The Analysis of the Conditions of Flow in the Tundish Performed by a Numerical and Physical Method

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Introduction: Studies of the liquid metal movement (hydrodynamic) in a real object (tundish) are substantially precluded due to the objective difficulties (high temperature and the size of metallurgical equipment), compared to their execution by the use of physical and numerical modeling. In presented study, two test methods for analyzing the flow and mixing of the liquid steel in the tundish were used. The calculation of fluid flow through the tundish was carried out using the COMSOL Multiphysics program.

Computational Methods: Two-stages numerical procedure „Segregated" was used to solve the equations. In the first stage (Segregated Step 1) the equations of „Velocity Field and Pressure" were solved, whereas in the second stage (Segregated Step 2) the equations of "Turbulent Kinetic Energy and Turbulent Dissipation Rate".
Calculations „Step 1" were conducted in the transient state „Time Dependent Procedure" till reaching the process time t=360 s. Calculations (Step 2) were carried out through 2000s assuming: „Initial values concentration" c_0 = 0 mol/m^3, diffusion coefficient D_c =1e-9 m^2/s.

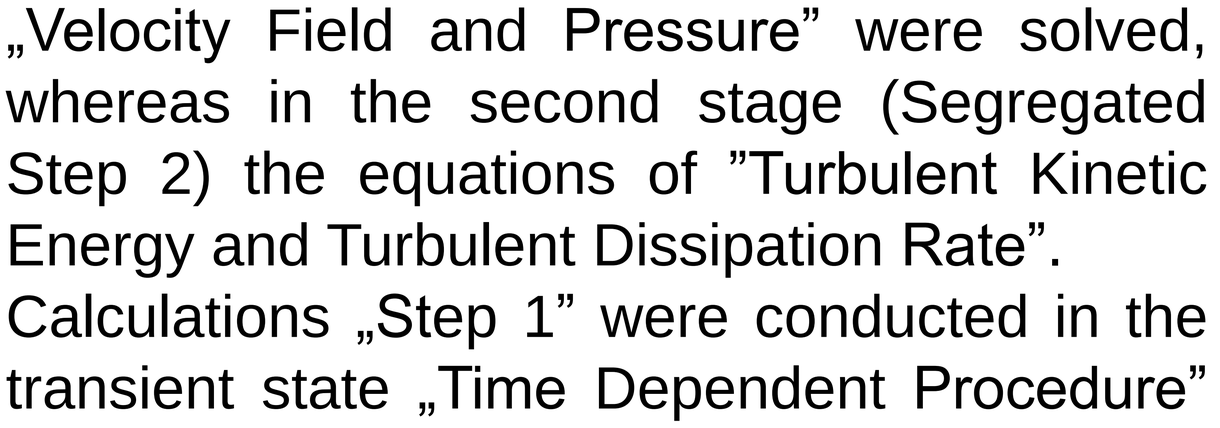

Figure 1. a) Scheme of the tundish, b) The test stand of CSC plant water model

Results: The forecasted variations in the dimensionless tracer concentrations is shown in Figures 2 and 3. Figure 4a shows mixing curve (F –type) for the tundish outlet (CFD and physical model). Figure 4b presents non-dimensional RTD curve (E-type).

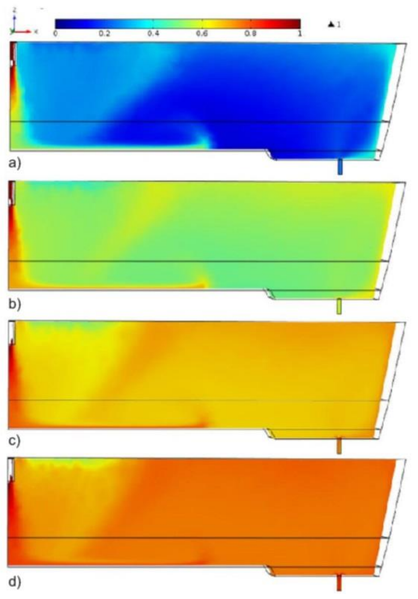

Figure 2. Isoconcentration lines of the tracer at : a) 100 s, b) 300s, c) 500s, d) 800s

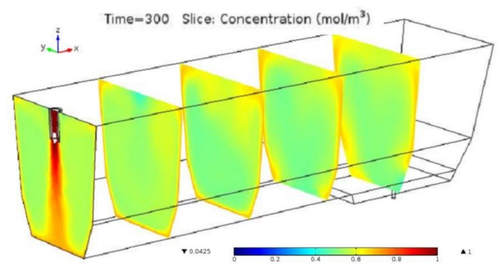

Figure 3. Isoconcentration lines of the tracer at the 300 s

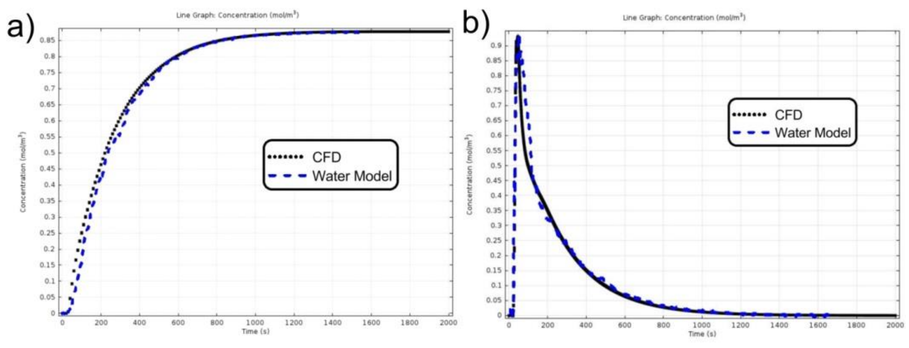

Figure 4. RTD characteristics from water model and CFD calculations: a) F –type, b) E-type

Table 1. The transient zone in the range of 0.2 to 0.8 of the max. concentration

Parameter	The transient zone [s]	
	CFD	Water model
0.2÷0.8	521.5	505.5

Conclusions: The carried out research gave important information about the working condition of industrial tundish. The analysis of obtained results showed that in the examined tundish are unfavorable phenomena taking into account the mixing and the steel flow. They are caused by the characteristic channel geometry of the working zone of the tundish.