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Mathematical Model of Melt Cooling Process in Iron Ladle

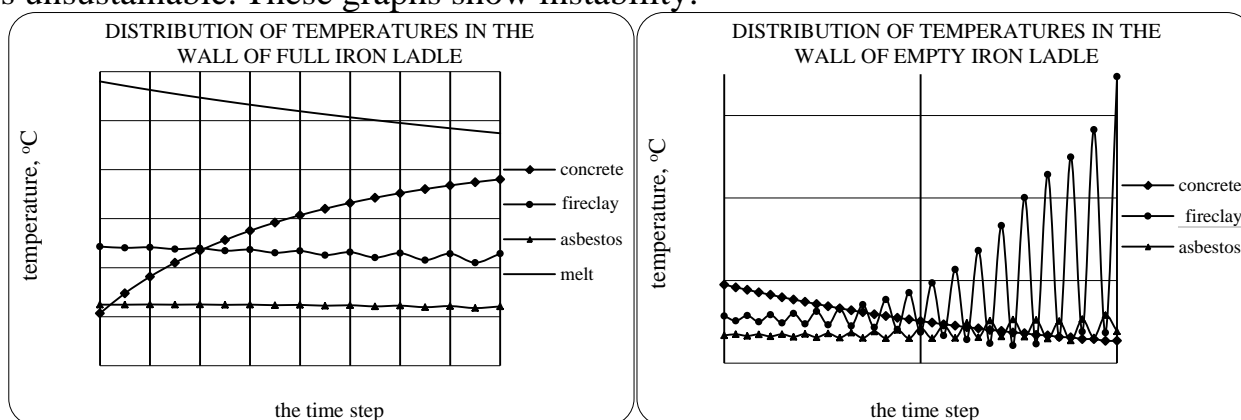
This work is the study of heat exchange process during iron ladle transportation. Ladle with iron is transported by railway from the blast furnace to the steelmaking plant and returns empty. Average ladle turnover time is 296 minutes. Transportation of full iron ladle – 96 minutes, and the empty ladle – 200 minutes.

One of the key parameters is the temperature of the iron which should be controlled during the technological operations with iron ladle. Temperature of iron reduces when it moves between bays. This fact influences the additional costs for heating iron in a mixer and the final cost of the end cast iron. Cooling of iron is due to heat loss through the side of the bucket, the bottom, and the radiation from the surface of the pig iron mirror. Iron ladle is lined by such thermal insulation materials as: concrete, fireclay, asbestos. Thickness of insulation is 170mm.

The purpose of the research is to determine heat loss, as well as temperature changes of pig iron and ladle during their movement for further prediction of heat loss and to develop measures for reducing loss of melt heat.

Method of modeling – study of phenomena by the models is one of the basic modern researches. A task is nonstationary. To solve this problem one of the numerical methods – method of finite differences by the explicit and implicit difference scheme was used. Essence of this method is to replace derivatives by finite differences of separate points in the differential equation. At the first stage of the study number of assumptions was made: complex form of ladle was replaced by simple geometric – cylinder; real ladle sizes were replaced by equivalent; bottom of iron ladle was not taken into consideration; thermo-physical properties of thermal insulation and melt are assumed constant; ambient temperature – constant also.

Calculation method of finite differences by the explicit scheme showed that it is unsustainable. These graphs show instability.



Therefore, method of finite differences by the implicit scheme was used. It has several advantages over the explicit scheme.