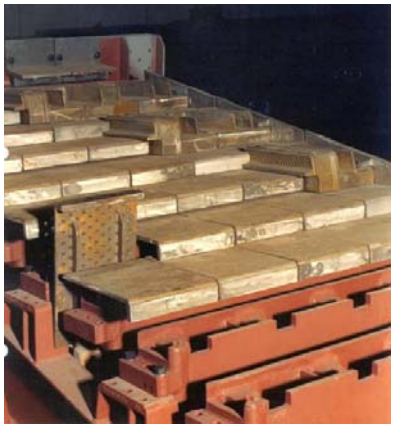
Key PMR’s

Frame alignment on clinker grate cooler Procedure



1. PURPOSE

Gaps between grate plates and side wear lips must be controlled to ensure proper cooler operation: An even distribution of the plates’ clearance on the grate reduces the cooling airflow through plates. Besides verifying that the proper gaps are maintained (see respective Key PMR, Gap Management on clinker grate cooler), the alignment of the cooler frame and beams plays a crucial role to assure the gaps can be kept at all.

In addition, proper alignment (together with functional guide rollers) avoids eventual damages on cooler side walls and seals due to rubbing.

Please refer to the Annexes at the end of this procedure for additional information on grate coolers and factors affecting the frame alignment.

2. SAFETY

Wear all required Personal Protective Equipment (PPE) according to local regulations. This may include, but it is not limited to: hardhat, safety shoes, safety glasses, earplugs, gloves, protective clothing.

The cooler must be properly de-energized. Use the local lock-out/tag-out/try-out procedure on the main drive, hydraulic and pneumatic systems (air blasters).

3. RESULTS AND ACCEPTABLE VALUES

During the alignment measurement, the difference in slope between supports will be measured. This is easier accomplished through the height difference between supports, measured from a reference point.

The height between supports must be maintained within 1 mm

The maximum deflection allowed on supports is of 3 mm

Please refer to the pictures within the Step by Step procedure for details on where to measure.

4. FREQUENCY OF REALIZATION

This measurement should be performed during every major kiln outage, as long as a significant amount of plates are being replaced (in order to perform the alignment, the plates must be dismounted from the grates.

The alignment can as well be triggered in case of beam deformation (e.g. due to overheating during operation).

5. STEP BY STEP PROCEDURE

5.1 Tools:

1 set of feeler gauges
4 measurement templates
1 straight edge
1 spirit level
Piano wire or theodolite
Wire brush
1 caliper

5.2 Steps:

1. Remove the plates from the section to be aligned, in order to get access to the supports
2. Check the plate contact points (seating) are in good condition. Remove eventual burrs or accumulated debris with a wire brush.

3. Check with a straight edge that the supports are not bent (max 3mm). Replace bent supports with new or refurbished ones.
4. Check the starting and ending row to be horizontal and to be at the right height compared to structure and sides (consult manufacturer drawings).
5. These 2 rows are checked to be parallel (same distance from right and left side; refer to Figure #1)

Figure #1. Checking parallelism of starting and ending rows

6. Install 4 templates at the 4 corners of the section. The templates include studs ensuring a repeatable and accurate positioning on the support as in Figure #2. Some suppliers provide specific dimensions for this template; the most important issue is that the template reproduces the required slope for the supports and that it can be firmly attached to the support

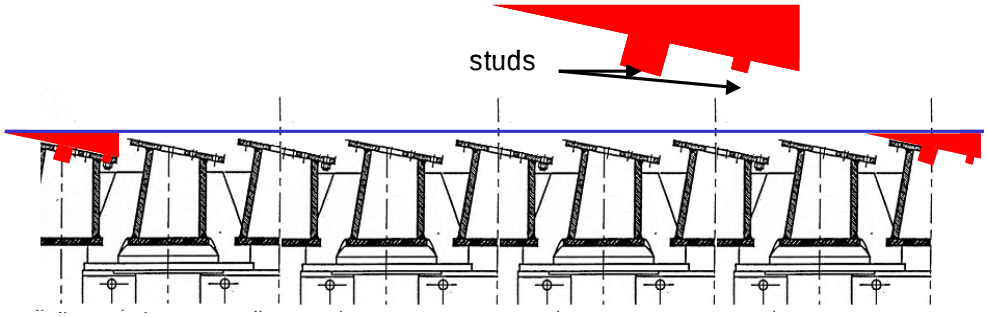


Fig.2 Position of the templates for measurement. Once the templates are in place the height difference to the piano wire will be equal to the required shimming thickness.

7. Install the piano wire between the templates at the extremes, on both sides
8. Install two additional templates on the support to be aligned, one on each side, and measure the difference with the piano wire. The height difference is equal to the required shimming. See Figure #3.

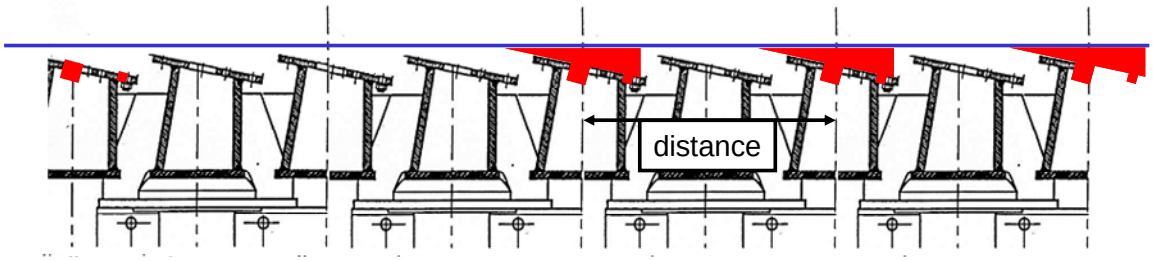


Figure #3. Measurement of height difference on the vertical axis of the support

Tip: the templates must be built in such a way that the height measurement can be performed following the support vertical axis. Otherwise the measurement will not be comparable from one support to the next.

9. **With a theodolite:** the principle applied is the same. The theodolite must be installed on a fix and stable base and its inclination should follow the support required slope. See Figure #4.

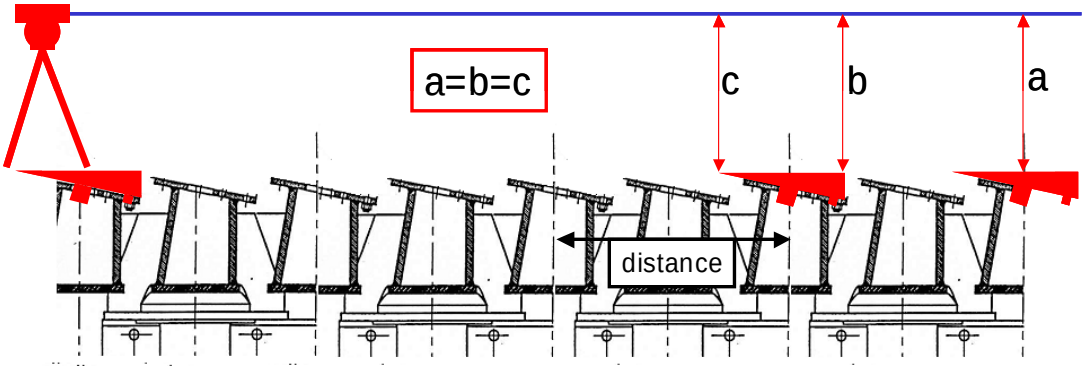


Figure #4. Measurement with theodolite. The indicated heights must be the same; otherwise shimming is required.

10. Record which supports need shimming and by how much.

6. OTHER ADVICE

The same templates are used to check the position of all other supports along the beams.
Make sure the final corrections (shimming) is properly recorded for the equipment history!

After the shimming is done, verify that the gaps between plates are within the acceptable range.

7. CORRECTIVE ACTIONS IN CASE OF DEVIATIONS

Once all supports have been surveyed, notify the respective supervisor to begin as soon as possible with the shimming.

The following are the main steps for shimming:

1. Shim the support accordingly
2. Fix the support on the new position
3. Remove the templates and proceed with the next support
4. Once all supports are aligned, install the cooler grate plates. Verify the achieved gaps are within tolerances
5. Check all plates are correctly positioned and well fitted
6. Weld the double nut on the plate bolts to secure fixation (for some types only)
7. Clean the grate surface from any metal pieces, welding rods, or other material.

Tips for shimming:

- Do not use more than three shim plates (prepare several plate thickness in advance).
- The total thickness of the shims should not exceed 5 mm. Large thicknesses are always result of wrong geometrical design of the plates:
    - The distance between 2 consecutives movable supports is constant along the cooler and is equal to the distance between 2 consecutives stationary supports (check the drawing of your grate frame).
      Therefore, the step between 2 consecutives row has a limit. Each millimetre above that limit will be added to the shims.
      On old Fuller/Constantin as shown below in Figure #5, the standard distance between 2 movable/stationary rows is 657 mm and the maximum step is 57 mm (657 x sin10° / 2).
      By design, this distance for the cast plate is 55 ±2 mm. For machined plates, the tolerance is reduced to ±0.5 mm.
      An increase of the thickness of the plate is most of the time the root cause of the non compliance to this distance.

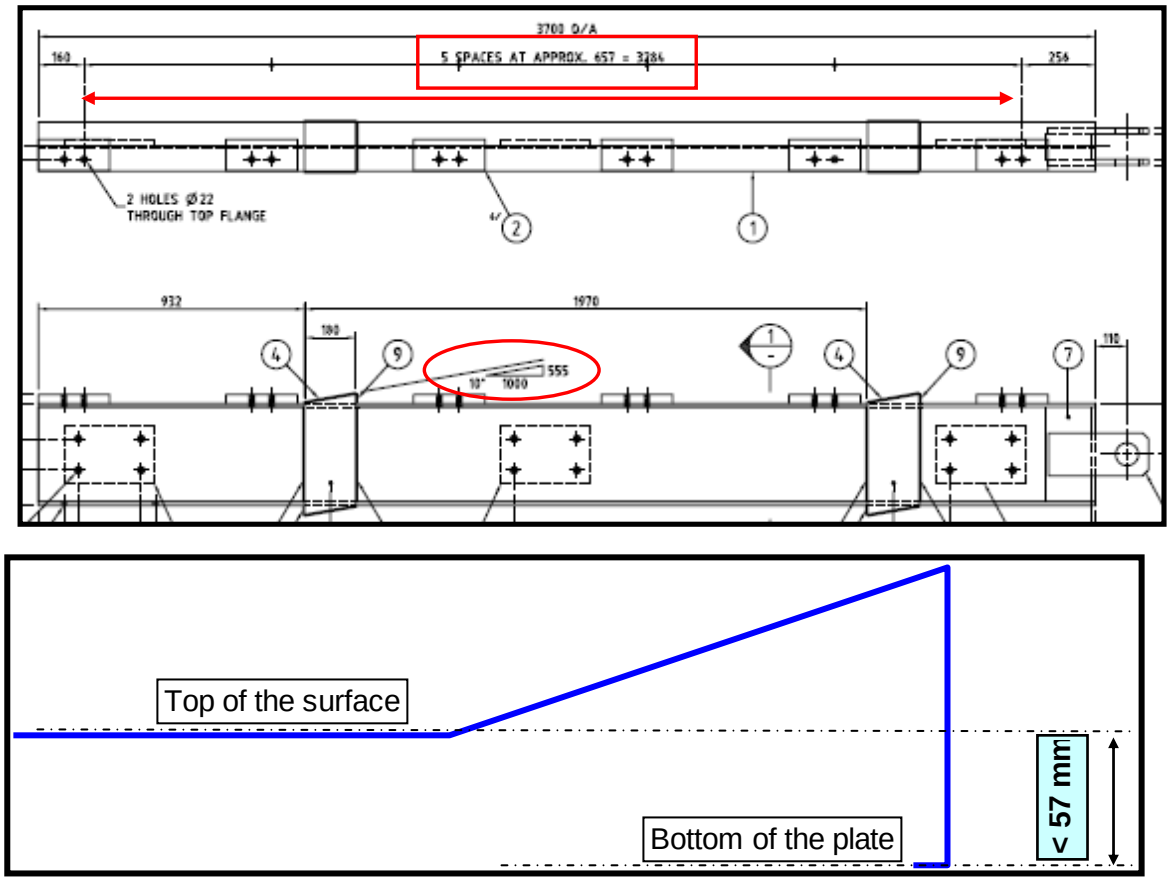


Figure #5. Distance and steps between rows.

- In case that distance is over the limit, grind the bottom of the plate to reduce the additional shimming.

Otherwise

- Weld the large shims together
- Use the largest shim possible to fill a gap. Never stack a bunch of thin shims to set a gap. Shim beams first to limit shimming of single grate plates

The main cooler beam might be distorted and it is then recommendable to add shims between support and beams

Grate supports must be straight to ensure straightness of the attached plates (machining of contact face is recommended)

In case a support is bent (from operation), small shimming between plate and supports is acceptable.

The installation of the new cooler grates should not require shimming if the grate quality is adequate and the alignment correct. Some individual plates may nevertheless require shimming

8. ANNEXES

Prior to any frame alignment and gap management, special attention should be paid to the efficiency of the air-tightening of the compartments and on the overall condition of the supports of the movable grates.

During operation, the temperature of the grate plates should be below 100°C on the whole cooler, whatever the cooler generation. Over-heating damages and deformations of the cooler frames can happen otherwise. Therefore, the frame re-alignment is a high cost operation, instead of an inexpensive routine measurement.

High temperatures are always the result of a combination of these root causes:

- Air leakage out of the compartment (see Examples in Annex 2)
  - Bad condition of the partition walls and of the outside walls.
    - No light should enter in a compartment (sun, light from next compartments).
    - All clearances between the moveable frame and the stationary plates support must be reduced to less than one millimeter. A box respecting the inclination of the supporting wedges must be fitted to the main beams of the grate frame.
    - All damages and holes on walls must be fixed properly
    - A good overall condition of the sealing around the crosshead shaft in the hot zone is required
  - Leakage at the clinker discharge.
    - A good overall condition of the valves is required
    - Unnecessary opening of the valves must be suppressed - The airflow of the fan should be checked (stop of the fan loop=constant speed of the impeller) when the valve is opened to avoid an unnecessary opening of a single valve

    Note: A cooler with a drag chain passing through all compartments cannot be considered as a reliable air-tightened compartment cooler. All coolers should have a floor with valves in each compartment to avoid air leakage through the drag chain

- Wrong design of the compartments (process issue)
- Wrong design of the fans (process issue)

Note: A low operating clinker bed, which is not mentioned above, is mainly a consequence of a bad air-tightening of the compartments and/or a wrong design of the fans in the hot zone.

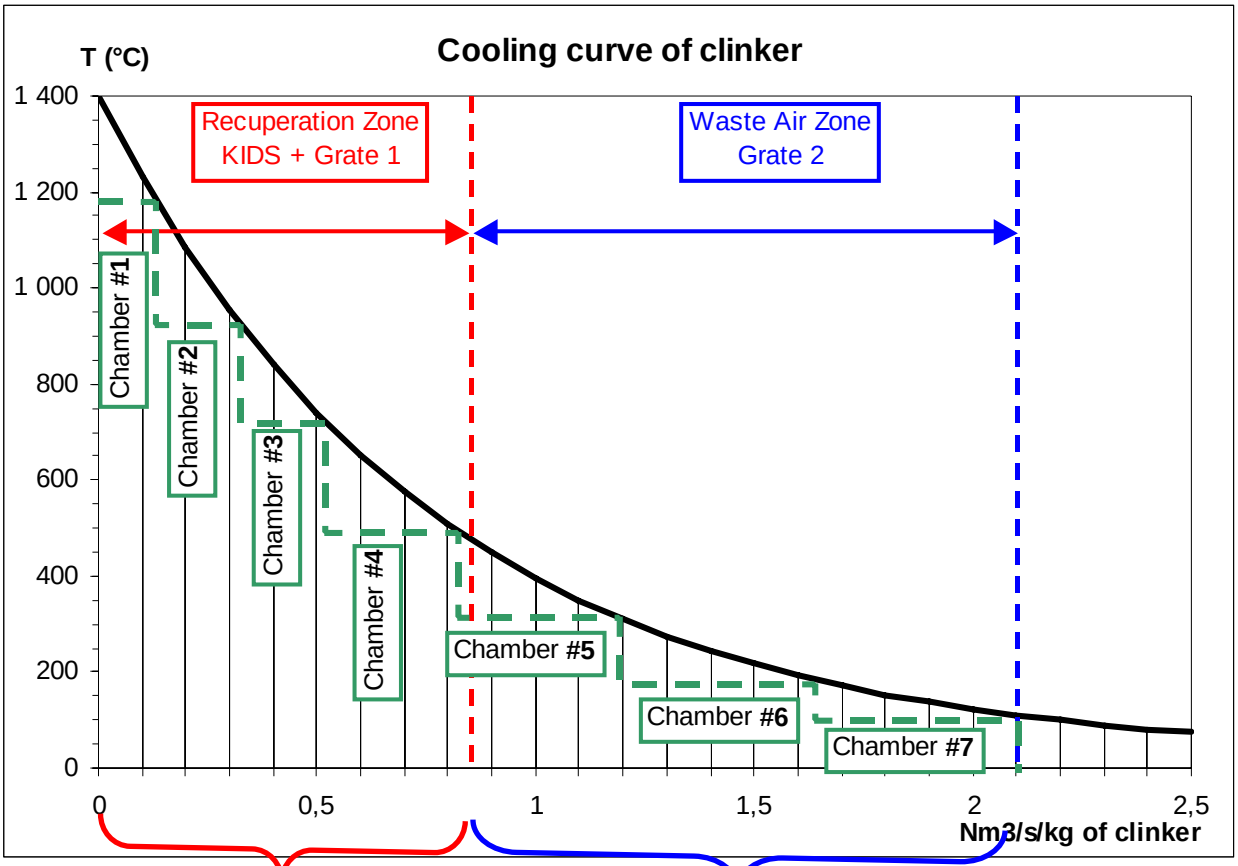
Also it is recommended to connect fans in the hot zone to the emergency generator to avoid any over heating of the plates during a general plant power failure (blackout).

Side movements of the grates are reducing the efficiency of the compartment seals during a campaign, if they are not limited below 2 mm. The grates must be leveled at each supporting stations with a water gauge and the clearance between the guide of the rollers and their wedge should not exceed 2 mm in total.

A common practice is to rotate about a quarter a supporting roller when a flat is present at the contact with the wedge. Such a practice is tolerated for a short period, but it must not be performed during a planned shutdown. A replacement of the roller is preferable to this practice

ANNEX 1

Key notions on clinker cooler

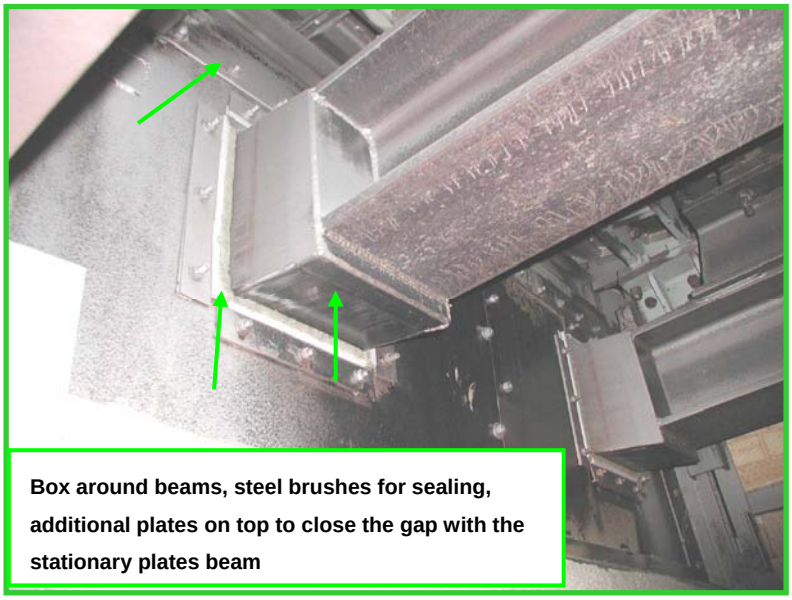


- A low amount of air has a big impact on the cooling of clinker: Air leakage is critical
- Fans are designed to deliver a small amount of air for a high pressure capacity
- A good condition of the sealing is required to have high pressure in the chambers
- Damage on the structure is always the result of a lack of cooling

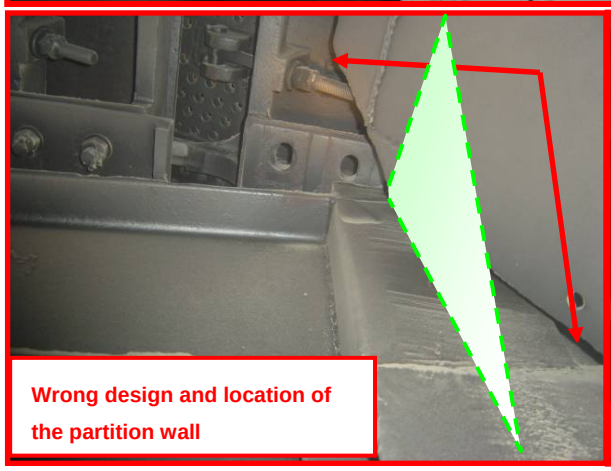
- A higher amount of air has a smaller impact on the cooling of clinker: air leakage has low impact on the cooling
- Fans are designed to deliver a higher amount of air at a lower pressure
- A good condition of the sealing is still required to cool flushing material
- Damage on the structure is the result of bad cooling in the previous part of the grate.

ANNEX 2

Examples of sealing condition in clinker cooler

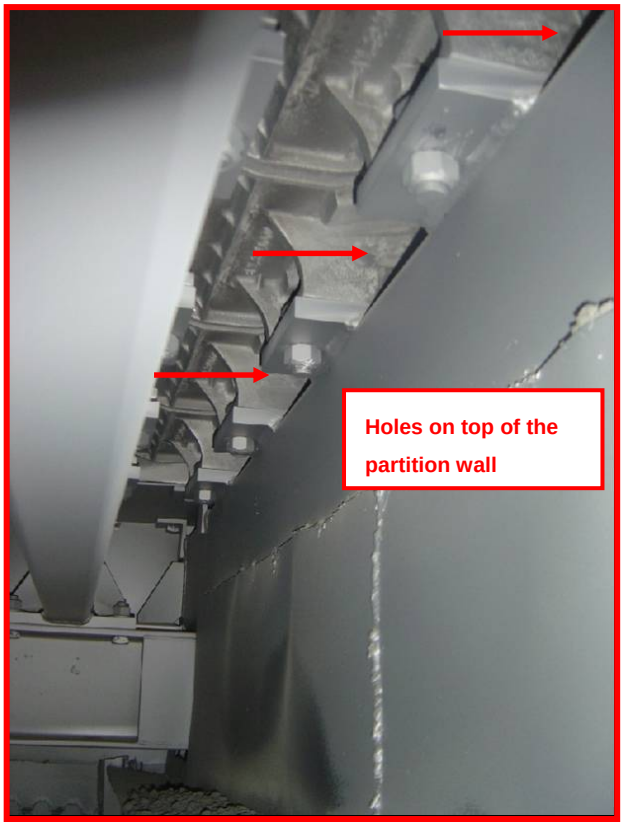


Box around beams, steel brushes for sealing, additional plates on top to close the gap with the stationary plates beam



Wrong design and location of the partition wall

No sealing box around the beam


Holes on top of the partition wall


No air-tightening with a drag chain


No Valve, high wear