Introducing Smart Layer™

Passive early warning system for Brazed Aluminum Heat Exchangers end of service life

The lifespan of a Brazed Aluminum Heat Exchanger (BAHX) depends on how it is operated and maintained, especially with respect to thermal gradients. If operated frequently outside the guidelines as recommended by ALPEMA*, then the gradual accumulation of stress can lead to leaks in the field. A BAHX will accumulate this stress related wear and tear on the inside and out of sight, where it is notoriously difficult to predict a pending leak.

A leak to atmosphere poses a danger to property and life, which means an unplanned shutdown with loss of production that is likely to add massively to the overall cost of corrective action.

Chart has introduced a new physical technology that is capable of providing early detection of end of service life for BAHX and is entirely passive from a plant operator's perspective. Patent pending Smart Layer™ won't reverse damage, but will give advance warning when a critical threshold of the operational life of a BAHX has been consumed, such that the operator can plan ahead for the unit's repair or replacement and significantly reduce the instances where unexpected external leaks require unplanned shutdowns and expedited delivery of a replacement BAHX.

The BAHX is an incredibly robust and reliable piece of equipment with a typical industry service life expectation of around 20 years, although units adhering to the ALPEMA guidelines can enjoy service lives of 40 years or more. Leaks can occur, but the majority are small. An internal leak between process streams could go unnoticed while having a small impact on plant performance and efficiency. An external leak is far more serious. The loss of containment may lead to explosive vapor clouds and environmental pollution.

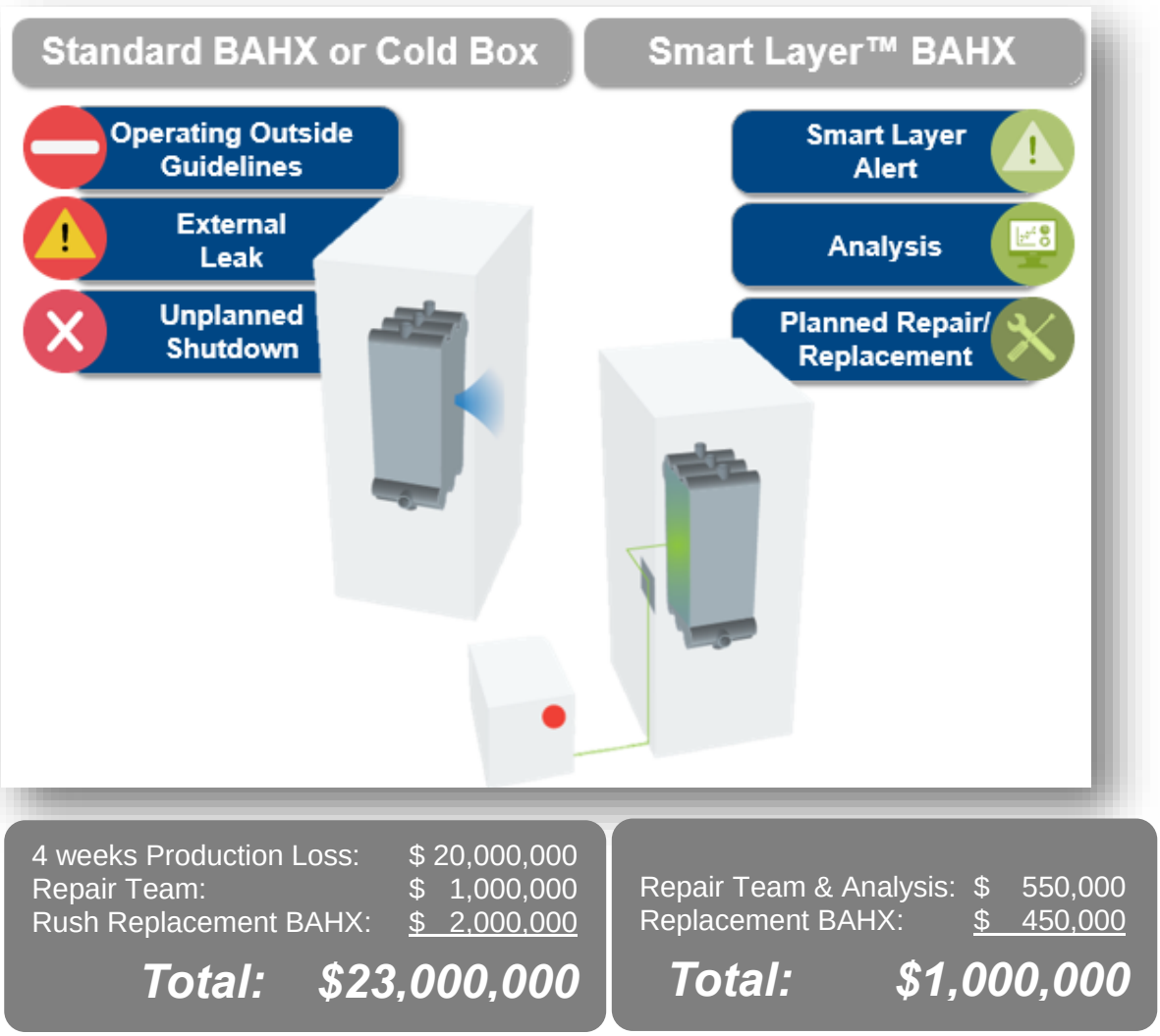
The majority of external leaks are caused by thermal fatigue, which is the accumulation of damage from the stress from varying thermal gradients, specifically operation outside ALPEMA guidelines. The typical presentation of a leak in a BAHX is a small hairline external crack, however, predicting when this will occur is notoriously difficult. Through Smart Layer we're introducing a physical feature that may be applied to most new Chart BAHX to serve as an early warning system to alert operators when continued operation is likely to lead to cracks and loss of containment. This serves as an indication that remedial action is required.

Crucially though, **Smart Layer allows continued operation without loss of containment** for a sufficient period of time until process and control system improvements can be implemented, or BAHX repair or replacement arrangements can be made.

Smart Layer Technology

The premise is that thermal fatigue stress will accumulate in Smart Layer faster than in other parts of the core. Crucially though, damage will manifest in Smart Layer **before** loss of containment occurs and serves as an indication that a significant portion of the life of the BAHX has been consumed.

This early warning gives owners and operators the opportunity to take action through analysis of the operating data to determine the root cause of the damage, followed by appropriate remedial action including adjusting operation to mitigate further damage to the BAHX and making arrangements for repair or replacement. Smart Layer will alert operators to damage without loss of containment having occurred. The BAHX can continue to operate for some period to allow these actions to be completed on a more flexible and convenient schedule.



4 weeks Production Loss:	$ 20,000,000
Repair Team:	$ 1,000,000
Rush Replacement BAHX:	$ 2,000,000
Total:	***$23,000,000***

Repair Team & Analysis:	$ 550,000
Replacement BAHX:	$ 450,000
Total:	***$1,000,000***

Looking at a hypothetical cost scenario**, you can see the clear advantage to the Smart Layer early detection; it avoids costly unplanned production losses and allows for planned, not expedited, repairs or replacements.

The cost of Smart Layer is nominal relative to the overall cost of the exchanger; the added costs include some extra layers and the related hardware such as drains, connecting piping, pressure valves, charging port and so forth. It would also involve additions to the maintenance schedule and start up tasks like extra leak testing. The cost will vary from unit to unit.

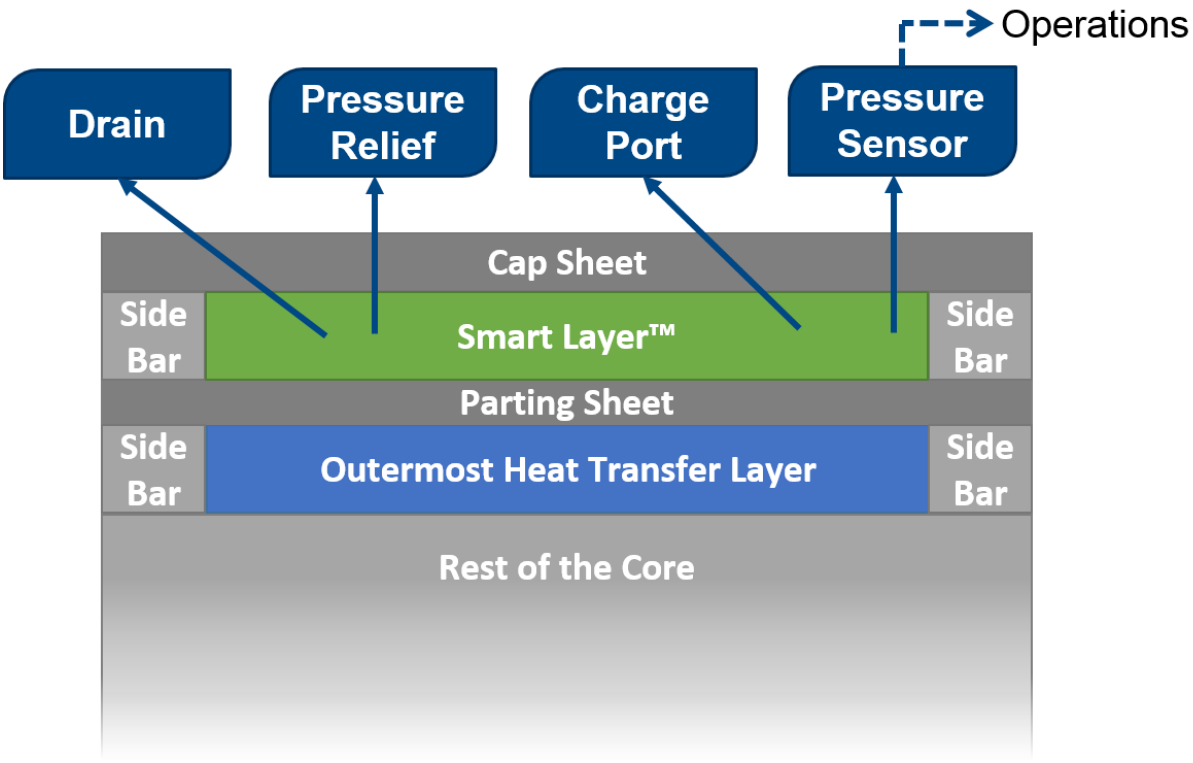
How does Smart Layer work?

Smart Layer is an inactive layer on the top and bottom of a core that has been pressure tested and rated to hold the full operating pressure of the outside active layer that is adjacent to it. Prior to start-up, Smart Layer is pressurized with an inert gas and sealed to create a positive pressure.

Pressure sensors are installed in Smart Layer and integrated into the plant Distributed Control System (DCS) so that the pressure in Smart Layer can be continuously monitored.

Smart Layer has two features that are critical to its design:

- It accumulates fatigue damage faster than the rest of the core
- It provides a way to detect this damage prior to loss of containment of process fluids.



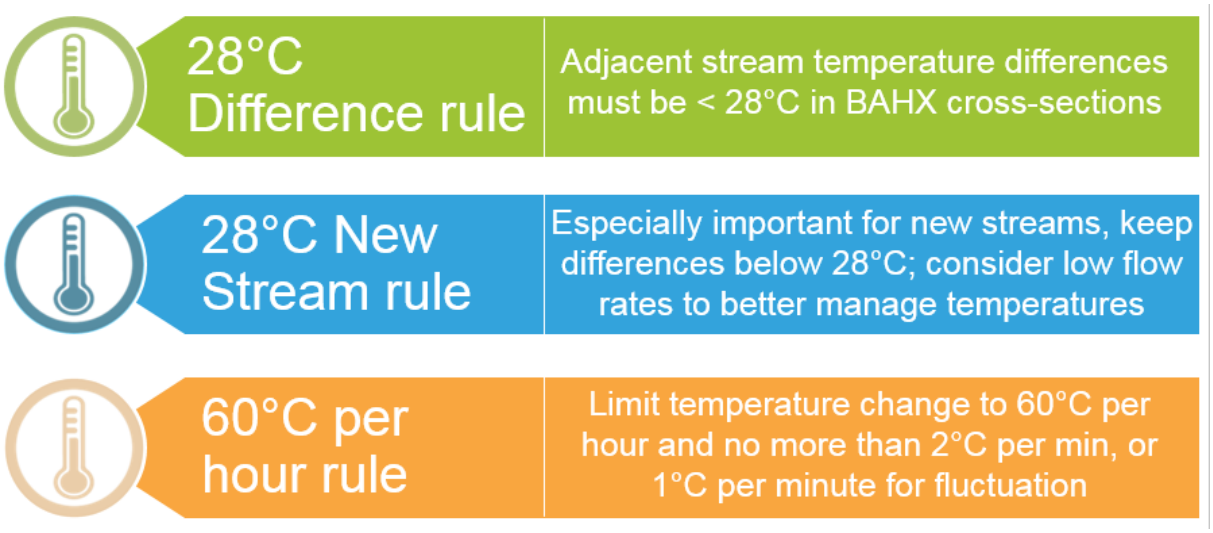
Operation outside ALPEMA guidelines will induce stress and fatigue in Smart Layer, and eventually a crack could form, either on the cap sheet, or on the outside parting sheet separating Smart Layer from the outermost active layer.

If a crack develops through the cap sheet, no containment loss of process fluids will occur, but Smart Layer will lose pressure. This will be detected by a pressure sensor installed in Smart Layer and integrated into the plant DCS system.

If a crack develops through the parting sheet separating Smart Layer from the outermost active stream, the fluid from the active stream will flow through the crack into Smart Layer. This will increase the pressure in Smart Layer and be detected by the pressure sensor. Smart Layer will contain the active stream that has leaked into it because it has been pressure tested and rated to hold full stream pressure and thereby preventing a loss of containment.

In either case, an alert of a pressure change is a good indicator that operating conditions are outside ALPEMA guidelines and damage is happening to the heat exchanger. The Smart Layer alert is an early warning indicating that a critical threshold of damage has been reached, and because this signal was received before loss of containment was experienced, it permits operation to continue unchanged for a limited time. This gives owners and operators the opportunity to investigate root causes and formulate repair or replacement plans without the need for a sudden unexpected shutdown.

Operating Best Practice to avoid thermal fatigue



Replacement

In some instances, full BAHX replacement is the best course of action. After the arrival of the new unit, it can either be installed right away, or kept on-site as a spare until the existing unit develops an external leak.

Conclusion

Consider Smart Layer as your cost effective insurance policy that protects plants against severe loss of production revenue through unplanned shutdowns and the potential for damage to property and life should external leaks go unchecked. Like any protective device, you hope you never need it, but you're mighty relieved it's there if you do and you have peace of mind regardless.

To learn more please contact us at BAHX@ChartIndustries.com

ALPEMA is the Aluminum Plate-Fin Heat Exchanger Manufacturer's Association and produces the standards that are the authoritative reference to all the main aspects of the specification, design, manufacture, purchase and use of BAHX.

****The figures used are for demonstration purposes only and will vary from facility to facility. A source has reported that actual daily cost of an unplanned shutdown at an NGL plant can be in the order of $4MM per day, including loss of $2MM gathering and production revenue. Those figures also exclude costs arising from closing down upstream operations, which can typically follow as a consequence.***