# Q-COOL

## Dynamic secondary cooling technology for continuous slab casters

**BENEFITS**

- **Possibility to install it on existing slab caster plants**
- **Optimized surface quality**
- **Uniform cooling across slab width**
- **Optimal temperatures at slab corners and edges at critical point of unbending and straightening**
- **Lower frequency of surface cracks**
- **Improved internal quality because of even cooling across slab width (no "W" slump or "dog bone")**
- **Fewer rejects on hot-rolled coil / plate**
- **ROI < 1 year**

## PROCESS

Q-COOL is capable of maintaining the strand surface temperature at the target profile, which is necessary to guarantee the surface quality irrespective of the change in casting speed and/or superheat variation. Thanks to the three-dimensional dynamic control, the surface temperature uniformity is guaranteed in longitudinal, transversal and thickness directions, avoiding hot and cold spots that are detrimental to the slab quality.
Q-COOL calculates the estimated product temperature profile and sends this data to the spray-water control system. The spray-water control system checks the Liquid Process Control (LPC) estimated temperatures against the optimal ones, as defined in the technological database for the casting product. The temperature difference is used as a feedback to adjust the spray-water flow rate.

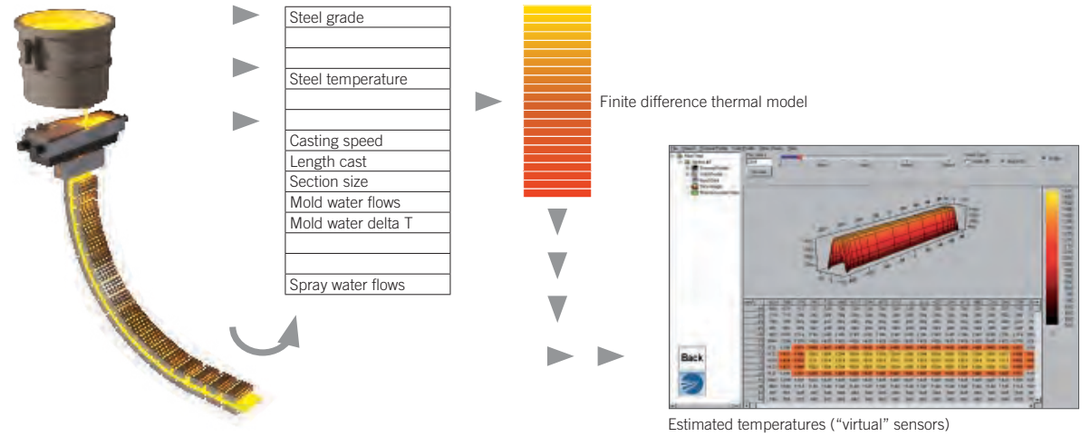
## EQUIPMENT

The Q-COOL model is based on a dynamic 3D mathematical cooling / solidification model, based on a finite-element algorithm, which solves the Fourier heat transmission equation in real time for the material from the meniscus down to the cutting torch.
Q-COOL employs multi-nozzle layouts across the slab width to provide even water distribution (and therefore even heat transfer). The nozzle layouts are offset in alternative roll pitches to ensure spray overlaps do not line up along the length of the caster. To limit over-cooling of the slab corners (especially for micro-alloy grades) the outer wide-side nozzles can have the water turned off dynamically.

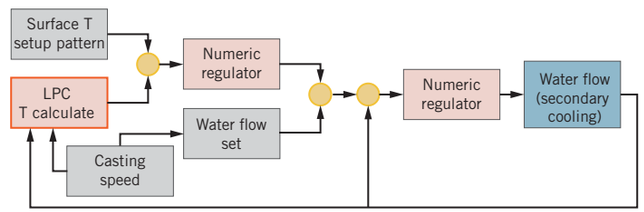
## PROCESS CONTROL

The Q-COOL model is based on a finite-element dynamic 3D cooling /solidification model, which solves the Fourier heat transmission equation in real-time for the material from the meniscus down to the cutting torch.
The casting strand is divided into a finite number of transversal sections.
The estimation of the surface temperatures permits the adequate real-time updating the spray water flows.

**Danieli Automation Q-COOL HMI interface.**




Estimated temperatures ("virtual" sensors)




**Model inputs.**

The estimation of the mushy and the liquid pool length permits the adequate real-time updating the roll gap configuration for the Q-CORE Soft Reduction Control.

The result is a model that, starting from automatically collected caster data, delivers for each slab section an estimated point-by-point temperature which is shown on the HMI in a 2D or 3D model.

Q-COOL calculates the estimated product temperature profile and sends this data to the spray-water control system.

The spray-water control system checks the LPC estimated temperatures against the optimal ones, as defined in the technological database for the casting product.
The temperature difference is used as a feedback to adjust the spray-water flow rate.
Here is shown a typical HMI screen page with core/sides/corner temperature profiles, cooling flow overview and liquid pool data.

## PERFORMANCE ACHIEVEMENTS

The Q-COOL package has been proven to allow a strong reduction in a corner crack length and frequency. By utilizing this technological package Danieli customers are able to control strand surface temperature through the critical unbending zone in excess of 950 °C.
Thanks to the Q-COOL system it is possible to improve the slab quality.
In a normal condition without the system is necessary to scarf the four corners;
if we assume a standard slab dimension (thickness: 250 mm; width: 1,800 mm) we normally have a loss of 0.53%, on a plant with 1 Mtpy of production. Assuming net cost 150 Euro/t of slab the total loss per year is 795,000 Euro.
Reduced cost of scarfing in terms of scarfing machine running time and maintenance, the total saving per year is approximately 700,000 Euro.
Moreover, with Q-COOL hard cooling practices can be implemented, which have proven particularly beneficial when casting boron-treated steels.