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Simulation of transient temperature and solidification evolution in a continuously cast slab using multiple transverse sections

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Accurate prediction of the temperature distribution in continuously cast steel slabs is critical for maintaining product quality and mitigating defects such as cracks and segregation. Mathematical modeling serves as a fundamental tool for investigation of the dynamics of temperature and solidification front evolution during the process.

A two-dimensional computational model is presented for transient temperature distribution and solidification during the continuous slab-casting process, encompassing both the mold and strand. Full understanding of the complete transient three-dimensional distributions is achieved by simultaneous tracking of multiple transverse strand sections.

The model solves the transient heat transfer equation, incorporating solidification via the Stefan equation to track the solidification front position as an internal boundary. An explicit finite difference method is employed to discretize and solve the equations. To enhance accuracy in fixed cross-section approximation, interpolation techniques utilizing historical temperature data are implemented.

The software system provides a detailed spatial representation of the evolving temperature distribution in transverse cross sections, both as they move with strand and at fixed positions below the meniscus in the mold. It allows evaluation of casting speed variations and secondary cooling parameters, including the spatial arrangement of water nozzles, nozzle types, and spray water flow rates, on strand temperature evolution and shell growth dynamics.

Examples are presented to showcase this computational model and software tool for researchers and engineers to investigate heat transfer and solidification in steel continuous casting.

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