Introduction
The La Union plant is situated in the northwest of the Philippines some 7 hours from Manila by car, close to the town of Bacnotan. The main cement market is the town of San Fernando and the province of La Union as a whole. The plant started up in 1993 with a design capacity of 2400 tpd.

After a service life of only 20 years the kiln line was not performing to the expected output – the main bottleneck was the cooler. The existing cooler had two horizontal grates with a static inlet, chamber aeration with mechanical flow regulators and a hammer crusher. The clinker was far too hot and although the cooler was greased every day there were an estimated 10 days per year of cooler related kiln stops. The high clinker temperature resulted in premature refractory failures in the cooler, thermal damages on the conveying system, damage to the clinker storage silo columns and in the cement mill. The high exhaust temperature caused severe strain on the dedusting system. These problems led Holcim to conduct a feasibility study in which three concepts were examined; two retrofit concepts and one where the whole cooler would be replaced with a modern state-of-the-art cooler. The mechanical condition of the old cooler was very poor – the lower section was deformed and worn out due to long durations of high clinker temperatures. The grate cooler was no longer competitive compared with the modern coolers available on the market. A payback of less than 2 years was estimated if a modern cooler were installed.

ANDRE VOS, CLAUDIUS PETERS PROJECTS GMBH, GERMANY, DISCUSSES THE MAIN FACTORS THAT LED HOLCIM LA UNION TO DECIDE ON A COMPLETELY NEW COOLER WHEN EXPERIENCING A MAJOR BOTTLENECK IN THE PLANT.
**Project**

After a tendering process in 2010/2011 the decision was made to select a Claudius Peters ETA Cooler; and in the summer of 2011 the contract with Claudius Peters was signed.

The scope of supply included:
- ETA 857 M: an ETA cooler with eight static inlet rows, five aerated lanes and seven cooling air chambers.
- RB 305-4 EM: a roller crusher with four electrically driven rollers over the entire width of the cooler.
- Kiln hood with a pneumatically operated kiln hood seal.
- 11 VFD cooling fans, one bull nose fan and one hanging wall fan.

Additional replacements linked to the cooler project were:
- Burner replacement.
- Kiln shell replacement.
- Cooler exhaust dedusting system modification.
- Installation of a kiln camera.

The first day of the kiln shutdown was 31 July 2013. Due to three typhoons in the area the work had been delayed quite a bit, but the Philippine spirits were not broken, since they are accustomed to such unfavourable weather conditions. In early October 2013 the kiln was finally lit and the first ETA cooler was in operation in the Philippines.

**Process**

What did the new ETA cooler bring to the La Union Plant? Was it the right decision not to go for a cooler modification but for a new ETA cooler? To answer these questions let’s take a look at the cooler heat balance.

**Flow sheet of old cooler from September 2009**

The heat balance of the old cooler clearly shows the weaknesses of the grate cooler technology. The secondary air temperature at 764°C and tertiary air at 740°C are at a low level, which results in excess fuel being burned to reach the required heat within the kiln. The kiln heat consumption is therefore at 3498 kJ/kgcl (835 kca/kgcl), which is on the high side according to today’s standards. The problem is clear: the bulk of the heat is not transferred from the hot clinker to the cooling air, but remains trapped within the clinker as indicated by a discharge temperature of 257°C. This trapped heat within the clinker is lost and results in a much lower cooling efficiency. In addition, this causes the aforementioned problems, such as damaged conveying systems, premature refractory damages and an excessive amount of heat that is exiting with the exhaust air, which puts strain on the dedusting system.

**Current flow sheet of the ETA Cooler in July 2014**

The ETA cooler heat balance reveals the potential of this machine.
The ETA cooler is operated at an actual clinker bed height of approximately 950 mm (as opposed to the old cooler technology, which operates around 600 mm). The secondary air temperature at 1020°C and the tertiary air at 930°C are higher than with the old cooler technology and the basis for a kiln heat consumption of only 3369 kJ/kgcli or 804 kcal/kgcli. The heat is being extracted from the clinker more efficiently by the ETA cooler, so the clinker discharges from the cooler at only 110°C at 1.54 Nm³/kg. The low specific air consumption results in a power consumption of only 3.76 kWh/t.

A comparison of the two coolers can be seen in Table 1.

Holcim La Union management is dedicated to continually improving its plant process in order to be as efficient as possible. This includes frequent investigations of all process steps, in particular clinker production costs. Since fuel charges are the main cost driver their development is highly scrutinised. The kiln audits conducted before and after cooler replacement give a clear picture of Holcim’s savings with the ETA cooler.

Lower heat losses for discharge clinker and exhaust air temperatures proved to be sustainable. The verified heat savings considered only at the cooler add up to ~274 kJ/kgcli. Considering further reduced heat losses after the preheater tower, the entire heat decrease can be expected to be ~410 kJ/kgcli. This gives room for other measures, e.g. AFR, to reduce operating costs.

With the ETA cooler a low clinker outlet temperature of below 100°C was reached; however this caused mill clogging at the mill discharge due to a lack of drying capacity. To avoid this problem the cooling air volume was reduced on several fans, reducing it as low as 1.54 Nm³/kgcli. With these measures the mill clogging situation was eased, although a further reduction of the cooling air amount is considered by Holcim. Other than this the ETA cooler performed as expected from the beginning.

Looking at the comparison between the ETA cooler and the old clinker cooler, the ETA cooler has improved all operational parameters. These improvements result in a reduction in fuel cost, an increase in cooler availability and a reduction in maintenance cost – above all: one less thing to worry about.

![Figure 3. Heat balance of ETA Cooler in July 2014.](image)

<table>
<thead>
<tr>
<th>Table 1. Comparison of the original cooler versus the ETA cooler</th>
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<tbody>
<tr>
<td><strong>Original cooler 2009</strong></td>
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<tr>
<td>Capacity</td>
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<tr>
<td>Secondary air</td>
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<td>Tertiary air</td>
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<td>Clinker outlet temperature</td>
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<td>Kiln heat consumption</td>
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<td>Cooler losses</td>
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<td>Clinker bed height</td>
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<td>Specific power consumption of the cooling air fans</td>
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The question is, how does the ETA cooler get the job done so efficiently? What are the secrets to its success?

No mixing of hot and cold clinker (plug flow)
In a conventional grate cooler the clinker is circulated due to the grate movement. This causes the temperature gradient over the clinker bed height to be disturbed. Colder clinker from a lower layer will be elevated and mixed with hotter clinker. Due to this disturbed temperature gradient the cooling air cannot take up as much heat, which results in a lower cooler efficiency. In the ETA cooler the aerated lanes move below the clinker layer, which avoids the mixing of the hot and cold clinker layers. The so-called “plug flow” enables the air to take up more and more heat from the clinker. Other cooler types use cross bars or paddles to move the clinker; these also generate a mixing effect and negatively influence the heat exchange between the clinker and cooling air and therefore the overall cooler efficiency.

Slight compression in the backward stroke
The backward stroke of the ETA cooler gives a slight compression of the clinker, which reduces the void volume of the clinker. This improves air-to-clinker contact and enhances the cooler efficiency. Coolers working with another principle, such as a grate cooler, do not have this phenomenon.

Controlled Side Aeration (CSA) and independent lane movement
Due to the turning of the kiln, a segregation of coarse and fine particles takes place. This causes red river problems on the sides of the cooler: hot fluidised clinker flowing freely to the end of the cooler, taking with it unrecovered heat. The ETA cooler is very well suited to handle this situation. On the left and right side of the cooler, longitudinal chambers enable a controlled aeration by a dedicated fan. This allows a targeted aeration of the problem areas.

Another advantage is the independent lane movement; the stroke length of each lane can be adjusted to the process requirements of the clinker flow. Typically, on the sides of the cooler, a stroke length of 175 mm is used and the lanes in the middle normally operate at 200 to 240 mm. Due to the shorter stroke length on the sides, the typical red river areas have more retention time and therefore greater heat recovery can be achieved. Conventional grate coolers do not have the operational flexibility to vary the clinker flow over the width of the cooler. The controlled side aeration can be implemented, but at a higher expense.

High clinker bed
The high clinker bed of 950 mm has become the new standard for the ETA cooler. This higher clinker bed gives clear advantages compared to the normal 600 mm clinker bed of a grate cooler. The air has an extra 350 mm to take up the heat of the clinker. This results in the high secondary and tertiary air temperatures of 1020°C and 930°C and the low cooling air amount of 1.54 Nm³/kg.

Summary
The success story of the ETA cooler continues with Holcim La Union. The combination of a simple aeration concept with controlled side aeration, independent lane movement and a high clinker bed make the ETA cooler's process successful. Plug-flow, for an intact temperature gradient, and the slight compression, which reduces the void volume, are inherent to the moving floor principle and cannot be achieved by any other type of cooler. The excellent process figures result in a very quick payback possibility. Especially worth mentioning here is the reduction in cooler losses of 274 kJ/kgcll. This amounts to a huge saving in the kiln heat consumption and gives room for other measures, e.g. AFR, to reduce operating costs. Modification of an old cooler for little money may not be the most economical option in the long-term. An ETA cooler is, in the long run, the better ‘cash cow’. And, most importantly, the cooler is no longer the bottleneck of the plant.

Figure 4. Support rollers of the ETA lanes.

Figure 5. Hydraulic cylinders.