EXPERIMENTAL STUDIES OF THE HEAT EXCHANGE BETWEEN THE WATER FILM AND THE CASTING ROLLER IN THE THERMAL PRECONDITIONING CHAMBER

Pereselkov A.R., Krugliakova O.V.
National Technical University «Kharkiv Polytechnic Institute», Kharkiv

When the casting roller is cooled or heated in the preconditioning chamber the water is supplied to its surface by flat-jet nozzles.

Operating costs for the roll thermal preparation depend on the processing time and the water consumption. However, it has been experimentally found that it is practically impossible to reduce the cooling or heating time of the roller body. The reason of it is that the temperature change along the roller body radius is influenced by the thermal conductivity factor much greater then by convection on roller body surface under the thermal preparation parameters. Or, in other words, thermal conductivity is the determining factor for the conjugate heat-exchange problem for the roller at Bio criterion values exceeding 20 that corresponds to the heat transfer coefficient of 2000 $W/(m^2 \cdot K)$. In this case, when using flat-jet nozzles to sprinkle the roller, it is sufficient to provide quite low spray rate of around 1–2 $mm^3/(mm^2 \cdot s)$. A further increase in the specific water rate, as well as its nonuniformity for in the sprinkling zones, does not affect the heat treatment time of the roller, resulting only in an excessive water consumption.

Therefore, the objective of this study is a possibility of water consumption reducing to cut down operating costs during the roller heat treatment.

The first part of the study was to investigate a rational flat-jet nozzles arrangement in relation to the roller surface to form a proper combination of different areas on the surface that is sprinkling areas and that under the spreading water film.

Taking into account the total impact of the inertial and gravitational forces, it was found that the optimal nozzle set corresponds to the vertical sprinkling areas, while a water film is completely spread between the areas.

Experiments have shown that the water film rate of flow is between 0.3 and 1.5 m/s.

The next research stage was to investigate the intensity of heat transfer for the areas with the spreading water film in relation with the film flow rate and the roller surface temperature.

Having the roll surface temperature fixed it was showed that the heat transfer coefficients are considerable even at low film rate of flow.

Based on the experiment data, a generalizing correlation was derived to show the relation between the bulk heat transfer coefficient, the film flow rate and the cooled surface temperature.

The obtained research data can be used for the rational arrangement of the collectors and flat-jet nozzles in casting roller preconditioning chambers to reduce the cold and hot water consumption and cut down operating costs.