COMPUTER-AIDED CALCULATION OF THE INGOT TEMPERATURE IN A PRESSURE CASTING MOLD

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The dimensional precision of ingots produced by pressure casting depends essentially on the mold and ingot temperatures at the instant when the latter is being removed. The ingot temperature can be regulated only by varying the length of time the ingot is held in the mold and it becomes necessary, for this purpose, to know the temperature–time relation.

The problem of ingot cooling is considered here with proper account taken of the gaseous clearance between ingot and mold during cyclical operation. A solution has been obtained with the following assumptions.

1. Both ingot and mold are treated as infinitely large plates.
2. There is no temperature drop across the ingot thickness.
3. Each cycle of mold operation consists of four stages: relieving the liquid metal of superheat, solidification, cooling the ingot in the mold, and cooling the empty mold.
4. During the first two stages only a film of lubrication separates the ingot from the mold. During the third stage there forms an additional gaseous clearance whose width depends on the ingot temperature.
5. The initial mold temperature is assumed first equal to the ambient temperature and then increasing from cycle to cycle until thermal equilibrium has been reached.

The problem is formulated in terms of the differential Fourier equation with a nonlinear boundary condition on the left-hand side. It is solved by the implicit four-point finite-differences method. A numerical solution has been obtained with the aid of a digital computer using the iteration procedure with various combinations of initial parameter values.

It has been found that the computed time–temperature curves for an ingot can be expressed within a 1% accuracy by an empirical formula of the following kind:

$$T_{\text{M}} = \frac{A}{\sqrt{\text{Fo}}} + B,$$

where T_M is the referred ingot temperature; Fo is the Fourier number for the mold; and A and B are empirical constants to be determined graphically as function of the consecutive cycle number.

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