Latest Developments in High Efficiency Clinker Cooling

Stephan Oehme – Claudius Peters
Director Sales and Technology
Why a New Clinker Cooler?

- “Fuel for my kiln is getting more and more expensive, I need more efficiency”
- “I do not want to stop one or two times a year, because my cooler fails”
- “I need cold clinker to protect my transports, silo, improve grinding and cement storage”
- “I’m tiered to spend thousands of Dollars each time for spare parts”
- “My God - maintenance, going inside the cooler, cutting steel, removing concrete castings, exchanging grate plates or bars, just with the knowledge that I have to do the same job soon again”
- “I want to get rid off the transport systems below the clinker cooler, there must be a solution for a system to safe my time and money”
- “I need a new clinker cooler, but I need production and I can’t effort a long stoppage”
Wouldn’t it be nice:

- to have **no** maintenance on the cooler between kiln stops?
- to have **cold** clinker all the time?
- to reduce the kiln heat consumption to a **minimum**?
- to have a cooler that has an availability of **100%**?
- to have a cooler **without** grate plates, hoppers regulation flaps or anything else that can **break down**?
My Answer – Is Your Answer

MINISTRY OF DEFENSE
EL ARISH CEMENT

Our El Arish 1 & 2 ETA Coolers went in operation July received a training from Claudia Peters which was easy to handle and our personnel quickly got familiar.

The coater surpassed our expectations in regards of uniform cold, ca. 65°C above ambient, which helps' consumption is low due to the high secondary air to 79%.

We did not have any cooler related stops therefore I spent some time and maintenance cost is very low.

Because of the excellent experience we had with the any cement plant the ETA cooler.

Finally we would like to thank Claudia Peters for the El Arish plants is also based on the excellent idea.

With best regards

Gen. Mahmoud Abdel Rahman
Plant Maintenance & Operations Manager

Subject: ETA COOLER 9610 for 5000 t/d with Roller Breaker
Claudia Peters No.: 02-5/160.774/512

The Clinker Cooler from Claudia Peters is based on the Walking Floor Principle (ETA-Cooler Type).
This cooler type was chosen because of the small construction height and safe and efficient operation. The positive operation experience from other users which made this decision before have been taken in consideration, too.

Begin 2009 the cooler has been successfully hot commissioned. The cooler is fulfilling our expectations in terms of availability and high process performance. Since start of clinker production there were no cooler related kiln shut downs.

The clinker capacity is app. 5000 t/d with a clinker end temperature of app. 100 C.

The clinker cooler works without clinker riddling that means no ridding collection system (e.g. drag chain) has been installed.

The clinker outlet temperature is matching to our production requirements.

Because of the high reliability and performance it is planned to increase the capacity up 6000 t/d.

All above shown matter are lastly based on the excellent relationship between TRACIM and Claudia Peters.
Moving Floor
## ETA Cooler sold

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooler in new kiln line</td>
<td>75</td>
</tr>
<tr>
<td>Stage cooler</td>
<td>53</td>
</tr>
<tr>
<td>Cooler with WHR</td>
<td>30</td>
</tr>
<tr>
<td>Replacement of grate cooler</td>
<td>32</td>
</tr>
<tr>
<td>Replacement of satellite cooler</td>
<td>18</td>
</tr>
<tr>
<td>Behind wet kiln</td>
<td>3</td>
</tr>
<tr>
<td>Return flow</td>
<td>2</td>
</tr>
<tr>
<td>In operation</td>
<td>59</td>
</tr>
<tr>
<td>Min. capacity (sold/ in operation)</td>
<td>700 / 1100 t/d</td>
</tr>
<tr>
<td>Max. capacity (sold/ in operation)</td>
<td>13000 / 13000 t/d</td>
</tr>
</tbody>
</table>
Why Moving Floor?

Efficiency?
**Difference?**

<table>
<thead>
<tr>
<th></th>
<th>Modern ETA Cooler</th>
<th>Traditional Grate Cooler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed height</td>
<td>950 mm</td>
<td>600 mm</td>
</tr>
<tr>
<td>Clinker retention Time @ 45 t/d/m²</td>
<td>42,6 min</td>
<td>26,9 min</td>
</tr>
<tr>
<td>Power consumption</td>
<td>4,89 kWh/t_clinker</td>
<td>4 kWh/t_clinker</td>
</tr>
<tr>
<td>Cooler Efficiency</td>
<td>77,8 %</td>
<td>73,9 %</td>
</tr>
</tbody>
</table>
Performance Results – Various Examples

76,9 %  
79,8 %

75,8 %  
97,9 %

Wet Kiln
Segregation Effects due to Kiln Rotation

Coarse clinker side, low pressure drop
Fine clinker side, high pressure drop

Tendency to:
- air flushes at the coarse side
- red river on the coarse and fine side
Cooling Curve & Air Temperatures

High influence at the front

Small influence at the end
Red River of Traditional Cooler

Typical Grate Cooler Troubles:
- Hot fine clinker reaches end of the cooler
- High wear on grate plates
- Hot air flows in exhaust air duct
- Clinker is not cold at the end of the cooler
- Recuperation is not optimum

NO Grate cooler can influence the Clinker flow over the cooler width!

Yes, ETA Can!
**Typical ETA cooler results:**

- Optimum recuperation
- High secondary and tertiary air temperature
- High middle air for WHR or drying purposes
- Cold clinker at the end of the cooler
Static Inlet HE Module

- Static clinker layer protects the plates
- Vessel system minimises pressure loss
- Flexible air control with small aeration fields
- Targeted aeration in the beginning of the cooling curve
Clinker movement in clinker coolers

**Reciprocating- grate, track and beam coolers**

**Clinker Circulation due to grate movement:**
- Vertical mixing of clinker
- Disturbed temperature gradient
- No optimum heating of air due to mixed layers
- Increased wear due to permanent hot clinker contact

**Claudius Peters ETA Cooler**

**Plug – Flow Transport:**
- No vertical mixing of clinker
- Undisturbed temperature gradient
- Steady heating of air, due to homogenous layers

**Slight compression in backward stroke:**
- Improved heat transfer due to low void volume

3 - 5% higher cooler efficiency
Why Moving Floor Maintenance?
Long lifetime concept ETA

<table>
<thead>
<tr>
<th>ETA Cooler</th>
<th>Grate Cooler</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No transport elements in clinker</strong></td>
<td><strong>Grate plates 100 % in clinker</strong></td>
</tr>
<tr>
<td>Self-protected design with pebbles and high clinker layer</td>
<td>Burnt and broken grate plates possible, due to direct hot clinker contact</td>
</tr>
</tbody>
</table>

Hardfacing

Lane filling with pebbles

Photo courtesy of client
Moving Floor vs. other Static Floor Coolers

ETA has no wear parts (!) in the clinker layer:
no mixing of hot and cold clinker layers
This leads to a 3 - 5% higher efficiency for the ETA cooler

No moving parts in clinker!!
Holcim Siggenthaler after 4 & 9 years of Operation

After 4 years

Only paint is off, the cooler is ready for production
Long lifetime concept ETA

Static Inlet & cross sealing

8 months of operation

20 months of operation
Aerated Lanes - Self-protecting design

- 95% of shear area protected by ordinary pebbles
- Exposed area partly hardfaced
- Protective pebbles layer with < 3.5 mbar pressure loss, incl. aeration system < 10 mbar
- Never exchanged a lane since first start in 2004

5 year guarantee
High Efficiency Module (HEM)

Protection:
- Static layer protects the grate plates of the HE Module

5 year guarantee
Long lifetime concept

Heavy duty Rollers

- Designed on fatigue strength and continuous operation
- Slow movement and hard faced surfaces
- Greasing once a year only
- Never replaced a roller since start in 2004

Rollers after 6 years and after 10½ years of operation

And still counting for many more years

5 year guarantee
Hydraulic Cylinder

- Designed with purging system to constantly exchange the oil
- Cylinders are in a protective air chamber no influence from outside dirt
- Easy observation through lower wall inspection window
- Large Chamber and Large doors perfect accessibility
- Designed on fatigue strength and continuous service
- Small / maintenance friendly cylinders
- Cylinder failure does not cause the stoppage of the cooler
# Clinker Cooler Drive - Safeguard operation

<table>
<thead>
<tr>
<th>Failure mode:</th>
<th>Modern ETA Cooler</th>
<th>Traditional Grate cooler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure of one pump</td>
<td>Bypass is opened, clinker production continues</td>
<td>Standby pump must be activated</td>
</tr>
<tr>
<td>Failure of one lane drive</td>
<td>Production continues at almost 100% Capacity</td>
<td>Production stop</td>
</tr>
<tr>
<td>Failure of 2 lane drives</td>
<td>Production continues at reduced Capacity</td>
<td>Production stop</td>
</tr>
</tbody>
</table>

Failure mode:

- **Modern ETA Cooler**
  - Bypass is opened, clinker production continues

- **Traditional Grate cooler**
  - Standby pump must be activated
  - Production stop
ETA Benefits

**ETA Cooler**
- Very long stroke length
- Very low grate speed
- \( \rightarrow \) Lowest maintenance requirements in market

**Grate Cooler**
- Short stroke length
- High grate speed
- \( \rightarrow \) Substantial damage possible on grate plates, spring suspensions, bandages, shims

<table>
<thead>
<tr>
<th>[stroke length mm]</th>
<th>ETA Cooler</th>
<th>Grate Cooler</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>100</td>
<td>200</td>
<td>250</td>
</tr>
<tr>
<td>150</td>
<td>200</td>
<td>250</td>
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<td>200</td>
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<tr>
<td>300</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>[stroke cycles / min]</th>
<th>ETA Cooler</th>
<th>Grate Cooler</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>9</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>12</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>15</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1: HE-Module:
HEM-Plates are protected by a static clinker layer
   - 5 year life time guarantee on plates

2: Aerated Lanes:
95% of the surface is covered with ordinary pebbles
   - protection against mechanical wear
   - protection against heat damage
   - 5 year life time guarantee on lanes

3: Stroke Length / Cycles:
Long stroke length causes slow movement which reduces wear
4: Heavy Duty Rollers
Designed on fatigue strength and continuous operation
Slow movement and hard faced surfaces ➔ extended lifetime
- 5 year life time guarantee on rollers

5: Hydraulic Cylinders
Designed on fatigue strength and continuous operation
Cylinder failure does not cause the a stoppage of the clinker production
## Moving Floor Benefits

<table>
<thead>
<tr>
<th>ETA Cooler</th>
<th>Grate Cooler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grate riddlings: NO</td>
<td>Grate riddlings: YES</td>
</tr>
<tr>
<td>→ Simple foundation work</td>
<td>→ Complex hopper system with pneumatic piping or mechanical transport</td>
</tr>
</tbody>
</table>

Photo courtesy of client
ETA Benefits Cooler Dedusting System

<table>
<thead>
<tr>
<th>ETA Cooler</th>
<th>Grate Cooler</th>
</tr>
</thead>
</table>

- **Less cooling air demand**
  Approx. 1.7 Nm$^3$/kg$_{cl}$

- **Higher cooling air demand**
  Approx. 2 Nm$^3$/kg$_{cl}$
  → Bigger exhaust air system
  → Higher energy demand
## Operation Cost comparison

### Advantage [Euro/a]

<table>
<thead>
<tr>
<th>Item</th>
<th>ETA Cooler</th>
<th>Grate Cooler</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Cooler availability</td>
<td>99.9%</td>
<td>99.5%</td>
</tr>
<tr>
<td>2: Cooler efficiency</td>
<td>77.8%</td>
<td>73.9%</td>
</tr>
<tr>
<td>3: Power con. cooler [kwh/t clinker]</td>
<td>4.89</td>
<td>4.00</td>
</tr>
<tr>
<td>4: Maintenance cost [Eur/a]</td>
<td>10.000</td>
<td>40.000</td>
</tr>
<tr>
<td>5: Exhaust air volume [Nm³/kg]</td>
<td>0.904</td>
<td>1.100</td>
</tr>
<tr>
<td>6: Combustion gas volume [Nm³/kg]</td>
<td>0.896</td>
<td>0.919</td>
</tr>
</tbody>
</table>

### Predicted savings

- **1: Cooler availability**: 63,400 €/a
- **2: Cooler efficiency**: 618,900 €/a
- **3: Power con. cooler**: 44,100 €/a
- **4: Maintenance cost**: 30,000 €/a
- **5: Exhaust air volume**: 40,600 €/a
- **6: Combustion gas volume**: 24,200 €/a

### Grand Total based on predictions

777,100 €/a

### ETA Cooler Total Savings Advantage

733,000.- €

### Total ETA Saving Advantage

44,100 €/a

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**20 Mercedes Benz E-Class**
<table>
<thead>
<tr>
<th></th>
<th>ETA Cooler</th>
<th>Grate Cooler</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cooler Efficiency</strong></td>
<td>77.8%</td>
<td>73.9%</td>
</tr>
<tr>
<td>@ 0.85 Nm³/kg recuperation air</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wear Protection</strong></td>
<td>Autogenous protection → Due to pebble layer</td>
<td>Grate plates 100 % in clinker</td>
</tr>
<tr>
<td><strong>Heat Protection</strong></td>
<td>Safe due to higher clinker bed and pebble lane filling</td>
<td>Direct contact between hot clinker and grate plate</td>
</tr>
<tr>
<td><strong>Stroke Length</strong></td>
<td>Approx. 300 mm-2-4 strokes /min</td>
<td>Approx. 120 mm 10-16 strokes /min</td>
</tr>
<tr>
<td><strong>Grate Speed</strong></td>
<td>Low wear</td>
<td>High wear</td>
</tr>
<tr>
<td><strong>Expected Lifetime</strong></td>
<td>&gt;&gt;10 years on lanes and support Rollers</td>
<td>Worst case less one year for grate plates reportet</td>
</tr>
<tr>
<td><strong>Cooler Availability</strong></td>
<td>Highest</td>
<td>Average</td>
</tr>
</tbody>
</table>
## Summary II
### Moving Floor Benefits

<table>
<thead>
<tr>
<th></th>
<th>ETA Cooler</th>
<th>Grate Cooler</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydraulic System</strong></td>
<td>Continuous production possible</td>
<td>Production stop with cylinder pump failure</td>
</tr>
<tr>
<td><strong>Plant Investment</strong></td>
<td>Grate riddlings: No system needed</td>
<td>Grate riddlings: Yes, system needed</td>
</tr>
<tr>
<td></td>
<td>→ Less construction height</td>
<td>→ Additional building height due to:</td>
</tr>
<tr>
<td></td>
<td>→ Simple foundation work</td>
<td>• Hopper installation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Drag chain installation</td>
</tr>
<tr>
<td><strong>Preheater ID Fan</strong></td>
<td>Lower combustion gas volume due to higher secondary air temperature</td>
<td>Higher combustion gas volume Δ +0,05...0,1 Nm³/kg&lt;sub&gt;cl&lt;/sub&gt;</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>→ Smaller preheater ID fan</td>
<td>→ Bigger preheater ID fan</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Exhaust Air</strong></td>
<td>Lower total cooling air quantity</td>
<td>Higher total cooling air quantity</td>
</tr>
<tr>
<td><strong>Quantity</strong></td>
<td>Smaller exhaust air system</td>
<td>→ Bigger exhaust air system</td>
</tr>
</tbody>
</table>