INSTALLATION OF REFRACTORY BRICKS IN ROTARY KILNS

“ESSENTIAL INSTRUCTIONS”

Date: 01/2020
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01.-PREPARATIONS BEFORE STARTING THE WORKS

- Before entering the kiln and starting any job, be sure that all the clinker/meal/coating deposits have been already removed.
- Ensure that a safety briefing has been given to all people involved in the kiln stop.
- Measure if the required conditions (oxygen percentage, enough ventilation and illumination) are fulfilled.
- Before starting the demolition, make sure to measure the remaining brick thickness either by drilling holes into the actual lining or using any other available method.
- Check the stock quantities of bricking material before starting the demolition, and be sure to install the correct material in the correct area.
- Cover the areas suitable to be stepped by machines (forklifts or similar) or in contact with metallic platforms with a soft material to avoid breaking the lining.
02. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Before starting the brickling works, be sure that all the bricklayer’s personal is equipped with the appropriate PPE:

Depending on the work actually carried out, some additional protective equipment may be compulsory.
03.- LINING TOOLS

- Masonry trowel
- Mortar Mixer
- Spirit Level
- Steel Hammer
- Rubber Mallet
- Shim Diver
- Brick Cutting Saw
- Strait Line Marker
- Planetary Concrete Mixer
04.- LINING METHODS

- Brick Rig Machine
- Pogo Sticks
- Screw Jacks
- Lining speed
BRICK RIG MACHINE

Is the safest lining method, and needs no turning of the kiln.

Each machine works for a certain range of diameters
Installation process:

Always work from outlet and inwards

Preparing the bed
Inserting the machine
Close the rings
POGO STICKS
Really cheap system to support the lining.
No air pressure or kiln turning needed.
Usefull on small diameters
SCREW JACKS

Quick set-up system
Low cost equipment
Low maintenance costs

An excess of strength may cause brick damages
05.- LINING SPEED

SAFETY → QUALITY → SPEED. IT’S IMPORTANT TO KNOW WHAT’S IMPORTANT

The often cited rule of thumb:

- Kilns with Ø4m → 5 meters per shift (10 meters/day)
- Kilns with Ø5m → 4 meters per shift (8 meters/day)

With accurate planning, sufficient number of skilled and qualified workers and the right working conditions, the meters that could be lined in a day could go up to 15m in short terms, even without incurring in quality issues, but that is an special situation that has to be considered only when there’s an unexpected situation
06.- LINING STARTS - REFERENCE LINES

Reference lines are strongly recommended to ensure a proper alignment

- For a correct alignment, an axially running welding seam can be used as a reference line. Else, they can be plotted as shown
- Perpendicular to axial lines, radial welding lines should be marked with a straight line marker. Recommended distance between two lines is between 1 and 2m
07. - LINING STARTS - OLD BRICK LINING SUPPORT

In order to avoid old lining movements due to vibrations, using steel supports to fix it is really important. From 6 to 8 supports are usually used, but depends on tightening.
08.- LINING STARTS - FIRST BRICK PLACEMENT

When starting a new lining against an old one, it is important to smooth as much as possible the contact surface, and to ensure that the lines are as parallel to the reference lines as possible.
09. - LINING ADVANCE - CORRECT MIXING RATIO

It’s very important to always keep the correct ratio for the lining.
Theoretical lining ratio will be given by the supplier, but deviations are expected.

- Always try to follow the lining ratio. If a deviation is found, follow the instructions of the next pages.
- Mortar is not expected to be used to correct a lining deviation. However, it could be used in exceptional situations and always when the deviation is no bigger than 2mm.
- Alumina bricks are expected to be ALWAYS installed with mortar. Clench installations are not recommended by KROSAKI.
- Deviations are expected to be documented and sent back to the supplier, in order to adjust quantities over next orders.
FALSE INSTALLATION: UNDERARCHING

When underarching happens, correctly by using more slow wedge bricks even if the ratio is affected.

Don’t forget to document the divergences.
FALSE INSTALLATION: OVERARCHING

When underarching happens, correctly by using more fast wedge bricks even if the ratio is affected.

Don’t forget to document the divergences.
10.- LINING EXAMPLES

STAGGERED LINING PATTERN:
Overlapping of adjoining bricks let individual rings move without edging. Most common system

CROSSLINING PATTERN:
Two interlocked rings of a total length of 500mm per ring. Distributes radial forces evenly
STRAIGHT LINING PATTERN:
Fastest and easiest system to install
Avoid installing key bricks in the same line
Only in specific situations

BONDED LINING PATTERN:
Interlocked rings to distribute forces
Don’t interlock more than 1.5m at a time
Only in specific situations
11.- TWO TAPER SYSTEM

For every kiln radius, is important to use the correct brick mixing ration and to follow the supplier’s recommendations. To adjust the correct diameter, is important to confront the theoretical ratio and the real mixing ratio, and to document it.
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Be careful with open joints. They will be always loose, even after shimming. Don’t forget to correct the ratio.
12.- LINING ADVANCE - CORRECTING DEFORMATIONS

Usually, shells are not as good as expected. After some time of use, some deviations or deformations may appear. Correcting the deformation in a useful manner is which transforms a normal lining into an exceptional one.

There are basically 2 kind of deformations, according to their impact:

- Deformations lower than 8mm in a brick length (198mm)
  * When a deformation is lower than 8mm height, it’s considered to be solvable by the liner without affecting the brick. The use of mortar to fill the gap is allowed, making always sure that at least a part of the brick is in contact with the shell

- Deformations bigger than 8mm in a brick length (198mm)
  * If the deformation goes over 8mm, the brick has to be affected. The gap left has to be filled with mortar, and as much of the brick surface as possible has to be in contact with the shell

It’s important to always attack the deformation in an optimal point, so when possible, the deformation should be placed in a position between 3-5 o’clock, or 7-9 o’clock. Never have key bricks inside a deformation.
Bricking over distortions below 8mm
Bricking over distortions over 8mm (cut on installation)
Distorted upper kiln shell, correction with mortar (radial view)
Punch distortion correction with mortar (axial view)

MAX 8mm
Distorted lower kiln shell, correction with mortar (radial view)

MAX 8mm
Punch distortion correction with mortar (axial view)

MAX 8mm
13.- ADJUSTING RINGS IN RADIAL DIRECTION

Do not use steel shims

It's recommended to use mortar to adjust

NEVER go over 2mm thickness in each piece

It's better to make 4 adjustments of 1mm than 1 of 4mm
14.- SPECIAL INSTALLATIONS

Installing bricks in a kiln is not only done in perfect tubular sections, we have some zones that have to be considered accordingly:

- Nosering sections
- Retaining rings
- Conical sections
- Patching

Always consider the installation drawings given by your supplier

The considerations shown are only given as an standard procedure
CONCRETE NOSERING SECTIONS

The most common way to install a nosering is with concrete on the outer section.

Use ceramic paper to isolate the sections and lower thrust.

Anchors will be defined by the supplier, but you can consider that a freedom degree should be left at all times.

If the retaining ring is inside the concrete, always cover it with paper.
RETAINING RING CONSIDERATIONS. CONCRETE OUTLETS

Retainer rings are designed to absorb kiln’s thrust. Always ensure a good contact.

To ensure a good contact have a paper joint between the bricks and the concrete.

Make a division in the concrete to cover the front piece and avoid cracks.
When installing a retainer ring in a bricked zone, it is important to ensure that the section in contact with the bricks upwards is smooth.

Cover the empty zone near the outlet with paper or castable.

A correct lining presents no step between the lining before and after the metallic ring.

Always follow your supplier design.

GAP POSITIONING IS REALLY IMPORTANT!
ACCEPTED DESIGN:

A step of around 50mm is acceptable at the retainer ring.
Double rings have to be filled with concrete

ACCEPTED DESIGN:

Cutting a brick to avoid the retainer is OK if the retainer is small enough.
Remember to dry-cut magnesia bricks
CONIC SECTION

RECOMMENDED DESIGN:
Double conicity bricks give the best performance with no deviation. Cut on both ends to best contact

ACCEPTED DESIGN:
Using normal ISO bricks is accepted if the step is not bigger than 50mm. Always look for a good stability
PATCHING: BEGINNING

Place the area to patch approx. 30° from the bottom of the kiln

Initial aspect of the patch
PATCHING

STEP 1
Start by inserting wedges in the bricks that are going to stay in order to avoid movements.

STEP 2
Open the rings in order. Never open more than 3 rings at once.

STEP 3
Start changing bricks to avoid having more than 3 rings open at a time.
**STEP 4**
Keep advancing the lining while opening the rings

**STEP 5**
Finish the patch by inserting all the new bricks. Have special care with last key brick

**STEP 6**
Remove all the wedges before operation. Patching finished

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15.- IMPORTANT CONSIDERATIONS

EXPANSION CARDBOARDS:

Do not remove cardboards.
Cardboards are used to control the expansion of the bricks.
MAGNESIA BRICKS:
Do not cut magnesia bricks with water. Magnesia bricks will suffer hydration and properties will be lost.

ALUMINA BRICKS:
Alumina Bricks have to be cut with water to easy the process. Do not use hammer to knock corners.
QUALITY CHANGE:
Do not change quality over tyres or girth gear

OK

NOT OK

The installation may be weakened
16.- LINING FINISHING - RING CLOSURE

Tighten bricks with an hydraulic jack.
While jacking, knock bricks with a rubber hammer to ensure positioning.
Be careful not to exceed $\frac{1}{2}$ brick cold crushing strength in pressure.
17.- LINING FINISHING - KEY BRICKS

Key bricks are used to finish the rings

Some recomendations are listed below:

- No key bricks should be installed side by side within the same ring, always distribute along the key area
- Avoid key bricks to be placed side by side in two consecutive rings
- Limit key bricks to a maximum of 2 for each key shape
- Key bricks are used to close the ring. NEVER cut a brick in axial direction
- Tightening should be made by metal shims
  - Metal thickness should not exceed 2mm
  - Limit the use of shims to 3 per ring. 2 shims are recomended
  - If several shims have to be used, distribute them along the biggest possible surface
  - NEVER use more than one metal shim per joing
  - NEVER place a metal shim in contact with a key brick
18. LINING FINISHING - CONNECTION TO OLD LINING

When the existing brickwork is not straight, cutting should be done in the last ring.

Fill the gaps with mortar

Cut length has to be more than 2/3 of the brick

198mm → cut length > 132mm
300mm → cut length > 200mm

If the gap is too big, a 300mm (L shape) has to be used to cut, or just use more rings to adjust the cutting.
19. - LINING FINISHING - VISUAL SUPERVISION

After closing the last ring, some actions are required to ensure that the lining is correct and that the job’s quality is acceptable:

1. Remove the bricking system (Rig, Pogos...)
2. Check for defects (Open joints, Sagged rings, Wrong positioning...)
3. Turn the kiln 180° at the lowest speed
4. Repeat point 2
5. Tighten or re-shim loosen rings (if necessary)
6. Confront theoretical and actual installed bricks quantity and shapes. Document the divergences and share them with your refractory material provider
7. Check the drying/heating up instructions (if castables had been used)

At any point, if any deficiency is found, a corrective action must be done and the process should restart
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