Best practices in maintaining plate heat exchangers:
Getting the most out of indirect-based technology

Today's moving bed heat exchangers (MBHEs) are incredibly robust. Highly engineered and world-tested, it's not uncommon to see these units still operational decades later with minimal investment along the way. Yet that doesn't mean they are unbreakable. Foreign materials, changing process conditions and, most commonly, neglect are just a handful of the common culprits behind why these heat exchangers are often cut down before their time.

By Sven van der Heide and Francisco Castellano, Solex Thermal Science (All images courtesy of Solex Thermal Science)

MBHEs that use vertical plate technology to indirectly heat, cool or dry free-flow granular solids are no exception to the danger of early retirement. The internal components of this proven heat exchange technology used in industries such as fertilizer, oilseeds and sugar represent the infrastructure that supports the science of heat.

And these components need some attention – specifically the heat exchanger plates that have likely seen plenty of front-line action.

The good news is it's rarely too late to maintain your heat exchanger plates. The key is knowing what to look for when it comes to early signs of aging, mitigating processing conditions that might contribute to excess wear and, most importantly, creating a regular maintenance schedule.

But first, how does this technology work?

MBHEs that use vertical plate technology blend the thermal efficiency of plate heat exchange design with the science of uniform mass flow to cool or heat a full range of free-flowing granular solids, from fertilizer to foundry sand and battery materials to processed biosolids.

The tower-like design – which often has a physical footprint of about two meters by two meters – cools or heats the product by conduction instead of convection (e.g., air cooling). Free-flowing materials such as granules and pellets enter the exchanger, slowly passing between a parallel series of plates that contain a flow of water or other heat transfer fluid. The flow of solids is controlled by a discharge feeder that is integral to the MBHE's performance. While certain details change according to the properties of different products, the principles of operation remain the same.

This plate shows examples of where the laser weld is both fading (left) as well as striations are showing (right).

So how does plate wear occur?

The most common culprit behind accelerated plate wear is if the heat exchanger is not operating properly.

One of the root causes can be traced back to product blockages. MBHEs that use vertical plate technology are designed to operate most effectively when the product is moving uniformly through the unit. Yet, obstructions within the plate bank of a heat exchanger can reduce the cross-sectional area in these sections, leading to increases in flow velocity in other areas. This can also cause temperature variations at the outlet that, in turn, can result in a product that fails to meet process requirements due to a lower-than-needed residence time in the heat exchanger.

Another reason for accelerated plate wear is the product level – namely, the amount of product in the heat exchanger is too low and the tops of the plates are exposed to a falling product stream.

Low product level can increase the impact velocity on the edges of the top plates by five to 10 times, when compared with plates that are fully submerged. This can dramatically increase the wear rate. Best practice is to schedule regular inspections of the level sensor throughout the year and minimize the amount of time the product is falling directly onto the tops of the upper plates.

What else causes plate wear?

Many seeds and grains such as rapeseed or canola, for example, are extremely hard and durable, and can therefore be abrasive on plates when moving outside of recommended velocities. These robust granules can cause additional damage when they enter heat exchangers with chaff and loose parts from upstream equipment, which can also cause blockages, leading to high velocity flow zones in the heat exchanger.

The wear to heat exchanger plates can happen on the inside, too. When the heat transfer fluid is compromised – for example, it contains higher-than-desired concentrations of chlorides or compounds that corrode stainless steel – then the plates can be slowly eaten from the inside. This typically occurs in situations involving open-loop systems: for example, water from plant cooling towers.

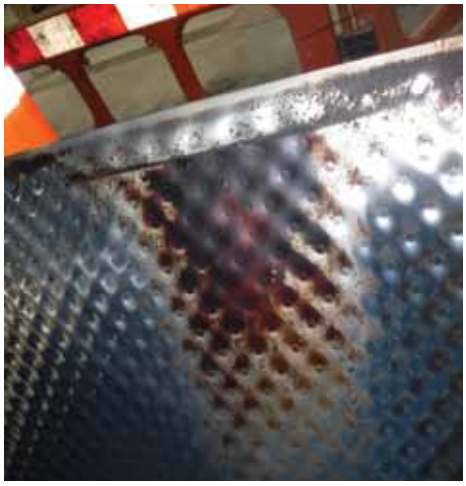
Plate wear can also occur during the removal of a blockage with incorrect tools. Using metallic tools such as metal bars to remove blockages can do additional damage by puncturing the plates.

In summary, plates can either be eroded from the inside or worn down on the outside, which makes routine inspections and monitoring a relatively inexpensive but effective method of reducing failure risk.

How do you know it's time to replace your plates?

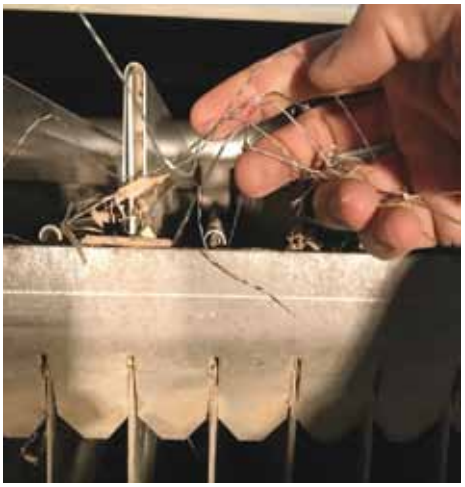
Although it is the least likely scenario, the most obvious sign that a plate needs to be replaced is if it's leaking. A visual inspection can also indicate that a plate may need to be replaced. As mentioned earlier, dents or gouges can be caused by foreign objects such as from broken pieces from upstream equipment or cleaning tools.

In addition, areas of a plate that look "over polished" or have localized striations are indications of advanced wear.



Foreign material that enters the heat exchanger can cause blockages (e.g. plugging), leading to high velocity flow zones that are manifested by areas of discoloration on the plates.

Agglomerated product that comes into the heat exchanger can lump on the tops of the plates and cause wear to the caps, as well as lead to blockages further down the unit.



Foreign debris is a common culprit to plugging in an MBHE, and excessive plate wear.

We often recommend operators pay special attention to the smoothness of plate dimple circular welds, as well as the condition of protective plate caps, where applicable. If either are smooth, that's an early indicator the plates need to be more thoroughly inspected and, potentially, replaced. Other visual indicators from wear may include:

- A shiny and clean area on the plate before cleaning (least amount of product build-up)
- Discoloration
- Less-pronounced laser welds
- Deformed dimple shape
- Apparent "flat spot" in inflation profile

An important note before replacing plates: We highly encourage operations and maintenance personnel to work with their MBHE provider as worn or damaged plates can often be repaired and put back into service.

If any concerning areas are found, it's also best to contact the technology provider for an assessment and a recommended method for further evaluation. This could include, for example, an ultrasonic measurement of the plate's thickness that, when compared to other areas, can provide an indication as to the amount of wear.

It could also mean a hydrotest to the pressure stamped on the nameplate of the unit plates. This test could show bulged areas and provide a more definitive indication of possible plate failure.

It's also possible to pull a single plate in an area of concern (high velocity) and perform many of the checks mentioned above. However, it's important to then reinstall the plate and return the unit to service. It's not recommended to leave a plate out as debris tends to fill the plate spacers and make future installations difficult.

How do I get the most out of my plates?

There are several methods that can extend the life of your heat exchanger plates, starting with regular and thorough inspections.

First, pay attention to draw down and level control in the inlet hopper. Make sure the plates are not exposed and there are no unusual flow patterns. If you do see them, take note of the "fast" areas.

Next, make sure the unit is regularly cleaned and common trouble areas are cleaned out. These trouble areas cause wear elsewhere and are often near the plugged areas. The frequency of cleaning should be determined based on an assessment of the need.

A note on recommended velocities:
They are determined on the combination of design feed rate and the cross-section area. All things being equal, the velocity increases if the feed rate increases, or if the cross-section area is reduced due to blockages.

Another way to get the most out of your heat exchanger plates is to make sure the upstream product preparation processes are working properly. This could include, for example, lump breakers, screens or air-cleaning systems. As blockages are often initiated by material such as chaff in oilseed applications or fertilizer dust that builds up on the plates over time, proper product preparation processes will help to prevent plugging of the MBHE.

Cleaning inside the plates is also sometimes required. For example, using water with a high content of carbonates can lead to a thin layer of calcium carbonate on the inside the plates, decreasing their heat exchange capacity. This can be prevented by using a citric acid solution during the cleaning process. Your plate supplier can assist with additional steps on how to internally clean the plates.

Finally, it's important the unit operates within its design parameters. That means maintaining product flow rates within design conditions to avoid significant increases in the velocity of material going through it. If the material is coming in at the rate and quality that the unit was designed for, and the quality of the heat transfer fluid is maintained, plates can easily last 15 to 20 years.

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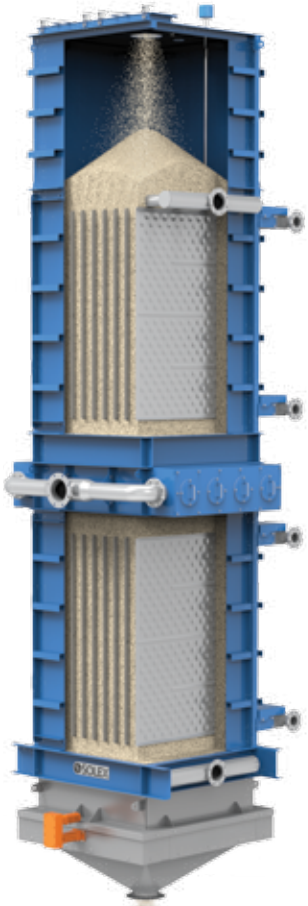
Both Sven and Francisco have spent the past six years in various roles related to thermal engineering, including project managing, pilot testing, servicing and commissioning numerous MBHEs around the world. For more information about their work at Solex, visit www.solexthermal.com.



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