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# Fertilizer Focus

**The Middle East fertilizer market in 2022**

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# Advances in fertilizer cooling is the key to storage efficiencies

## Vertical plate technology is improving plant operations and product quality

*Written by*

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**Advancements in fertilizer cooling technology are providing producers with an ever-more diverse and robust catalogue of storage solutions for their products before they are shipped to market. The cooling stage in the fertilizer production process represents one of the last opportunities to get it right, whether that's optimizing operational efficiencies, ensuring a high-quality final product or improving safety measures.**

Jill Caskey, Global Sales Director at Solex Thermal Science
*Source: Solex Thermal Science*

In recent decades, this has led to more mainstream adoption of moving bed heat exchangers that use vertical plate technology to indirectly cool fertilizer due to their proven accuracy and consistency. In this article, we'll explore some of the different improvement opportunities producers are realizing at the storage stage as a result.

### Anti-caking

For proper storage and transport, fertilizers must be cooled to a certain temperature so the final product temperature is within 10°C to 20°C of the ambient temperature. This prevents moisture migration from the air to the product that can lead to agglomeration or caking.

Caking during storage represents a significant challenge for fertilizer producers. Product agglomeration not only threatens product quality, but also leads to issues such as excessive dust and increased safety risks when the product is being unloaded from storage due to the high temperatures. Most often, the cause of caking can be traced back to inadequate cooling.

### Why does caking occur?

Fertilizers such as NPK, urea and MAP/DAP products are hygroscopic, as are fertilizer salts such as potash. This means they will start to absorb moisture from the surrounding air at a precise humidity – otherwise known as critical relative humidity (CRH). Moisture transfer from the air to the fertilizer, or condensation, will, when combined with dust, lead to product caking.

Where does this available moisture come from in the first place? Simply put, it comes from the air that is entrained within the fertilizer, filling the pore space.

For example, if the air enters at 75°C with a relative humidity of 35%, it will contain about 96 g of water per kg of dry air. As it is cooled, to say 40°C, the air will only be able to hold 49 g of

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water per kg of dry air at 100% relative humidity. This means 47 g of water per kilogramme of dry air will condense out of the air as it is cooled. This is where the moisture comes from. To prevent this, cooling the product to the required temperature for storage and transport is extremely important.

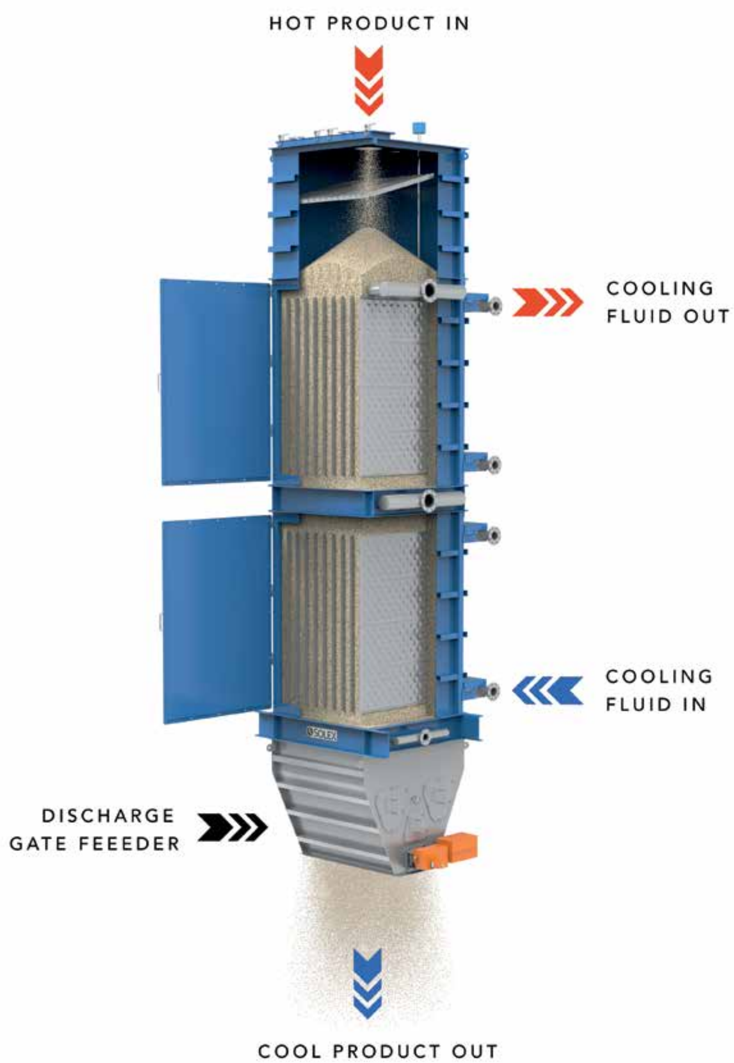
Moving bed heat exchangers that use vertical plate technology to cool fertilizers are well-suited to mitigate subsequent caking through a process that relies on conduction as opposed to convection (air cooling).

The product enters a vertically oriented heat exchanger and then flows by gravity through a series of parallel stainless-steel plates that contain cooling water or other fluid mediums. The plates absorb the heat and the product cools indirectly as it slowly and uniformly moves downward, with the flow rate controlled by a discharge feeder.

One of the keys to avoiding caking in heat exchangers that use vertical plate technology is air injection. By adding small amounts of purge air at target dew points – which are below the temperature of the fluid-cooled plates – operators can prevent condensation, and thereby caking, from forming in the heat exchanger.

It is important to note, however, that air is not used as the cooling medium in indirect plate cooling. In fact, less than 2,000 Nm3 (normal cubic metre cubed) per hour or 1,200 SCFM (Standard Cubic Feet per Minute) of purge air is needed at a particular location in the heat exchanger. The design ensures the water temperature profile and plate temperatures are always above the dew point of the air in the void space.

**Figure 1.** An example of a moving bed heat exchanger that uses vertical plate technology to cool fertilizer by conduction. The product flows by gravity through a series of parallel stainless-steel plates that contain cooling liquid. The plates absorb the heat as the product cools indirectly.

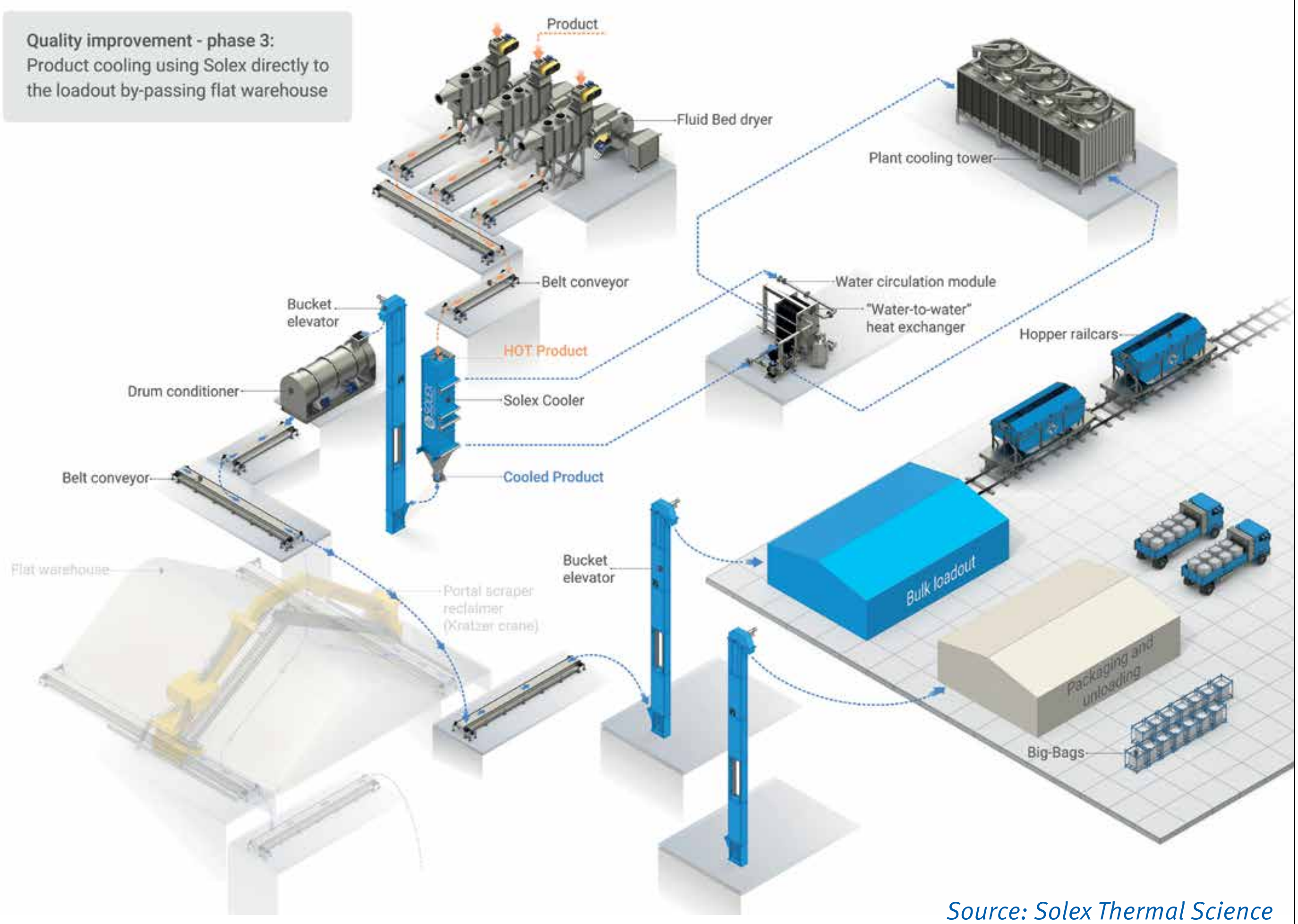



*Source: Solex Thermal Science*

Another key point is the counter-current flow of the fluid inside the plates, which allows for greater thermal efficiency and, as a result, more effective cooling. In addition, the plate design provides more surface area to cool the product than other direct-contact alternatives such as fluid beds or rotary drums, and in a more compact space. The typical required footprint for a vertical heat exchanger is two metres by two metres.

Combined, these factors allow plant operators to evenly cool their product without the risk of condensation, excessive temperature changes and, ultimately, caking. It can also lead to higher throughputs while simultaneously mitigating the need for housing product in flat storage that relies largely on time to achieve the necessary cooling.

**Figure 2.** NAK Azot used vertical plate heat exchanger technology at the cooling stage to eliminate its reliance on bulk storage, thereby recouping the three- to four-day final cooling time.




*Source: Solex Thermal Science*

## Improving storage practices

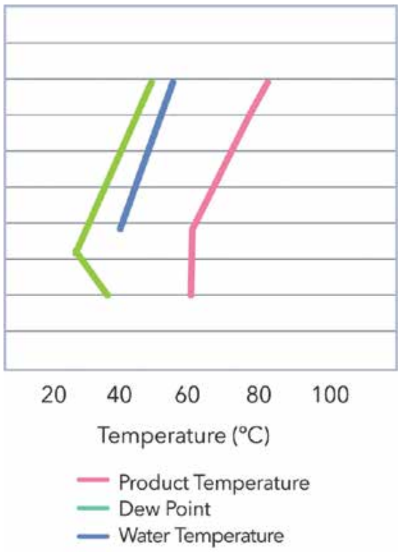
In many regions of world with hot and/or humid climates, certain cooling methods can be insufficient in keeping up with production demands. For example, the cooling capacities of direct-contact air coolers such as drums and fluid beds are often challenged and sometimes limited when the ambient air is too hot – which, for many parts of the world, can be upward of 48°C during the summer months. For reference, the typical temperature of fertilizer required for stable storage should be in the range of 40°C to 45°C.

The capacity constraints of direct-contact coolers trace back to their reliance on high volumes of air – not just for the heat transfer, but also for scrubbers or baghouses that must clean the air in accordance with local emissions tolerances. The load on these air-cleaning systems is often too much in these climates given the ambient air is too hot and/or humid to cool the fertilizer.

This creates a bottleneck that leads to inefficient bulk storage practices such as "stack-cooling" the hot fertilizer in warehouses. The resulting three-to-four-day cooling process complicates plant logistics – for example, demurrage and warehouse management. It also leads to scheduled planned production rate reductions in which producers lower their throughputs so the cooling capacity can catch up. In doing so, they are leaving profits on the table by not fully maximizing the sale of their product to local and global markets. This can be significant given the volumes of fertilizer involved.

Moving bed heat exchangers that use vertical plate technology, however, allow producers to consistently cool their product prior to packaging and storage independent of ambient temperatures. Because it relies on conduction as opposed to convection, or forced air, to cool fertilizer, the technology is not influenced by ambient conditions.

**Figure 3.** To prevent caking from occurring, cooling the product to the required temperature for storage/transport is important.




*Source: Solex Thermal Science*

## Case study

Novomoskovskiy Azot (NAK Azot), a subsidiary of EuroChem Mineral and Chemical Company, faced production constraints and product quality concerns due to inadequate cooling capacities at its granulated urea plant in Novomoskovsk, Russia.

Specifically, the second largest ammonia producer and the largest nitrogen fertilizer producer in Russia was seeking to debottleneck calcium ammonium nitrate production.

At the time, the process relied on three parallel fluid bed coolers designed to lower the post-granulation fertilizer temperature to between 65°C and 75°C. The product was then conveyed to a rotary drum cooler for secondary cooling before sitting in bulk storage for three to four days until the temperature dropped to its target range of between 35°C and 40°C.

However, the still-hot product heading into bulk storage was highly susceptible to drawing in moisture from the atmosphere, leading to caking. This forced NAK Azot to reclaim the caked product using two Kratzer-Crane scrapers, which led to variable grain-size distribution and a high percentage of fines.

To achieve better quality control, NAK Azot started by upgrading its rotary drum to allow for anti-caking additives to be injected into the hot fertilizer before sending it to bulk storage. This helped to reduce the amount and thickness of the caking.

The producer then turned to moving bed heat exchangers that use vertical plate technology to increase its cooling capacity. The process involved taking the product directly from the fluid bed dryer at a temperature between 65°C and 70°C, and then discharging it at an optimum temperature of between 37°C and 41°C.

The switch to vertical plate technology allowed NAK Azot to eliminate its reliance on bulk storage, thereby recouping the three- to four-day final cooling time. In addition, the producer avoided breakage or degradation of the fertilizer granules. Overall, the process allowed the granules to keep their form, resist caking and hold their integrity during storage and transportation.

Satisfied with the results with calcium ammonium nitrate, NAK Azot has since expanded its use of the vertical plate heat exchanger technology to also cool its high-density ammonium nitrate.

By doing so, producers can send cooled product directly to the loadout, thereby eliminating the need for inefficient warehouse cooling practices and avoiding planned production rate turndowns.

## Improving safety

Safety represents an additional consideration when storing fertilizer. When throughputs exceed processing conditions and fertilizer is moved to large on-site storage facilities to stack cool, it can still pose significant handling risks even three to four days later.

That is because fertilizer is a great insulator. Even after sitting for extended periods of time, it can still be dangerously hot in spots, and therefore potentially hazardous to operators and truck drivers at loadouts when the fertilizer is above the 40°C to 45°C range.

Moving bed heat exchangers that use vertical plate technology eliminate these hot spots from occurring by providing producers with a consistent prescribed temperature that is safe to handle at the outlet. The uniform movement of product through the heat exchanger, controlled by a mass flow discharge feeder, ensures every prill or granule is accurately dialled in before being stored, or directly shipped to market. ■

**About the author**
Jill Caskey is a Global Sales Director at Solex Thermal Science, a North American-based leader in thermal and bulk materials engineering. She has an extensive background in technical equipment design (thermally and mechanically) within multiple different markets, notably nearly a decade with fertilizer-specific applications.

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