



KEEPING COOL

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Introduction

The cement industry is under pressure to reduce operating costs. Some of the challenges associated with the current commercially available technologies for cement cooling are their high energy consumption, high maintenance cost, and high water consumption.

The cement cooling technology that is widely used in the industry was first introduced in the 1980s. The industry is changing, and it is time for an efficiency upgrade. New and innovative technology is the enabler for improved performance and reduced costs.

Seeking a solution

Lafarge, a large global cement producer, recognised the industry challenges and was looking for a

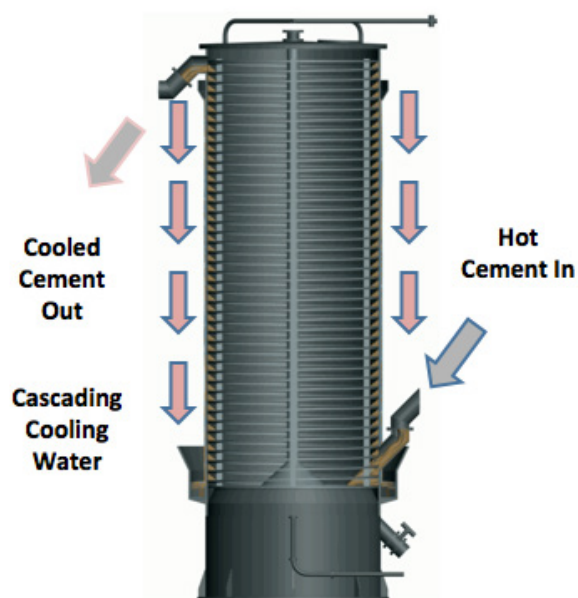


Figure 1. Conventional cement cooling technology.

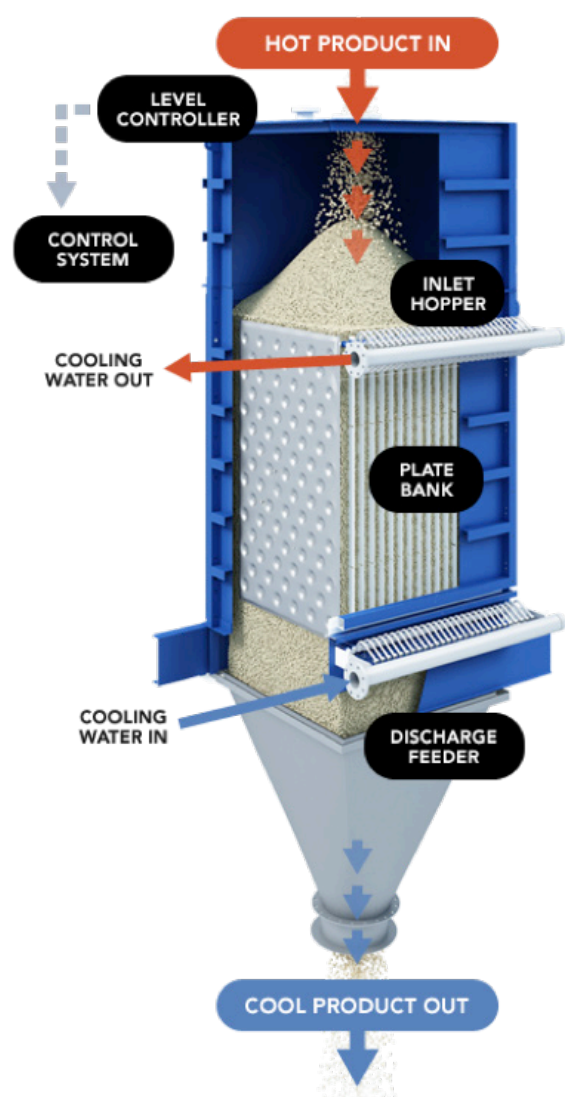


Figure 2. Indirect plate cement cooling technology.

solution. In 2013, Lafarge approached the indirect plate heat exchange manufacturer, Solex Thermal Science Inc. Lafarge and Solex partnered to find a better solution to its current cement cooling process using Solex's heat exchange technology.

The current cement process

In most cases, once it leaves the kiln, the finished cement product will need to be cooled before being conveyed into storage silos. This is in order to reduce lump formations in the cement product, which causes problems with storage, packaging, and handling of the cement.

Cement should generally be cooled below 80°C after being milled to mitigate the risk of gypsum dehydration, which can cause the cement to form lumps. The temperature of the cement can affect the hydration rate of the cement and reduce the setting time of concrete. The closed modern milling circuit systems meet some of the cooling needs; however, there is often a need for further cooling of the cement, especially if the clinker feed and ambient air temperatures are high.

Challenging the conventional way

The 2014 testing at one of Lafarge's plants in Alberta, Canada, confirmed that indirect plate cooling systems offer significant benefits to energy consumption, improved maintenance, and lower cooling water flow. This collaboration between Lafarge and Solex proved the benefits of the new technology in addressing key cooling challenges.

Energy consumption

The indirect plate cooling technology can realise energy cost savings over conventional equipment. The cement product is fed through the plates using gravity, which differs from the conventional way. Using an elevator (if required in the process) to lift the product will have a lower power requirement compared to the screw mechanism used to lift product in conventional cooling systems. A large plate surface area provides improved efficiency of heat transfer. Due to the lower water volume required to achieve the heat transfer load requirement, the plate heat exchanger can use a much smaller pump to move water. The system allows the use of discharge devices that typically have lower energy consumption. Combined, the lower energy required to lift, pump, and discharge cement in the plate heat exchange system will result in significant reduction in energy consumption. Figures 1 and 2 show a comparison of product flow through the indirect plate cooling technology and the conventional cement cooling technology.

Maintenance

Some of the known challenges with an open-loop water system are blocked drains and water contamination. This results in multiple annual shutdowns of 3 – 5 days at a time to remove concrete buildup and clean the drains and screen. The indirect plate heat exchanger technology uses a closed-loop water system that prevents the cement

Table 1. Cooler technology performance comparison

| Parameters | Conventional coolers | New high efficiency coolers |
|------------------|-----------------------------|-----------------------------|
| Type | Tube cooler | Plate cooler |
| Product capacity | 2 units × 65 tph | 2 unit × 65 tph |
| Cement in | 70°C | 70°C |
| Cement out | 45°C | 45°C |
| Water in | 10°C | 10°C |
| Water out | 16°C | 32°C |
| Flow rate | 2 × 250 gpm (500 gpm total) | 2 × 65 gpm (130 gpm total) |

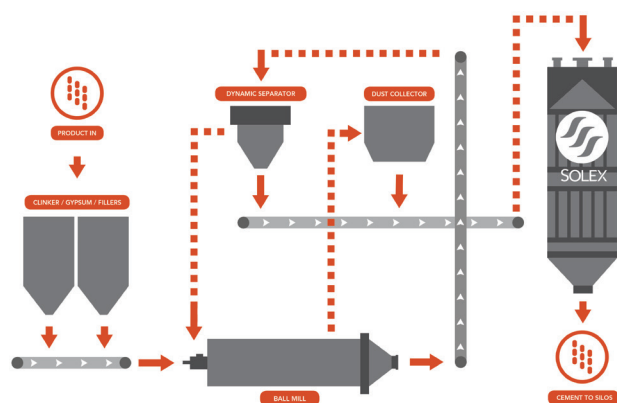


Figure 3. Cement cooling process diagram.

coming into contact with water, and eliminates the need for shutdown and wasted worker hours.

In addition, indirect plate heat exchangers have no driving equipment or bearings to maintain. Due to the uniform flow of cement through the system at a controlled rate, there is virtually no wear on the parts and no dusting.

Water treatment and consumption

The closed-loop water system eliminated water contamination and greatly reduced make-up water. This eliminated the need for water treatment at the plant.

Pilot testing at Lafarge cement plant

The testing in 2014 was conducted at a plant operated with a closed circuit grinding system, with a two compartment mill. The first mill compartment had step liners and the second had classifying liners. The mill feed consisted of clinker from two weigh feeders, limestone, gypsum, grind aid, and small amounts of process additions. There was a high-efficiency separator fitted within the closed circuit, along with two dust collectors, a mill sweep, and a dust collector from the separator. Off-spec cement (fringe) was re-introduced back into the system separator dust collector, where it was blended. Additionally, the circuit had two vertical cement coolers.

The issues faced at the pilot facility directly correlated with those faced across the industry.

How indirect plate cement coolers fit

Through the use of Solex's thermal modelling software, ThermoPro, the heat exchanger is designed to optimise heat transfer and prevent condensation buildup on the plates. Indirect plate heat exchanger technology combines the science of mass flow and indirect heat transfer. For cooling applications, water, or a glycol/water mix, is circulated through the plates, which have welded connections to the inlet and outlet manifolds. The heat transfer medium flows counter current with the product to obtain a better thermal efficiency. As the product flows vertically downward through the plates by gravity, it is indirectly cooled by the heat transfer medium. The uniform velocity from the flow of product to the mass flow discharge device created a true mass flow, which enabled flow rate control and residence time. This helped mitigate one of the main challenges within the cement industry: product buildup within the cooler.

This indirect plate cooler uses less water compared to conventional technology when cooling the cement, as the water is contained within the welded hollow plates and the flow rate is determined for each individual application. Outlet temperatures are managed to ensure maximum efficiency and the cooling circuit is able to use a cooling tower to create a closed loop, with a dry cooler to eliminate water losses.

The results

The uniform mass flow at Lafarge's plant was observed between the plates of the indirect cement cooler and there was no bridging within the unit or buildup of material on the plates. There was a light dusting of residual material on the plates due to the nature of cement being static and cohesive. The testing capacity rate at the Lafarge plant was 150kg/hr steady rate; the indirect cement cooler achieved cooling from 80°C to 36°C, which was well below the targeted 50°C. Ambient air conditions during the unit's operation were dry, with <0°C dew point.

The new indirect heat exchange technology significantly reduces energy consumption and water usage, and improves operational efficiency (Table 1). There is higher thermal efficiency, as shown in the differential of temperature of the cooling water. Make up water usage could be reduced to zero for indirect coolers when used in a closed loop cooling system.

Conclusion

The results from the pilot test conducted at the Lafarge plant showed how indirect cement coolers can directly mitigate the core issues that cement producers have been facing with the use of conventional technologies. Through the application of this technology, the cement industry could reduce its energy consumption, experience lower maintenance, and optimise water consumption. Indirect heat exchange technology has helped many other industries solve challenges relating to heat transfer. Solex is setting its sights on the cement industry to provide innovative heat transfer solutions to its current challenges. 