# COOLED ATTEMPERATORS

## TWO SHIFT OPERATION POWER PLANTS

*Wind, solar power and other renewables energy generation creates a more flexible demand on gas fired power stations to balance the grid.*
*To operate in a reliable, quick, modulating and start/stop regime, some improvements are necessary.*

*To start and stop a CCGT installation takes time. The gas turbine should be warmed through as well as the rest of the power plant, the HRSG, (Heat Recovery Steam Generator) downstream of the gas turbine, the interconnecting steam pipework, the steam turbine and all other balance of plant items.*

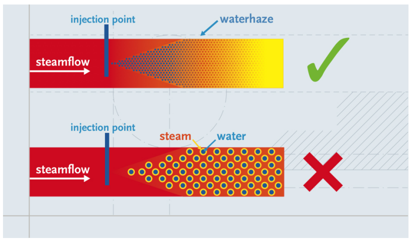
*This should be done as quick as possible to limit the starting costs and to supply as soon as possible to the grid. For all CCGT plants the demand for being reliable and the need to be able to start the installation, to supply to the grid, is the single most important driving factor*

## MOST CRUCIAL

*One of the most crucial components in an installation are the attemperators. The range ability, the capability to atomize the water droplets and to guarantee a good distribution makes the attemperator a installation component which have to be designed and chosen carefully.*

## THE DROPLET SIZE TO BE MAINTAINED AS SMALL AS POSSIBLE.

*The water droplets should be as small as possible. The heat exchanging surface is maximised and quick evaporation guaranteed.*




*Schematics regarding evaporation*

## 1. PRESSURE DROP AT POINT OF INJECTION (PRIMARY ATOMISATION)

## 2. INJECTED INTO A TURBULENT STEAM FLOW (SECONDARY ATOMISATION)

## 3. INJECTED THROUGHOUT THE WHOLE FLOW,

## 4. SUFFICIENT SUPERHEATED TEMPERATURE (MIN 8 °C)

*With these 4 conditions we can control to downstream steam temperature. Other factors influencing the final result are upstream and downstream straight length, the position of temperature transmitters and the water temperature.*

## FROM BASE LOAD TO MODULATING AND START UP OPERATIONS

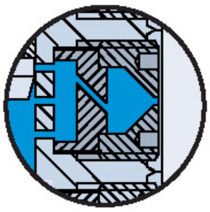
*Changing operating conditions are demanding more from the installed attemperators, HP and HRH bypasses, drains and the main steam valves.*

## *HOW TO CREATE SMALL DROPLETS? THIS REQUIRES ENERGY.*

### *BY MEANS OF A PRESSURE DROP*

*Pressure drop creates small droplets. This pressure drop should take place at the point of injection.*

*By using a spray nozzle, the pressure drop is used to create an additional swirl. If the first nozzle has a small CV value fine cooling can be achieved. Single nozzle coolers are limited in their range ability in these instances.*

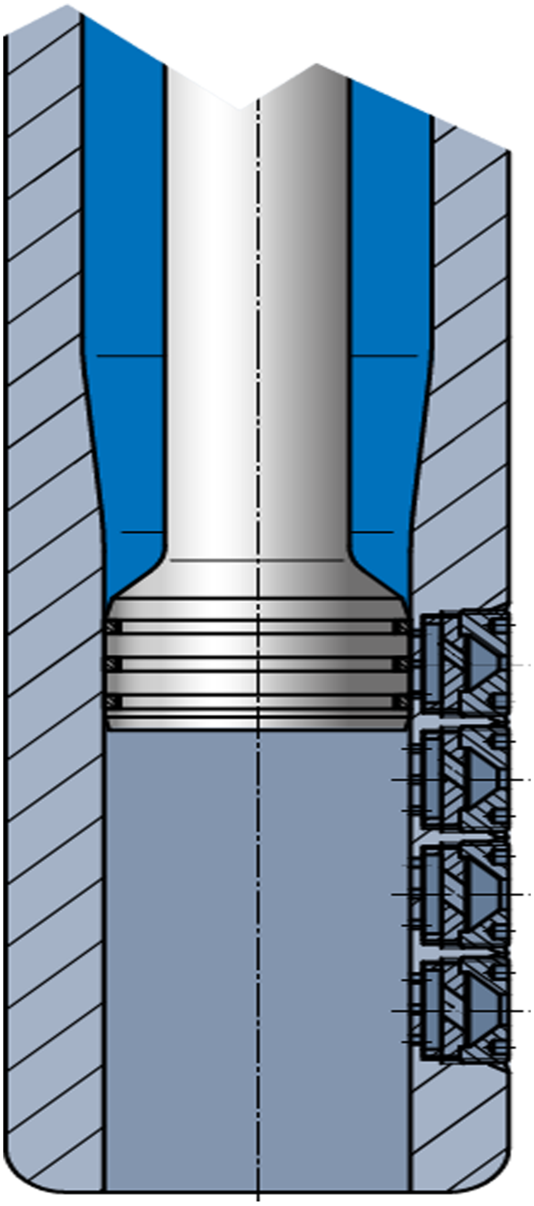


Typical nozzle

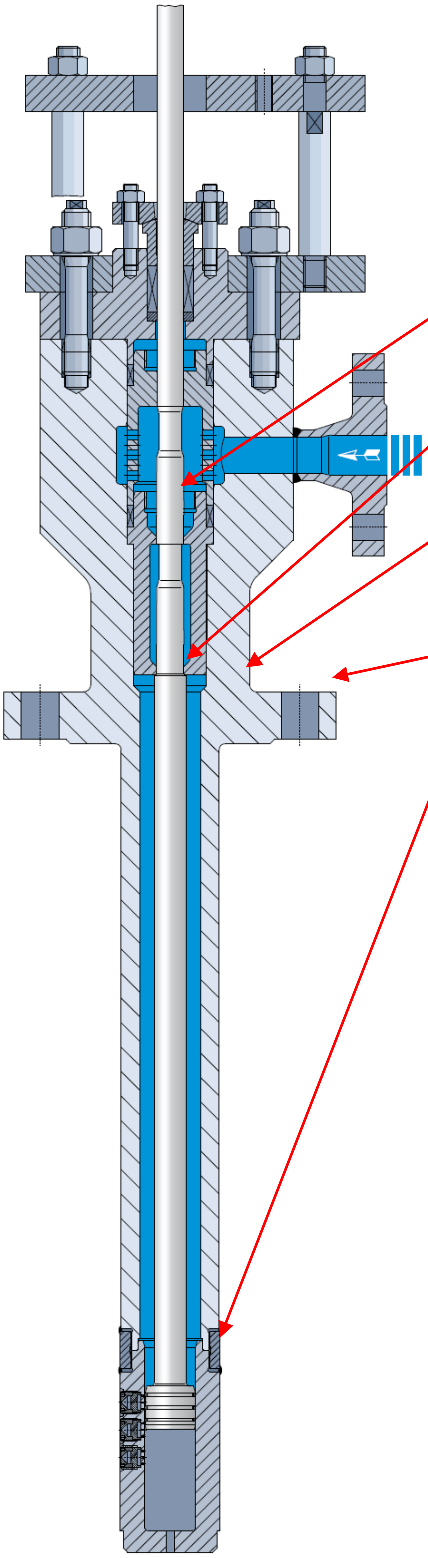
*An attemperator with a nozzle head with a number of nozzles will give the best result. For this design a piston with piston rings opens the nozzles one by one. At a minimum flow only one small nozzle can atomize really small mass flows, at maximum. capacity all nozzles (up to 24) can spray an impressive amount of cooling water. In all cases the water droplet size remains at its optimum.*

*A limitation is found in the pressure drop over the nozzle. Pressure drop creates fine droplets; too much pressure drop creates additional wear and tear. This can be an important issue especially for the hot reheat coolers.*

*HORA attemperators can be provided with one or two additional pressure reducing stages in the top of the valve to guarantee an optimal constant pressure drop over each nozzle.*



## MULTI NOZZLE ATTEMPERATOR



The multi nozzle cooler is based on the use of a set of nozzles that opens one by one. Pushing down the plug will open the different nozzles in turn. A continuous and fine cooling spray based on the correct pressure drop is the result over the full range ability of the attemperator.

### BENEFITS

**1.** If the cooling water pressure is very high it is possible to install additional pressure reducing stages. This feature is designed to maintain an optimum pressure drop over the nozzle.

**2.** **T**he injection water seat is located outside of the hot part of the attemperator.

**3.** The valve body, located in the steam flow, is designed to withstand the bending forces. The body of the valve in a one piece forging and it can be forged in F1, F11, F22 and P91.

**4.** Different connection flanges in EN/DIN and ANSI are available to suit your installation.

**5.** A multi nozzle head with a selection of different nozzle sizes to create the best possible capacity and characteristic.

**6.** The attemperator can be fitted with a pneumatic, an electrical or a hydraulic actuator.

### EXAMPLE

A number of these coolers have been fitted to a coal fired power station in The Netherlands, The coolers, fed from the main feed water pump at 220 barg, are cooling the hot reheat at 50 barg. The 170 bar pressure drop is handled by three control stages and the nozzle head. The coolers are performing very well.

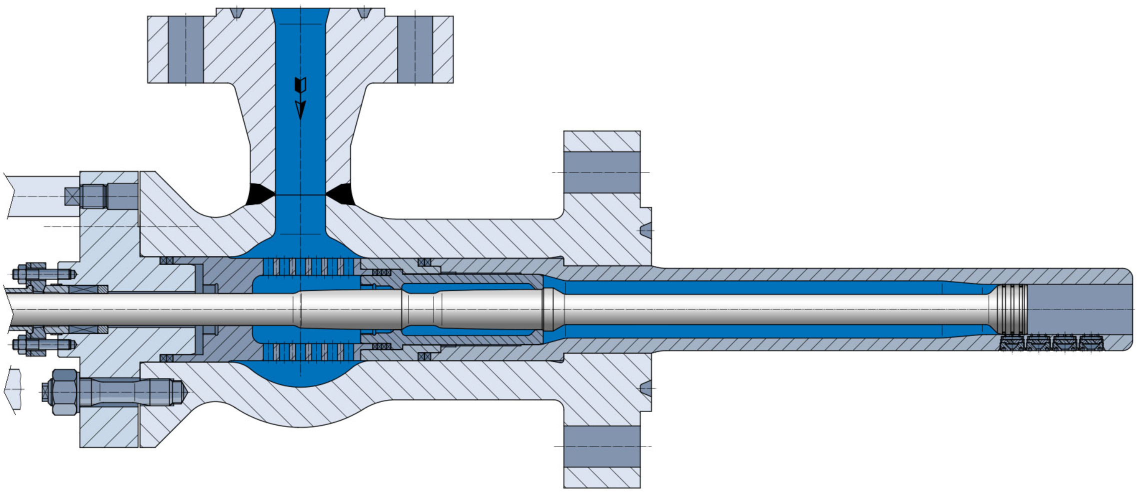
*Standard attemperator with two additional stages, single forged body, Jammed seat and multi nozzle spray head.*

## HIGH CYCLE AND COOLED HIGH CYCLE ATTEMPERATORS

*There are applications for attemperators, both mast type and ring style, in complex situations. An example is an attemperator operating dis-continuously. During start up and shut down or in case of an emergency to protect the main steam lines the attemperator is required to start, the mast will suffer thermal shock and will be damaged. A limited number of cycles can be expected before the fatal damaged will occur.*

### THE HIGHCYCLE DESIGN

*An enormous improvement is made by the design of the high cycle attemperator. In this design the screwed on nozzle head is eliminated and the mast with nozzle is now one piece. The wall is significantly thinner and less venerable for thermal shock.*



*High cycle attemperator*

*This design is a very good improvement.*

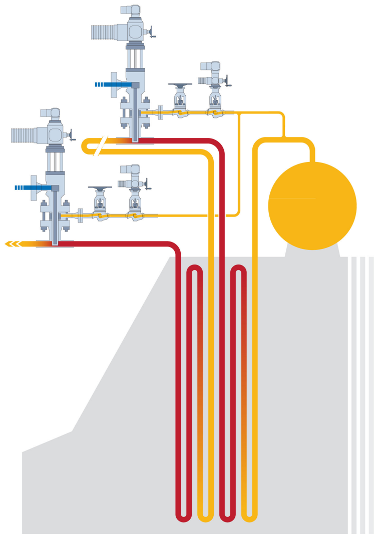
*There are however cases where even this design meets its limits. If an attemperator has to discontinue operate many cycle during a shift, we can offer a better solution:*

### THE SOLUTION

*To avoid thermal stress in the spray style attemperator the temperature differential between the cooling water and the steam temperature should be significantly reduced. By "cooling" the mast with saturated steam, its temperature will reduce and the temperature differential between injection water and attemperator body temperature minimizes, which will not lead to thermal shock. The attemperator is now suitable for numerous starts and stops.*

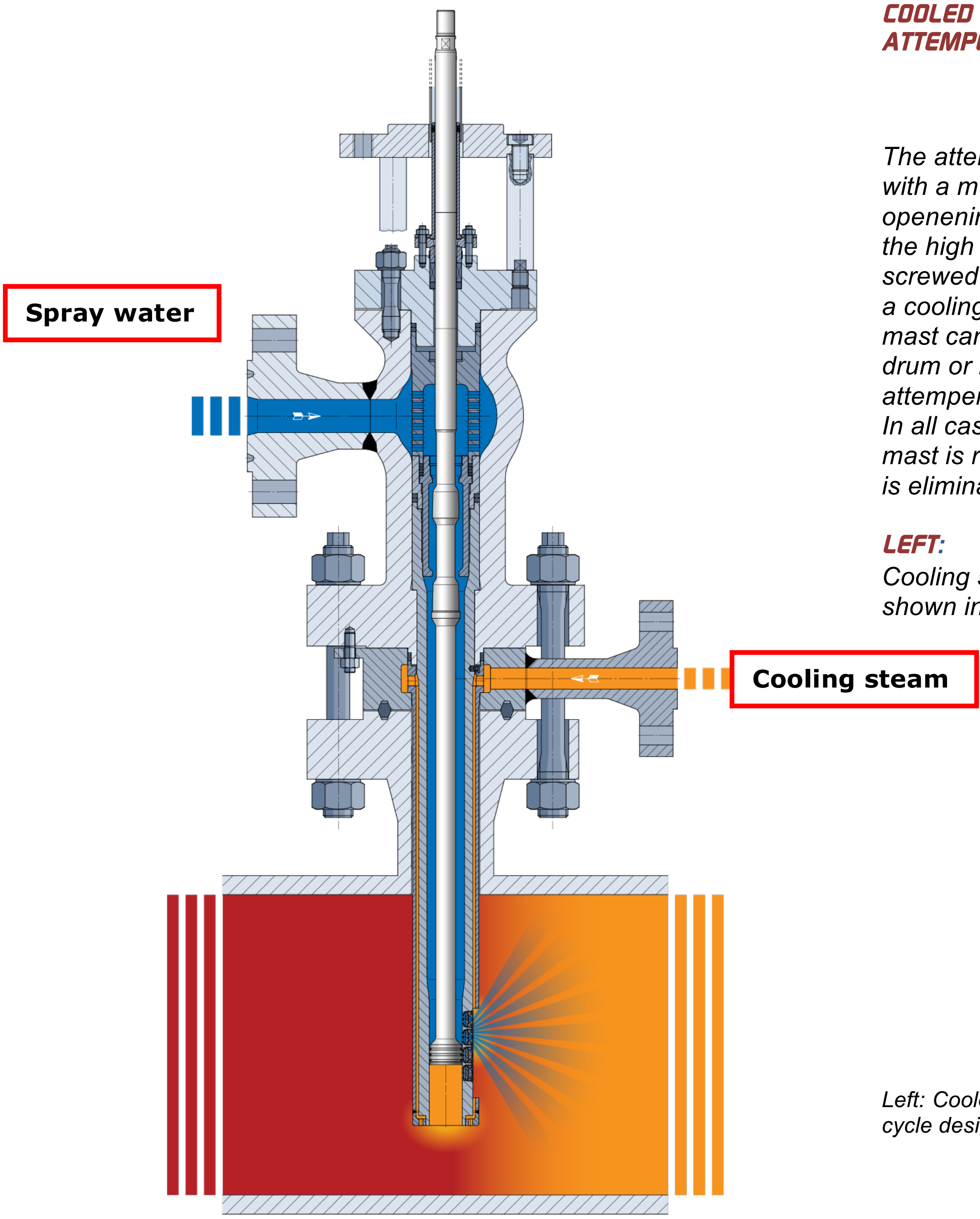
### A LIFE TIME EXPECTANCY OF MORE THAN 25 YEARS OR › 100.000 CYCLES SHOULD BE ACHIEVABLE.

*A limited amount of saturated steam bypasses the super heater and is brought into a "cooling jacket". This steam is cools the valve body, keeping it to the saturated temperature. The saturated steam then leaves the jacket and will mix up with the super-heated steam. The saturated steam flow to the attemperator is controlled by a small control valve and a manual stop check valve.*
*The cooling steam can be extracted from the overflow lines, between drum and superheater. In case of a hot reheat attemperator the cooling steam comes from the cold reheat.*



*Cooling steam, from the overflow line*

## *COOLED HIGH CYCLE ATTEMPERATOR*




*The attemperator is a mast type, with a multi nozzle arrangement, openening in sequence, based on the high cycle design without screwed on nozzle head, fitted with a cooling jacket. Steam to cool the mast can be extracted from the HP drum or in case of a hot reheat attemperator from the cold reheat. In all cases the temperature of the mast is reduced so thermal shock is eliminated.*

***LEFT:***
*Cooling steam flow path shown in yellow*

*Left: Cooled attemperator, based on high cycle design*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