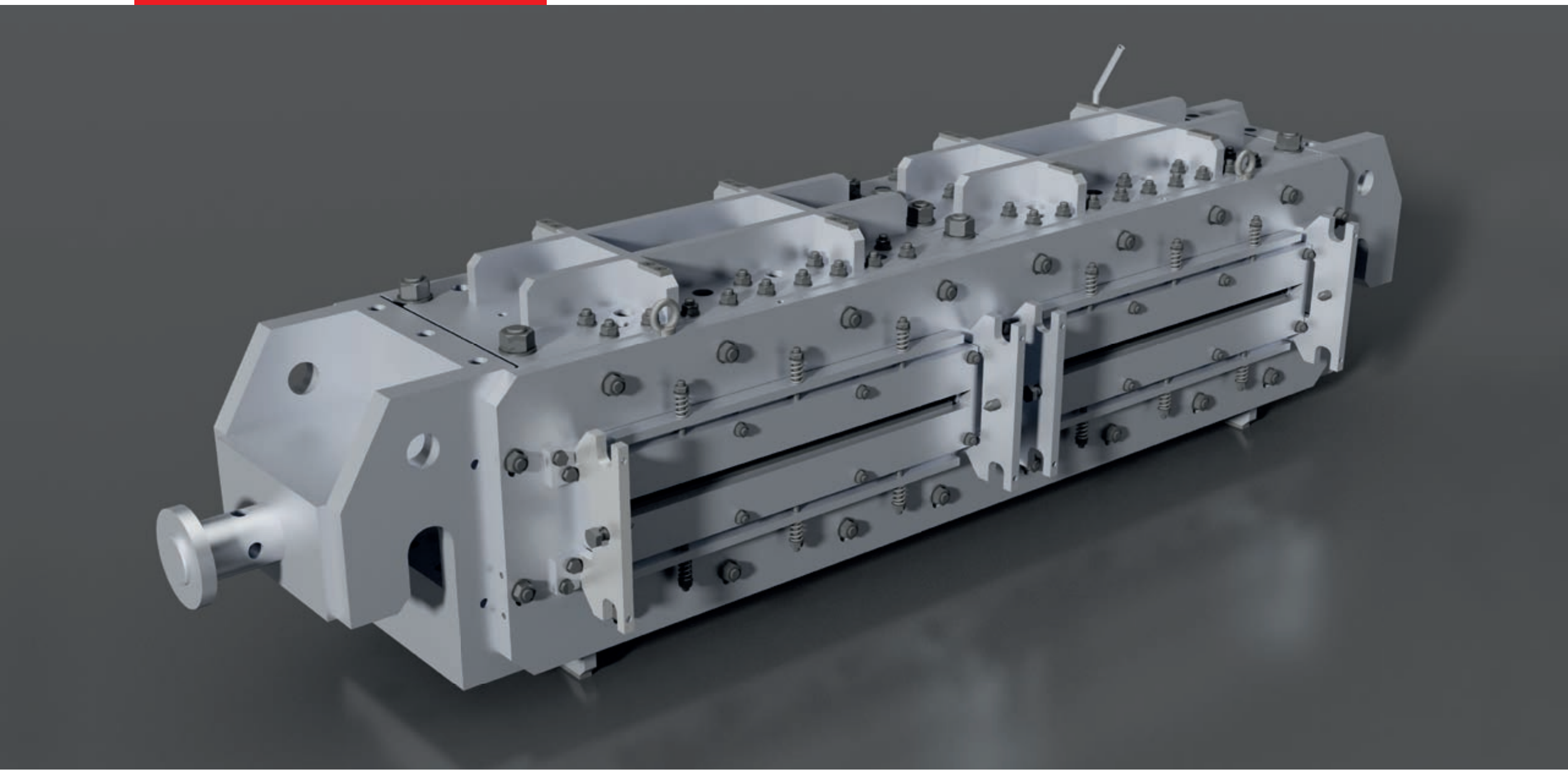


Die assembly

The design and choice of the die material are crucial when it comes to the quality and quantity of the product, as is the technical concept for the cooling system and its compatibility with the die material.

Electro-graphite is used almost exclusively as a die material. Electro-graphite owes its importance to the following special characteristics:

- high thermal conductivity
- minimal wetting by liquid metals
- good gliding properties and sufficient self-lubricating capability
- good wear resistance
- high temperature resistance
- good dimensional stability due to low expansion
- good machinability

There are basically two categories of cooling systems:

- Cooling units for metals with a solidification point such as pure metals (copper, silver, etc.) and short solidification range for low alloyed copper
- Cooling units for metals with long solidification ranges, including phosphor bronze, brass, nickel silver, etc.

Water is generally used as a cooling agent. Primary coolers for strip material usually have several cooling circuits, while coolers for round and square sections usually have only one circuit. Water cooling is based on the counter-current process.

The volume of water in each cooling circuit is controlled on the drain side as a factor of the rise in temperature. The flow rate of the water can also be changed in each cooling section.

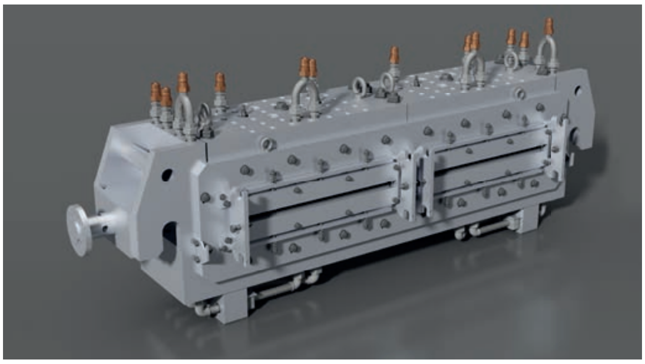
This system allows the cooling to be softer or harder, as well as more even in certain areas and easier to control. The back pressure causes a change of the flow conditions in the cooling gap by influencing the turbulence in the boundary layer that determines the heat transfer. The back pressure in the cooling gap counters local boiling and prevents uneven cooling.

The heat-conducting parts are connected in a special way in order to ensure permanent, excellent heat transfer from the metal over the die to the cooling water. This proven type of connection guarantees optimum yield and reproducible values.

Depending of the mode of operation, the graphite dies have a set service life, with this period being determined primarily by the material being cast, its gas content and temperature.

It is possible to remachine the die material to a certain extent, which means that the service life can be prolonged considerably in some cases.

The inert gas method is preferred for the casting of alloys with a high affinity to oxygen. This largely prevents oxidation of the graphite die and the strand surface and results in a longer service life for the graphite accompanied by increased casting capacity because of the more efficient cooling. Changing a die assembly takes about 60 minutes, depending on the cast size and the number of strands.



New features of the Thöni cooler

All leaks between the copper cooler and the steel frame have been eliminated.

The cooler has a sealed cooling system. The cooler and frame are no longer sealed by a gasket. This ensures that the moisture from the cooling system can no longer penetrate between the graphite and the copper plate.

Mechanical and design changes have been made to the cooler to reduce edge cooling and reverse solidification.

The reduction in edge cooling is achieved in four ways: The first cooling channel on the side has been moved inwards. Heat pockets have been applied on the rear of the graphite plate. The edges of the graphite die are now made of low-conductive carbon/graphite. An insulating layer can be added to the first cooling channel for further reduction of cooling.

If necessary, it is also possible now to modify the junction between the copper and the graphite in order to improve any irregularities in the junction cause by unevenness and air gaps. This guarantees much more even cooling across the width of the strip.

Depending on the degree of cooling, layers of graphite sheet are inserted between the graphite plate and the copper cooler to equalise thermal transfer.
In the case of cold equalisation, helium is introduced between the graphite plate and the copper cooler, thus achieving a better conductivity in the air gaps.

Both methods achieve an equalised thermal transfer in adjacent, different cooling zones.

Warning! Do not use helium in existing or different coolers. The old design is not suitable for this and could lead to serious quality problems.

Thermal stress has been reduced by modifying the steel frame and copper plate.

The coolers consist of different materials with different coefficients of thermal expansion. Introducing an anti-friction layer eliminates the interaction between the materials (steel and copper). The cooling conditions in the steel frame have also been changed in order to match the steel to the expansion of the copper.

The thermal storage capacity of the steel frame has been increased.

The stabilisation of a material depends on a number of factors. An improved and even temperature stability of the operating medium is important in the case of high thermal loads. The storage mass of the cooler has been increased in order to cancel out any temperature variations.

Maintenance costs have been reduced.

Eliminating the gasket between the steel frame and the copper cooler means it is no longer necessary to deassemble the die at regular intervals in order to fit a new gasket.

Using the optional test kit makes it possible to use the cooler for test purposes. Test castings and settings for new alloys can be carried out without problems. The kit also allows additional temperature measurements to be made close to the solidification area.

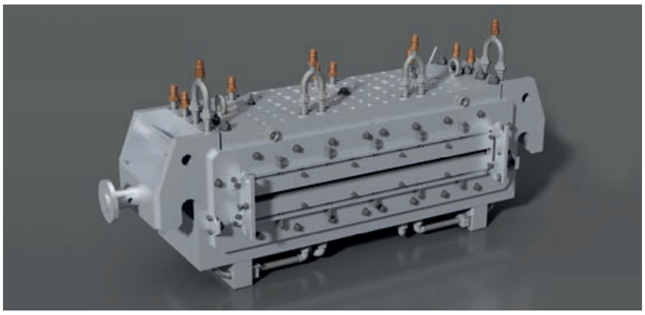
The R&D kit consists of several NiCrNi thermocouples, graphite plate studs with thermocouples, mounting channels and devices for measuring the temperature in the water circuits.

Manipulation of the thermal conductivity of the graphite used can be necessary in some cases.

Graphite with lower thermal conductivity and suitable open porosity can be modified in this cooler by using gas and gas mixtures to saturate and increase its conductivity.

The properties of the cooler are improved considerably in terms of:

- quality stabilisation in the casting
- improved operation
- higher flexibility when it comes to intended use
- increased performance and lower maintenance costs



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Subject to change.