through hydration bonding of the alumina cement by curing for 24 hours at normal temperature.

Characteristics

- Enables easy application of refractory lining walls with superior refractoriness.
- Has low thermal conductivity in comparison with shaped refractories, and can contribute to energy saving. Also offers greater resistance to thermal spalling than shaped refractories.
- Offers an extensive lineup of products with maximum service temperatures ranging between 1350℃ and 1800℃, and can be used for all manner of equipment.

Light weight insulating castables

- Powdered product consisting of carefully selected light weight aggregate and cement.
- Can be prepared simply by adding an appropriate amount of water and mixing using a mixer, and applied easily by either casting or trowelling. When applying by casting, prepare suitable forms.
- The requisite degree of strength can be achieved through hydration bonding of the cement by curing for between 24 and 48 hours at normal temperature.

Characteristics

- Enables easy application of refractory lining walls with superior thermal insulation.
- Offers an extensive lineup of products with thermal conductivity ranging between 0.1W/m·K and 1.2W/m·K, and can cater to all manner of energy-saving requirements.

Cement castables

THERVEK G (Dry gunning)

Superior gunning performance and excellent general-purpose characteristics

Gunning refractory materials

- Powdered product consisting of carefully selected refractory aggregate and alumina cement.
- Prepare a Need Gun or other gunning machine, supply the powdered product using compressed air, and apply to the refractory lining walls with the addition of water at the nozzle. Dry gunning does not require forms or mixing.
- The requisite degree of strength can be achieved through hydration bonding of the alumina cement by curing for 24 hours at normal temperature.

Characteristics

- Dry gunning castable refractory material with superior gunning performance (superior adhesion and low rebound loss).
- Significantly increases installation efficiency in comparison with casting, since no forms or mixing are required.
- Offers an extensive lineup of products with maximum service temperatures ranging between 1300℃ and 1800℃, and can be used for all manner of equipment.

Gunning light weight insulating materials

- Powdered product consisting of carefully selected light weight aggregate and cement.
- Prepare a Need Gun or other gunning machine, supply the powdered product compressed air, and apply to the refractory lining walls with the addition of water at the nozzle. Dry gunning does not require forms or mixing.
- The requisite degree of strength can be achieved through hydration bonding of the cement by curing for between 24 and 48 hours at normal temperature.

Characteristics

- Dry gunning insulating castable material with superior gunning performance (superior adhesion and low rebound loss).
- Significantly increases installation efficiency in comparison with casting, since no forms or mixing are required.
- Offers an extensive lineup of products with thermal conductivity ranging between 0.2W/m·K and 0.5W/m·K, and can cater to all manner of energy-saving requirements.

Low cement castables

THERVEK V (Vibration casting)

Low cement castable refractory with density that surpasses that of shaped refractories

- Powdered product consisting of carefully selected refractory aggregate, ultrafine powdered materials and a small amount of alumina cement.
- Can be prepared by adding an appropriate amount of water and mixing using a mixer, and applied by casting under suitable vibration. When applying by vibration casting, prepare suitable forms.
- The prescribed degree of strength can be achieved through coagulation bonding of the ultrafine powder within 24 hours at normal temperature.

Characteristics

- By using ultrafine powdered raw materials, low cement castable refractories succeed in dramatically reducing the amount of alumina cement and mixing water required, thereby achieving drastic improvements in corrosion resistance and heat resistance in comparison with cement castable refractories.
- By reducing the amount of mixing water, low cement castable refractories achieve greater density and drastic improvements in strength and abrasion resistance in comparison with cement castable refractories.
- Although conventionally the performance of monolithic refractories has been considered inferior to that of shaped refractories, the performance of low cement castable refractories is not inferior to that of shaped refractories.

Low cement castables

THERVEK F (Free-flow casting)

Low cement castable refractory that does not require the use of a vibrator

- Powdered product consisting of carefully selected refractory aggregate, ultrafine powdered materials and a small amount of alumina cement.
- Can be prepared by adding an appropriate amount of water and mixing using a mixer, and applied by casting without vibration. When applying by free-flow casting, prepare suitable forms.
- The prescribed degree of strength can be achieved through coagulation bonding of the ultrafine powder within 24 hours at normal temperature.

Characteristics

- By optimizing the combination of ultrafine powdered raw materials and dispersants, and offers improved the fluidity and free-flow casting.
- These refractories enable the application of refractory lining walls offering excellent corrosion resistance, heat resistance, strength, abrasion resistance and performance on par with shaped refractories without using a vibrator.These refractories display their effectiveness in narrow spaces and places where the use of a vibrator is not possible.

Low cement castables

THERVEK PTG (Wet gunning)

Low cement castable refractory that increases efficiency of installation using wet gunning

- Powdered product consisting of carefully selected refractory aggregate, ultrafine powdered materials and a small amount of alumina cement.
- The development of low cement castable refractories (free-flow casting) has enabled pumping of low cement castable refractories. Wet gunning is a method of application in which mixed castable refractories are delivered under pressure via a pump system, injected into the gun nozzle together with compressed air and setting agent.
- The prescribed degree of strength can be achieved through coagulation bonding of the ultrafine powder within 24 hours at normal temperature.

Characteristics

- The enabling of wet gunning has eliminated the need to set forms, and offers improved installation efficiency in comparison with vibration casting.These refractories enable the application of refractory lining walls offering performance on par with shaped refractories using the gunning application method.

Low cement castables

THERVEK AD (Dry gunning)

Low cement castable refractory that further increases efficiency of installation using dry gunning

- Powdered product consisting of carefully selected refractory aggregate, ultrafine powdered materials and a small amount of alumina cement.
- With wet gunning method of low cement castable refractories, the task of mixing the product in a mixer was a limiting factor for application efficiency. With its development of a specialized gun nozzle, AGC Plibrico has achieved the same mixing performance as a mixer with in-nozzle mixing, and perfected wet gunning method for low cement castable refractories. Prepare a PLIMATE-Ⅱ and Need Gun, supply the powdered product using compressed air, and apply to the refractory lining walls with the addition of water at the nozzle. The PLIMATE-Ⅱ is equipped with a built-in setting agent mixing quantitative supply system.
- The prescribed degree of strength can be achieved through coagulation bonding of the ultrafine powder within 24 hours at normal temperature.

Characteristics

- Dry gunning of low cement castable refractories does not require forms or mixing, and greatly improves application efficiency in comparison with vibration casting. These refractories enable the application of refractory lining walls offering performance on par with shaped refractories easily and conveniently using the dry gunning method.

Plastic refractories

THERVEK RM (Ramming)

Clay bonded ramming refractory with superior resistance to thermal spalling

- Plastic ramming refractory consisting of carefully selected refractory aggregate and highly-pliable clay, adjusted into a workable form with the addition of moisture. The product is supplied in 50mm-thick slices.
- Place slices of the product in the form, and apply to the refractory lining walls by ramming them firmly into place with a pneumatic rammer. Prepare forms for ramming application.
- Clay bonded plastic refractories maintain their shape after ramming due to the adhesive power of the clay. After firing, gives the refractories their strength (i.e. heat setting).

Characteristics

- Plastic refractories do not require mixing, and can be rammed as they are.
- Clay bonded plastic refractories offer superior resistance to thermal spalling.

Plastic refractories

THERVEK HR (Plastic gunning)

Clay bonded plastic gunning refractory with superior resistance to thermal spalling

- Plastic gunning refractory consisting of carefully selected refractory aggregate and highly-pliable clay, adjusted into a workable form with the addition of moisture. The product is supplied in granular clay-like form.
- Using AGC Plibrico's independently developed specialized gunning machine (HyRATE unit), it is now possible to apply plastic refractories by gunning (HyRATE method), achieving a drastic improvement in installation efficiency in comparison with ramming.
- Clay bonded plastic refractories maintain their shape after ramming due to the adhesive power of the clay. After firing, gives the refractories their strength (i.e. heat setting).

Characteristics

- Gunning significantly increases application efficiency in comparison with ramming.
- Clay bonded plastic refractories offer superior resistance to thermal spalling.

Plastic refractories

THERVEK PAT (Patching)

Patching repair material with superior adhesive properties

- Plastic refractory for patching use, consisting of a combination of carefully selected refractory aggregate and phosphate binder, adjusted into a workable form.
- Patching refractories are adjusted to a softer consistency than ramming plastic refractories, and used for repairing small-scale damaged sections of refractory lining walls by patching (i.e. manual filling).
- After application, patching refractories are fixed in place by the strong adhesive power of phosphate. When these refractories are heated to temperatures in excess of 350℃, a phosphate condensation reaction occurs, significantly improving the strength of the refractory (i.e. heat setting).

Characteristics

- These refractories are affixed firmly to the repair area by the strong adhesive power of phosphate.
- After heating, patching refractories display extremely strong adhesive strength in their adhesion to the base material.
- Patching in this way enables you to prolong the service life of your refractories by performing easy repairs.

Acid resistant castables

THERVEK AR Series

AGC Plibrico's acid resistant castable refractory series: AR Series

- AR Series are powdered products consisting of carefully selected refractory aggregate and binders, combined according to the application of use.
- These refractories can be applied by casting, trowelling or dry gunning.
- The prescribed degree of strength can be achieved within 48 hours at normal temperature.

Characteristics

- Alumina cement (which is typically used as the binder for monolithic refractories) exhibits poor resistance to acids, and cannot be used in applications where refractories will be exposed to strong acids.
- AR900 is a chemically (water glass) bonded castable refractory with superior acid resistant characteristics.
- AR800 utilizes a special alumina cement as its binder, enabling it to display superior performance in terms of resistance to both acids and alkalis.
- AR500 utilizes a special cement as its binder, offering superior resistance to acids.

Abrasion resistant castables

THERVEK ABR

AGC Plibrico's abrasion resistant castable refractory, for parts of FCC reactors subjected to abrasive wear by catalysts

- Powdered product consisting of carefully selected refractory aggregate, light weight aggregate, and a special binder.
- This series offers a lineup of products that can be applied by vibration casting, free-flow casting or dry gunning.
- The prescribed degree of strength can be achieved within 24 hours at normal temperature.

Characteristics

- Refractories used in FCC reactors (fluid catalytic cracking reactors, a type of apparatus used at oil refineries) are subjected to intense abrasive wear caused by the circulation of the catalyst inside the reactor. While this requires them to be resistant to abrasion, they must also have insulating properties in order to protect the reactor shell. The ABR of abrasion resistant castable refractories achieves the conflicting properties of both abrasion resistance and insulating performance.

Abrasion resistant plastic refractories

THERVEK CYMIX

AGC Plibrico's abrasion resistant plastic refractory, for parts of FCC reactors subjected to abrasive wear by catalysts

- Powdered product consisting of carefully selected refractory aggregate and a special phosphate binder.
- The refractory is prepared by adding an appropriate amount of water and mixing in a mixer, and applied by ramming using a pneumatic rammer. If the amount of mixing water is increased, CYMIX can also be applied by hand packing.
- The prescribed degree of strength can be achieved within 24 hours at normal temperature. On additional heating, a phosphate condensation reaction occurs, producing an extremely strong refractory installation.

Characteristics

- Refractories used in the cyclone sections of FCC reactors (fluid catalytic cracking reactors, a type of apparatus used at oil refineries) are subjected to particularly intense abrasive wear by the catalyst. This requires them to be highly resistant to abrasion. CYMIX is an abrasion resistant plastic refractory that is ideal for use in such locations.

Other monolithic refractories

THERVEK PX-BD

High-strength joint packing and bond

- PX-BD is a paste-type product consisting of refractory aggregate and water glass binder. It can be delivered in plastic tube, caulking tube or pail can form.
- PX-BD is a high-strength joint packing and bond.
  - PX-BD can be used to fill joints by inserting a tube into the open space between brick joints and filling them directly with the product.
  - When performing patching repairs, a thin underlay coating of PX-BD can be applied to the surface of the base material using a trowel or similar tool. Doing so increases the adhesive strength of the bond between the base material and the patching material, increasing the effectiveness of the repair.
- When PX-BD is heated to temperatures in excess of 500℃, chemical bonding occurs, increasing the strength of the refractory (i.e. heat setting).

Other monolithic refractories

THERVEK PX-CO

AGC Plibrico's coating refractory

- PX-CO is a powdered product consisting of refractory aggregate and a special binder.
- The refractory is prepared by adding an appropriate amount of water (or other dedicated fluid) and mixing in a mixer. A coating is then applied to the surface of refractory lining walls or metal surfaces using a trowel or pasting brush.

Characteristics

- PX-CO1700 (2P) is a highly corrosion resistant, high-strength coating material that can extend the service life of incinerators when used as a coating for incinerator walls.
- PX-CO1100 is an elastic, impact-resistant and abrasion resistant coating material, which improves abrasion resistant characteristics when applied to parts of FCC reactors that are subjected to abrasive wear by catalysts.
- PX-CO900 is an acid resistant coating material for application to metal surfaces.

Other monolithic refractories

THERVEK PX-IJ

AGC Plibrico's injection refractory

- PX-IJ is a powdered product consisting of carefully selected refractory aggregate and water glass.
- The refractory is prepared by adding an appropriate amount of water and applied by injection. It can also be applied by hot injection.
- When PX-IJ is heated at working temperature, chemical bonding occurs, resulting in hardening (i.e. heat setting).

Characteristics

- PX-IJ can be used to repair localized hot spots of equipment by injection.
- PX-IJ1600 is an injection repair refractory for blast furnaces.

Other monolithic refractories

THERVEK PX-DM

AGC Plibrico's heat setting mortar

- PX-DM is a joint mortar for alumina and alumina-silica bonding bricks. It is a powdered product consisting of carefully selected refractory aggregate and water glass.
- The refractory is prepared by adding an appropriate amount of water and applied by trowelling.
- When PX-DM is heated, chemical bonding occurs, resulting in hardening (i.e. heat setting).

Characteristics

- PX-DM offers a lineup with refractoriness ranging from 30 to 40, and is used according to the quality of refractory bricks.

Product Codes

[P] indicates that the product can be pumped under pressure.	**THERVEK C-27S-P**
[T] indicates that the product is designed for application by trowelling.	**THERVEK C-27T**
[K] indicates that an anti-explosive additive has been added to the product.	**THERVEK V-SHM1800K**
[S] indicates that the product is a high strength.	**THERVEK C-27S**
[A] indicates that the product contains low levels of iron.	**THERVEK C-LC24A**
[H] indicates that the product is a high heat resistance.	**THERVEK C-VRL-H**
[L] indicates that the product is a light weight refractory.	**THERVEK G-AR500L**
[W] indicates that the product has wire added to it (the number indicated the percentage amount added).	**THERVEK V-SHM1800K-W2**

Points for Attention in Applying Castable Refractories

1. Storage of castable refractories

■ Please pay attention to the following points when storing castable refractory products.

- Store castable refractories in a dry location. Pay particular care to rain and moisture from the ground.
- In summer, avoid direct sunlight, high temperatures and high humidity. Store castable refractories in a cool indoor location and avoid temperature changes wherever possible.
- In winter, store castable refractories in a warm indoor location wherever possible.
- In some cases, where products have expired their storage life, it may not be possible to achieve the prescribed fluidity and/or hardness characteristics. Please use castable refractories as soon as possible.

2. Casting of cement castable refractories

(1) Forms

- Use strong frame boards for forms to prevent loosing or deformation due to side pressure when from poured castable refractories, and use reinforcing materials as needed.
- Apply oil or other suitable coatings to the surface of the forms that are in direct contact with the castable refractory to ensure smooth removal of the forms after hardening.

(3) Adjustment of working time and setting time

- Working time of castable refractories (i.e. the amount of time for which the mixed product retains enough fluidity to be useable before setting) are designed to be around 60 minutes at an outside temperature of 20℃.
- Setting times for castable refractories are designed to be within 24 hours (or 48 hours for some products) at an outside temperature of 20℃. (Please check the “Standard setting times” column of the product information.)
- The working time of cement castable refractories decreases with increasing temperature. On the other hand, setting time tends to be longer at less than 10℃ and around 30℃.

- To ensure working time for ambient temperatures in excess of 30℃, lower the temperature of the materials, or use ice to cool the mixing water.
- To adjust setting time for ambient temperatures below 10℃, raise the temperature of the materials or the mixing water.

(2) Mixing

- Prepare a mixer (the standard equipment is a mortar mixer).
- Feed the entire contents of the paper bag or container bag into the mixer. Do not divide the contents of such bags into smaller portions.
- First, mix the product as it is for around 1 minute before adding water.
- Next, mix the product while adding around 1/2 of the standard amount of mixing water. Add the remaining amount of water a little at a time while checking the state of the mixture, until you obtain the desired level of fluidity.

- Use pure water for mixing (ideally, use drinkable water wherever possible).
- Use an amount of mixing water that is within the standard amount of mixing water, and the smallest possible amount with which application is possible.
- The standard mixing time is 3 minutes.
- Ensure that the mixer, scoops, trays, buckets and any other tools that you use are clean before mixing.
- After mixing is completed, clean the mixer and other tools thoroughly before placing other materials in the mixer, to ensure that none of the previously mixed castable refractories remain.

(4) Casting

- Mixed castable refractories lose their fluidity as time passes. Please complete casting work as soon as possible.
- When carrying out casting work, use a rod or other tool when filling the form to prevent the formation of surface voids in the casting. Where the product has been mixed with a small amount of water, a vibrator may be used.

(5) Curing and removal of forms

- After application, it is necessary to leave castable refractories without the application of external forces, until they have hardened and set. Only remove forms once the standard setting time has elapsed.
- Where the forms must be removed after a shorter period of time than the standard setting time for some unavoidable reason, check carefully to ensure that the refractory has hardened and set properly.
- Even in cases where the forms have been removed after a shorter period of time, leave the refractory in an untouched state for the remainder of the standard setting time.
- At temperatures of 5℃ and below, the hardening process for castable refractories slows to almost a complete stop. When applying castable refractories in winter, even where the mixing water has been warmed, there are cases in which temperatures fall rapidly overnight and forms cannot be removed in 24 hours. In such cases, warm the surrounding area using a heater, or use other heated curing measures.
- If castable refractories freeze during the curing process, they may not harden and set, or they may set but with an extremely degraded level of strength. When casting refractories during winter, take care to ensure that they do not freeze.
- Because the hardening of the cement used in cement castable refractories is an exothermic (i.e. heat-producing) reaction, the temperature of castings increases during the curing process. During summer, it is possible that moisture may evaporate along with the increase in temperature, leaving a shortage of the moisture required for the cement hydration reaction and leading to insufficient level of strength in the finished casting. In such cases, sprinkle water on the work surface, or cover the work surface with wet cloth or paper (water curing).
- In their undried state, castable refractories undergo a carbonation reaction (efflorescence) when they are in contact with air. This phenomenon is particularly likely to occur with insulating castable refractories. When applying an insulating castable refractoires layer on the operating side, drying as quickly as possible after it has been applied.

3. Application of cement castable refractories by trowelling

■ The procedure for application of cement castable refractories by trowelling is essentially the same as for casting. However, please pay attention to the following additional points that are specific to application of cement castable refractories by trowelling.

(1) Forms

• Forms are not required for the application of cement castable refractories by trowelling.

(2) Mixing

• In order to produce a good consistency for application of cement castable refractories by trowelling, it is necessary to mix the product sufficiently. Please mix for around 5 minutes.

(3) Trowelling

• Install a lath (wire mesh, etc.) or other supporting material on the refractory lining walls. Push the castable refractories in using a trowel (or by hand) to ensure that it fills the back part of the supporting material, and finish the surface using a trowel.
• The standard thickness for application of cement castable refractories by trowelling is 50mm.

4. Vibration casting of low cement castable refractories

■ The procedure for application of low cement castable refractories by vibration casting is essentially the same as for casting. However, please pay attention to the following additional points that are specific to application of low cement castables by vibration casting.

(1) Forms

• Vibration casting requires the use of more robust forms than for standard casting.

(2) Mixing

• Mixing times for low cement castable refractories tend to be longer than for standard cement castable refractories. Please mix for around 5 minutes.
• Adding excessive amounts of mixing water to low cement castable refractories causes significant degradations in their physical properties. Please observe the standard amount of mixing water to be added. In particular, low cement castable refractories for vibration casting are designed to only exhibit fluidity when vibration is applied to them. Please take care to avoid adding excessive amounts of mixing water, since these castable refractories appear to have no fluidity during mixing.

(3) Adjustment of working time and setting time

• Working time and setting time of low cement castable refractories become shorter as temperature rises. Especially in summer, working time may become shorter, presenting an obstacle to work. Therefore, add a setting retarding additive during mixing. Please check the product information for the particular product that you are using with regard to the amount of setting retarding additive to be added.

(4) Casting

• When applying low cement castable refractories by vibration casting, vibrate the castable refractories directly using a pole-shaped vibrator or similar tool, or attach a vibrator to the form and vibrate the form as it is being filled.

5. Free-flow casting of low cement castable refractories

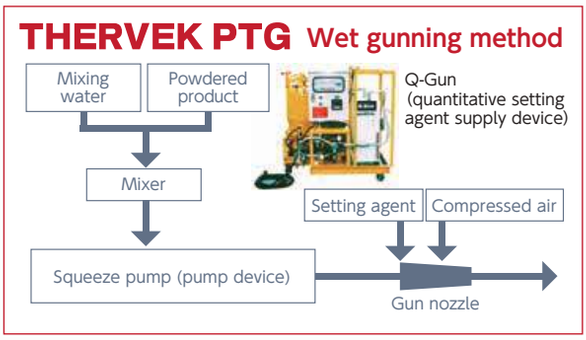
■ The procedure for application of low cement castable refractories by free-flow casting is essentially the same as for vibration casting, although neither a rod nor vibrator are required. Vibration the mixture may cause the castable refractories to separate.

6. Dry gunning of cement castable refractories

■ Dry gunning of cement castable refractories is a method of application in which the powdered product is supplied to a Need Gun or other gunning machine using compressed air, and applied by gunning, with the addition of water at the nozzle.
■ The PLIMATE system improves the quality of the gunning application and suppresses dust during gunning by adding a certain percentage of water to the powdered product in advance.
■ When gunning, hold the gun nozzle perpendicular to the work surface, and at a distance of between 0.5m and 1.0m from the surface generally.
■ Request for application of cement castable refractories by dry gunning to be carried out by AGC Plibrico or another specialist service provider.

7. Wet gunning of low cement castable refractories

- Wet gunning of low cement castable refractories is a method of application in which mixed castable refractories are delivered under pressure via a squeeze pump or other pump system, injected into the gun nozzle together with compressed air and setting agent, and applied to the refractory lining walls.
- In wet gunning of low cement castable refractories, a setting agent is added in the nozzle. The Q-Gun system supplies a measured quantity of powdered setting agent.
- When gunning, hold the gun nozzle perpendicular to the work surface, and at a distance of between 0.5m and 1.0m from the surface generally.
- Request for application of low cement castable refractories by wet gunning to be carried out by AGC Plibrico or another specialist service provider.



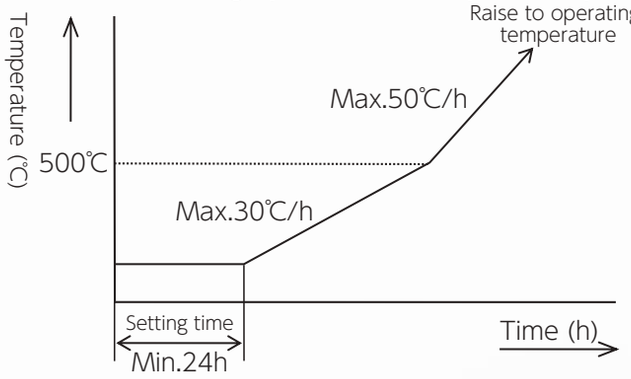
8. Dry gunning of low cement castable refractories

- Dry gunning of low cement castable refractories is a method of application in which the powdered product is supplied to a Need Gun or other gunning machine using compressed air, and applied to the refractory lining walls with the addition of water at the nozzle.
- The adoption of a specialized gun nozzle has enabled in-nozzle mixing of low cement castable refractories.
- The PLIMATE system improves the quality of the gunning construction and suppresses dust during gunning by adding a certain percentage of water to the powdered product in advance. It is also equipped with a system for supplying a fixed quantity of setting agent.
- When gunning, hold the gun nozzle perpendicular to the work surface, and at a distance of between 0.5m and 1.0m from the surface generally.
- Request for application of low cement castable refractories by dry gunning to be carried out by AGC Plibrico or another specialist service provider.

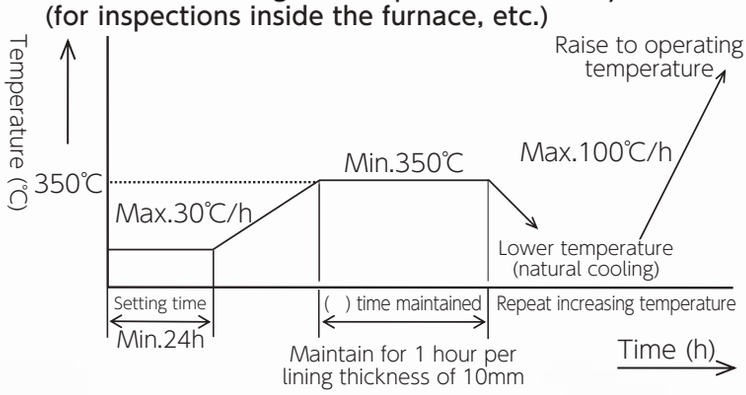
9. Drying of castable refractories

- Refractory lining walls constructed using castable refractories are dried, through a process called dryout, in order to gradually remove internal moisture. When doing so, if the temperature is raised too rapidly, there is a risk of causing explosive spalling as a result of massive steam pressure arising inside the refractory lining walls, which could damage the refractory lining walls themselves. Please carry out dryouts according to the prescribed speed of temperature increase. In addition, please raise the temperature carefully in the following cases.
  - When castable refractories (especially low cement castable refractories) are applied with an amount of low water, maintain a retention time of 350℃ because of the refractory lining wall with density at the curing temperature is lower 10℃.
  - The temperature of chemically bonded (water glass) castable refractories is increased at a moderate speed because dehydration is difficult to proceed.

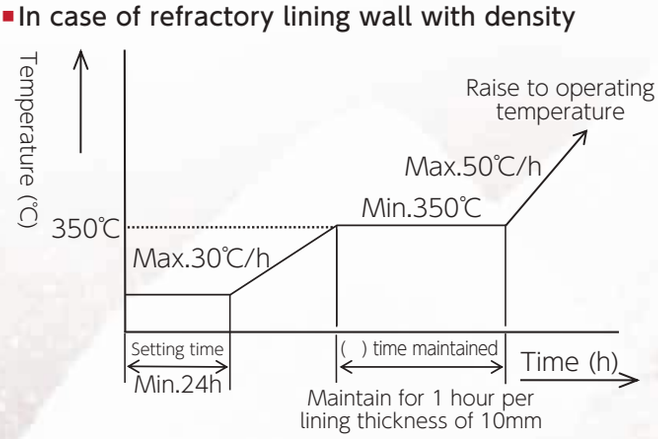
In case of entering operation directly from dryout



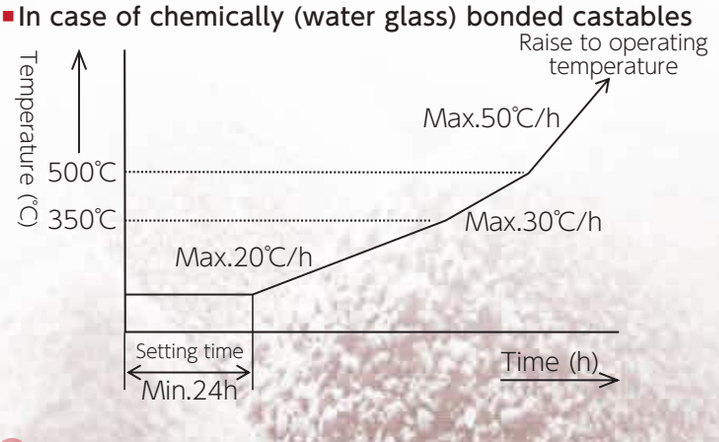
In case of lowering the temperature after dryout (for inspections inside the furnace, etc.)



In case of refractory lining wall with density



In case of chemically (water glass) bonded castables



Points for Attention in Applying Plastic Refractories

1. Storage of plastic refractories

- Please pay attention to the following points when storing plastic refractory products.
  - Store plastic refractories in a dry location. Pay particular care to rain and moisture from the ground.
  - In summer, avoid direct sunlight, high temperatures and high humidity. Store plastic refractories in a cool indoor location and avoid temperature changes wherever possible.
  - In winter, store plastic refractories in a warm indoor location wherever possible to prevent them from freezing.
  - If plastic refractories are removed from their packaging and left out they will harden and lose the suitable viscosity required for application. Do not remove plastic refractories from their packaging until immediately before application.
  - Always use new materials. Do not use plastic refractories that have expired their storage life, or have dried out.

2. Ramming of plastic refractories

(1) Forms

- Use forms that are strong enough to sufficiently withstand the force of ramming.
- Take care to use sufficient reinforcement to prevent deformation of forms when building the framework, and ensure that the shape and dimensions of forms do not change during the ramming process.

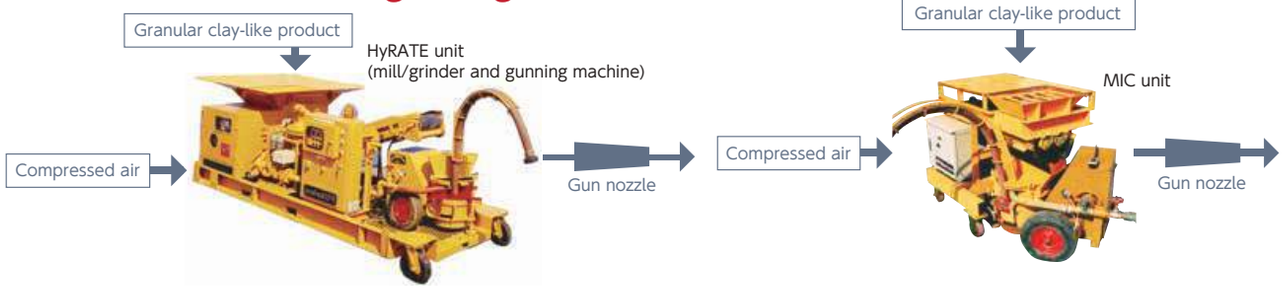
(2) Ramming

- Since the product is in clay-like form, mixing is not required. The product can be rammed immediately after opening.
  - Please prepare and use a pneumatic rammer.
- Lay out slices of plastic refractory to the full thickness of the refractory lining wall, and ram them into place evenly with the pneumatic rammer.
- When ramming, hold the pneumatic rammer as perpendicular to the ramming surface as possible. Move the pneumatic rammer backwards and forwards in the direction of the wall thickness, and shift it sideways as you proceed with ramming.
- When a single ramming thickness is greater than 50mm, the force of impact from the pneumatic rammer is not transmitted all the way to the bottom, and each slice layer will not be in sufficiently close contact with the others. Be sure to carefully ram each slice thickness thoroughly into place. As a guide, sufficiently ram each slice such that a slice with thickness of around 50mm is compressed to a thickness of around 25mm.
- After ramming, the rammed surface will be smooth and flat. Use a scraper or other tool to scrape the surface into a rougher texture before laying the next piece of material on top of it.

3. Gunning of plastic refractories (HyRATE method)

- For gunning of plastic refractories, a dedicated gunning machine (HyRATE unit) is used.
- Since the product is granular clay-like product, mixing is not required. The product can be fed directly into the HyRATE unit.
  - With gunning plastic refractories there is no worry of explosive spalling. Drying is also completed in a shorter period of time than in comparison with castable refractories.
  - The compact, miniature-sized MIC unit is convenient for small-volume gunning.
- When gunning, hold the gun nozzle perpendicular to the work surface, and at a distance of between 0.5m and 1.0m from the surface generally.
- To ensure that layers are not formed in the refractory lining walls in the direction of the thickness, perform the entire gunning process for the prescribed thickness of refractory material in one go, without leaving any time in between.
- Clean as you work to ensure that rebound losses do not build up inside the refractory lining walls as they are constructed.
- It is necessary to pay continuous attention to the direction of the nozzle to ensure that voids are not formed in the shaded parts around the tile anchors.

THERVEK HR Plastic gunning method



Points for Attention in Applying Plastic Refractories

4. Finishing

(1) Trimming

- After applying plastic refractories, perform trimming (i.e. finishing to roughen the surface) to make it easier for moisture from inside the refractory to escape.
- Remove the forms before the refractory lining walls harden and trim them using a scraper or other such tool.
- The purpose of trimming is not to form the shape of the refractory lining walls themselves. Assemble ramming forms as precisely as possible to minimize the amount of excess trimming required by as much as possible.

(2) Score lines

- After trimming the surfaces of the refractory lining walls, make score lines into them before they harden. The purpose of this is to concentrate contraction of the refractory lining walls due to drying and minimize the occurrence of irregular cracks.
- Before making score lines, be sure to draw gridlines with chalk or some other writing implement, and make score lines along those gridlines.
- Position make score lines between anchors, and make shallow score lines using a hard bladed tool. As a guide, make score lines around 3 to 4 lines per tile anchor interval.
- The depth of score lines should be around 1/3 the thickness of the wall itself. Take care to score lines at the same depth, and perpendicular to the wall surface.

(3) Venting holes

- After making score lines in the wall surfaces, make venting holes across the whole surface of the plastic refractory walls. This is effective in allowing moisture inside the lining walls to which the plastic refractories have been applied to escape when the temperature of the furnace rises.
- Make venting holes by poking a wire (of diameter ϕ3-4mm) perpendicular to the refractory lining walls, and opening holes randomly at intervals of around 100-150mm. As a guide, open holes to a depth of around 2/3 the thickness of the plastic refractory layer that you have applied.

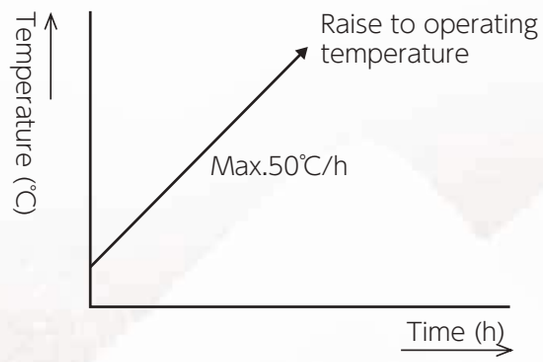
5. General points for attention after installation of plastic refractories

- During and after the installation of plastic refractories, take sufficient care to ensure that the refractory lining walls do not become wet with rainwater or other water.
- After the installation of plastic refractories, leave them without the application of external forces until initial firing, in order to promote the natural drying process.
- If plastic refractories freeze after installation, there is a possibility of falloff and other issues during initial firing. For installations during winter, take sufficient measures to prevent freezing.

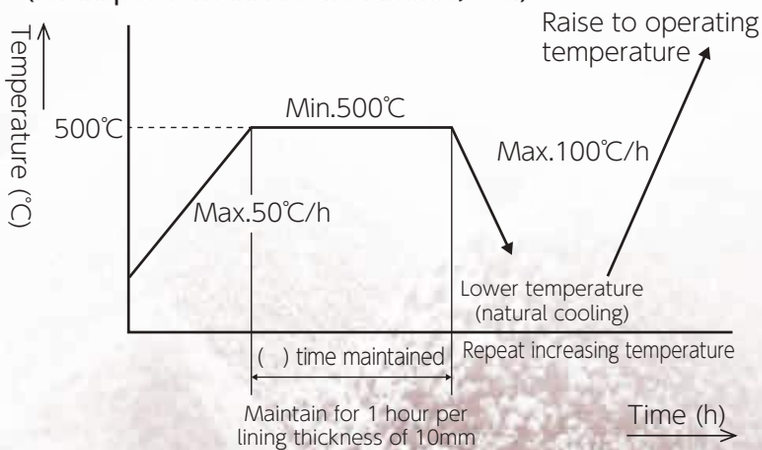
6. Drying of plastic refractories

- If a rapid increase in temperature takes place during initial firing, refractory lining walls constructed using plastic refractories can be weakened as a result of the collection of steam formed from moisture inside the walls collecting at the work surface, resulting in material falloff. Therefore, carry out the initial increasing temperature at the prescribed speed. Be sure to check the minimum initial firing time for each particular material.

■ In case of entering operation immediately after initial firing temperature increase



■ In case of lowering the temperature after dryout (for inspections inside the furnace, etc.)



AGC Plibrico Co., Ltd.

Head Office・East Japan Branch

6F Mita-NN Bldg., 1-23, Shiba 4-chome, Minato-ku, Tokyo
108-0014 JAPAN
TEL +81-3-3455-1359 (Overseas Sales)　FAX +81-3-3455-1362

https://www.plibrico.co.jp

Form No. (1000) 07.2019