AALBORG CSP

CHANGING ENERGY

with HEAT EXCHANGERS based on

HEADER-AND-COIL TECHNOLOGIES

CHANGING ENERGY
with header-and-coil ***heat exchangers***

To comply with the CSP power plants' critical requirements for cyclic operational time (frequent starts/stops) and high operational steam pressure, the Aalborg CSP header-and-coil type heat exchangers has over the years undergone several performance and price optimization practices with primary focus on reliability and performance. Since introducing Aalborg CPS's heat exchanger using header-and-coil technology to a commercial plant in 2009, it has been optimized to fit both thermal oil, molten salt and water/steam applications.

In 2019, Aalborg CSP celebrates its 10-year anniversary for no leaks. Since 2009, the header-and-coil technology has been operating in Spain without any leakages in the tube bundles contributing to a significantly lower operation and maintenance cost.

We supply the 3rd configuration of our steam generation system for thermal oil CSP plants and the 4th configuration for molten salt CSP plants as well as the oil-to-salt heat exchanger for TES capacity.

The equipment is designed based on traditional power boiler principles providing multiple operational benefits. This design philosophy has proven high reliability and availability in some of the most efficient CSP plants in the world.

Key header-and-coil benefits

RAPID RAMP-UP

LEAKAGE FREE DESIGN

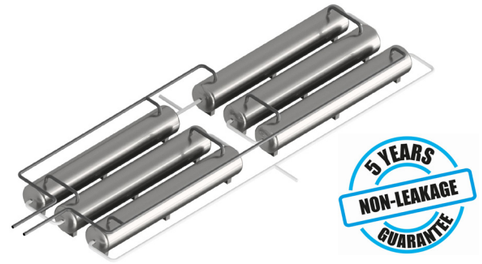
LOW MAINTENANCE REQUIREMENTS

NO FOULING

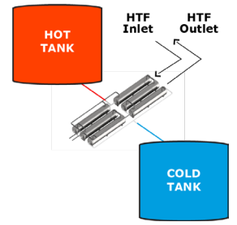
HIGHER ΔT & STEAM TEMPERATURES
with oil-to-salt heat exchanger system

The header-and-coil type oil-to-salt heat exchanger system is based on the exceptional operational experience from the thermal oil and molten salt steam systems and ensures a safe and reliable heat transfer and optimized performance between the hot and cold TES tanks.

The oil-to-salt heat exchangers are based on a proven technology, using thermal oil inside the tube and molten salt on the shell side. The heat exchangers are manufactured based on traditional boiler principles. They are 100% welded header-and-coil type designed according to ASME and EN standards. This contributes to many operational benefits compared to the TEMA standard u-tube type heat exchangers and therefore have the potential to reduce LCOE of CSP plants by up to 5-10%.



The Aalborg CSP header-and-coil oil-to-salt heat exchanger



Due to the full counterflow design of the header-and-coil heat exchanger, an optimized performance across the entire steam cycle can be achieved contributing to a significant cost reduction. During charge and discharge, higher temperatures can be achieved across the steam cycle.

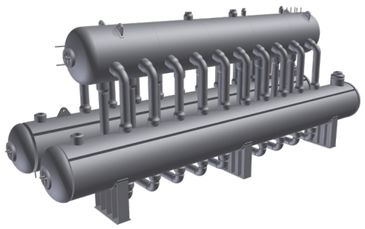
Compared to the TEMA u-tube type heat exchangers, the header-and-coil technology makes it possible to increase the salt temperature of the hot salt tank while simultaneously reducing the salt temperature of the cold tank. By doing so you achieve a high ΔT between the hot and the cold tanks, as the heat exchanger is not limited by the vertical thermal stresses that occurs in the tube sheet. Likewise, it is possible to design the heat exchanger with a lower approach point (below 2 °C) in the thermal energy storage operating mode. The steam cycle optimization can enable a >10% reduction of the required salt volume thereby achieving a significant CAPEX reduction.

ELIMINATING LEAKAGES
in thermal oil plants

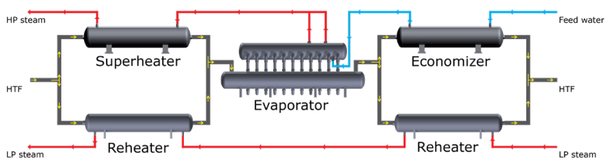
The 3rd configuration of the Aalborg CSP steam generation system, which is securing reliable operation of the Godawari 50MW CSP plant, is developed based on traditional boiler principles (ASME and EN standard header-and-coil type) and not as ordinary heat exchangers (TEMA standard kettle- and shell-and-tube-type).

This contributes to several operational benefits and therefore, has the potential of reducing levelized cost of energy (LCOE) of CSP plants by up to 5-10%:

- fast start-up (up to 10 °C/min)
- guaranteed leakage-free operation
- low maintenance requirements
- natural circulation



Steam Generation System configuration 3 evaporator and steam drum with natural circulation



System layout of a 50MW thermal oil steam generation system consisting of five main components

HIGHER AVAILABILITY
in molten salt plants

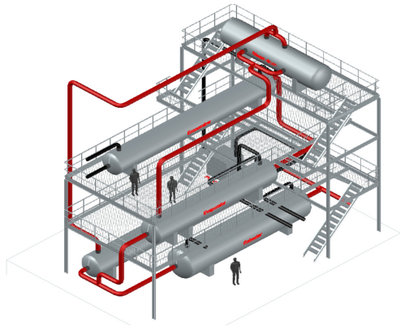
The optimized 4th configuration of Aalborg CSP's steam generation system is based on heat exchangers using the header-and-coil technology complying with ASME and TEMA standards. The most significant feature of the optimized configuration is that it allows all the components to have molten salt on the shell side while maintaining the option of using natural circulation for optimal and stable operation below 140 bar. Furthermore, for the evaporators Aalborg CSP selects a suitable tube material, which can operate with high temperatures sustaining normal blow-down levels during operation. This can translate into operational benefits and up to a €4 million initial capex saving on auxiliary equipment for the steam generation system designed for a 100MWe reference plant. Moreover, it results in lower operation and maintenance costs due to two main reasons:

1. No need for circulation pumps

The natural circulation within the evaporator unit eliminates the use of circulation pumps and the associated initial investment costs. Furthermore, the electricity consumption and the risk for operational failures are significantly reduced.

2. Reduced amount of venting and drain valves

The elevated layout contributes to automatic venting and achieves easy draining as the header-and-coil heat exchangers allow the molten salt to flow by gravity alone. Therefore, there is less need for venting and draining valves, enabling the customers to save costs on auxiliary equipment that would normally be required, which consequently makes operation and maintenance of the plant easier.



Header-and-coil no-leakage design

The header-and-coil technology has been optimized to reduce the cost of equipment utilizing the full counterflow principle, which also eliminates leakage risk as the header-and-coil design absorbs thermal stress. The material selection for the evaporator tubes is optimized to avoid stainless steel corrosion cracking as austenitic stainless steel is not recommended – or even prohibited according to ASME - for water-wetted environments. Combined, these component design optimizations reduce the weight of the equipment significantly and lowers CAPEX of the system by more than 10%.

CHANGING ENERGY
around the world

Aalborg CSP is a leading developer and supplier of innovative renewable technologies aiming to change the way energy is produced today. Relying on extensive experience from some of the most efficient concentrated solar power (CSP) projects around the world, the company designs and delivers green technologies and integrated energy systems to lower the cost of energy for industries and power plants worldwide.

Aalborg CSP places strong focus on R&D activities and partners with knowledge-based companies and institutions to create leading-edge technologies. As a result, the Aalborg CSP engineering design is centred on a value-adding concept providing solutions that excel in operation, increase plant revenue and contribute to a greener future.

Headquartered in Aalborg (Denmark) and with sales & service offices in Spain, the US, Australia and Indonesia, Aalborg CSP has realised more than 1,700MWth cost effective green energy solutions to a variety of industries worldwide.

5 sales & service locations
more than 1,700 MWth solar installations

AALBORG CSP
- Changing Energy

Aalborg CSP A/S | Hjulmagervej 55 | 9000 Aalborg | Denmark
Phone: +45 88 16 88 36 | E-mail: sales@aalborgcsp.com | Web: www.aalborgcsp.com