

Installation methods for monolithic refractories

Casting / Vibration casting

Castable refractories are generally supplied in moisture-proof bags and they are mixed with water on site and poured into forms in a similar manner to Portland cement concrete construction. It is very important to follow the proper installation methods in order to acquire the desired physical properties of the refractory lining structure.

Vibration casting is essential especially for the installation of low cement castables to obtain smoothness and enough fluidity of the casted materials at the time of pouring into the form.

● Preparation for Installation Work

- Mixer:** Arrange for a mortar mixer (a pan mixer).
- Vibrator:** Arrange for hand-held internal vibrators or external vibrators attached to the form as required.
* In case that low cement castables are used, or in case that fluidity of conventional castables requires improvement when mixing, water is minimized within allowable range so that a high-strength refractory lining can be constructed.
- Mixing water:** Arrange for clean and drinkable water. Seawater, water contaminated with over 1,000 ppm of total impurities, such as sulfates, magnesium chloride, ammonia, etc., or water having an acidity of pH5 or less shall not be used. When the quality of the water is uncertain, analysis test is necessary to determine whether it is usable or not.
- Mixing water measuring bucket:** Arrange for a bucket with scale marks in order to measure the quantity of mixing water precisely.
- Other tools and apparatus:** Arrange for a clean mortar box, a scoop, a gutter or other tools as required.
- Lining-support fittings:** Install lining-support fittings to the shell, such as metal anchors (L-anchors, V-anchors, Y-anchors) or ceramics tile anchors.
- Formwork:** For installation of castable refractories, pouring forms are necessary. Wooden or metal form is commonly used according to the condition of the lining structure. Clean the surface of the form before use. To facilitate removing the form from the refractory lining, apply oil, grease, lubricant or wax, etc., beforehand. Make sure the amount is moderate.

● Mixing Work

- Clean the mixer thoroughly.
- Put the castable into the mixer and at first mix it without mixing water for one or two minutes.
- Then add about two-thirds of the required amount of mixing water and mix.
- Pour the rest of mixing water gradually and mix till the desired consistency is achieved.
- Mixing time varies according to the material used, but is normally three to four minutes after adding the mixing water.
- The suitable consistency of the mixed conventional castable for the casting work is "JIS standard consistency" which is easily recognized by the following practices.
 - Pick up the mixed castable by hand and make a ball on the palm.
 - Throw into the air up to 30 cm high and catch again with the palm.
 - If the mixed castable becomes slightly flat and extrudes up to the same thickness of the finger through the gaps between the fingers, it can be judged that the mixed castable has the proper consistency for achieving good workability.
- The amount of mixing water shall be precisely measured and added in accordance with the figures showed in the quality table below. Adding excess water results in the decline of the physical properties of the refractory lining structure.

Self-flow casting

Asahi self-flow castables have been developed through our long-term consistent research on fluidity of castable refractories. Thanks to this effort, our self-flow castables have sufficient fluidity without vibration.

Installation method is the same as the ordinary casting method as mentioned above but the vibrator is unnecessary.

● Casting/Vibration Casting

- The conventional castable after mixing with JIS standard consistency can be usually poured into the form without vibration. Low cement castables, however, shall be installed with vibrator and sometimes even the conventional castable is installed with less quantity of water than that in the catalog in order to make a stronger refractory lining. In this case, because of the low consistency of the castable, vibration casting is essential.
- In case of vibration casting, forms shall be stronger in structure than for casting installation because of high lateral pressure. For this reason, metal forms are normally used in case of vibration casting.
- Complete the casting work within 30 minutes after mixing.
- Waterproof the back lining**
Most of monolithic refractory structures consist of multi-layered linings. The back lining is normally the insulation castable, the insulation board or the insulation brick. This back lining is installed at first and then the front lining is installed. Before the castable for the front lining is installed, the waterproof treatment is necessary on the surface of the back lining.
- Arrange expansion joints, separation joints, separation cuts (score line) in castable lining to minimize the occurrence of cracking at the time of heating-up.
- Castable refractories are designed to exhibit stable workability and the appropriate hardening time at 20°C. The workable time and hardening time of castables depend on the temperature. Therefore in accordance with the condition of the temperature on site, adjustment to the workable time and hardening time is necessary. Refer to "Adjustment to the workable time and hardening time for castable refractories" on P25 and P26 for details.

● Curing

- Cure for at least 24 hours after completion of the installation work as a general rule.
- Sprinkle the installed refractory lining of the conventional castables, because the conventional castables continue to generate heat, for three to four hours following the completion of installation work.
- Hardening time of the castables depends on temperature. Refer to "Adjustment to the workable time and hardening time for castable refractories" on P25 and P26 for details.
- Heat the installed refractory lining with a heater or a floodlight when the air temperature falls below 0°C during curing in the winter season or in cold latitudes since freezing in the castables deteriorates the strength of the refractory lining structure.
- In case that the surface of a light-weight castable is exposed directly to atmosphere, be careful of carbonation which results in powdering or peeling of the refractory lining. To lessen carbonation, once the installed lining has been hardened, heat and dry the refractory lining immediately, or cure it by applying the anti-carbonation paint on the surface of the lining with sufficient aeration and ventilation. (Please contact us for details on anti-carbonation paint.)

● Removal of the Formwork

Remove the formwork after checking that the installed refractory lining structure has hardened enough.

Trowelling

Purpose-built castables for trowelling are available and they are recognizable by the mark "T" at the end of the product name, such as "CA-13T" or "LC-12T". Normally, trowelling castables are treated in the same way as casting castables.

However, casting castables usually cannot be trowelled.

- Set the lining-support fitting on the shell, which is normally a welded wire mesh (ø3.2 mm x 100 mm square netting) or a chain link wire netting.
- Push and fill the mixed castable with water into the wire mesh/netting and cover the wire mesh/netting up to the lining thickness, and give a proper finish to the surface with a trowel.
- The lining thickness for trowelling is generally 20 to 40 mm.

Pumping

Normally, pumping castables are treated in the same way as casting castables. The mixed castable with water is delivered by means of a squeeze pump and poured into the form.

- Arrange for a squeeze pump and a mixer.
- Lay the delivery pipes carefully to prevent clogging inside the pipes. Use 2" steel pipes for a squeeze pump with a rubber hose at the tip. Reduce the number of bends to as few as possible and avoid sharp bends for smooth delivery.
- Ensure that the forms and tie bolts are strong enough for pumping installation. The pumping installation method speeds up pouring and increases lateral pressure to the form.
- At first, run the mortar milk (a castable slurry without coarse aggregates) through the pump and pipes to lubricate them. The mortar milk shall be of the same type as the pumping castable.
- Feed the mixed castable with suitable consistency to the pump as quickly as possible after mixing. Do not use again mixed castable that lost its suitable consistency, and discard it.
- Clean the pump and pipes thoroughly immediately after completion of pumping.

Gunning (dry type)

In dry gunning, castables are slightly premoisted and delivered pneumatically through the rubber hose. Mixing water is added at the nozzle.

The "Asahi Caster for Gunning" and "Asahi Light Caster for Gunning" are dry type gunning castables.

- Use dry type gunning machines such as a Need Gun.
- To avoid laminations of the refractory lining, gun the castable up to the full, final thickness all at once.
- Hold a gunning nozzle at right angle to the surface of the shell being gunned, and maintain a distance from 0.8 to 1.0 m between the nozzle and the surface of the shell being gunned.
- Proceed with gunning from the bottom to the top when the surface being gunned is vertical.

Gunning (Pneumatic Rheo-flow)

Pneumatic Rheo-flow (NRF) castables are gunned with special gunning equipment.

Both water and a quick hardening agent are mixed at the nozzle.

For details, please consult us if you want to use Pneumatic Rheo-flow (NRF) castables.

Ramming

An air rammer normally is used to ram plastic or ramming refractories, but if the quantity of refractory is small, a masonry hammer can be used.

● Preparations for Installation Work

- Arrange for an air rammer and other tools such as a scraper for trimming, a fine-edged trowel or electric cutter for cutting score lines, a metal rod for venting holes.
- Install the lining-support fittings to the shell such as metal anchors (L-anchors, V-anchors, Y-anchors) or ceramics tile anchors for the wall and ceiling installation work.
- Arrange for a formwork as needed. To use a formwork prevents loss of compacting force of ramming, assures firmness, and minimizes cracking. To use a formwork also helps maintain accurately the specified lining thickness.

● Ramming

- Fill plastic refractory or ramming material into the formwork to a thickness of 50 mm because the compacting effect of the rammer does not extend beyond a thickness of 50 mm.
- Execute uniform strokes of the air rammer on the upper surface of plastic refractory or ramming material and ram it twice over the whole surface.
- Shift the head of the rammer while allowing slight overlapping of the strokes. The first stroke of the rammer is the basic one and the second is the finishing one. Both strokes must be at the right angles to the surface.
- Roughen the surface of the rammed first layer with a scraper after being rammed. Then fill the material for the next layer and ram.
- Continue with this installation layer by layer so as to construct the whole lining structure uniformly.

● Trimming, Venting Holes and Score Lines

- Trim the surface of the lining with a scraper immediately after the formwork is removed. The purpose of the trimming is to give the surface a rough finish and allow excess water to escape.
- Once trimming has been completed, make venting holes from 4 to 6 mm in diameter by using a metal rod throughout the overall lining surface in intervals from 100 to 200 mm. Depth of the venting hole is about half of the lining thickness. Venting holes allow the water to drain from the inside of the installed lining as the temperature rises at the time of heating-up.
- Cut score lines with a sharp instrument like a hard, fine-edged trowel or electric cutter. A score line is normally around 3 to 5 mm in width, 50 mm in depth and 1,000 mm square. Score lines help lessen the occurrence of cracking at the time of heating-up.

Storage

- Castable refractories are generally supplied in moisture-proof bags, but use them as soon as possible since they are prone to be affected by moisture or humidity. Long-term storage might sometimes deteriorate their quality.
- Store castable refractories in a well-ventilated warehouse in dry condition, avoiding direct sunlight or high temperatures.
- To avoid moisture from the floor, put castable refractories on a pallet or the like for storage. Do not put them on the floor directly.