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OPTIMIZING THE DESIGN AND OUTER DIMENSIONS OF THE SEALING REFRIGERATOR USING COMPUTER MODELING TECHNOLOGIES

The results of computer simulation of solidification of steel castings in a metal mold using outdoor refrigerator presented. Influence of design features and material for outdoor refrigerator sealing process castings and die from carbon tool steel is defined.

Design, outdoor refrigerator, modeling, system simulation of casting processes «Polygon», solidification, sealing.

Introduction. One of the major structural components of the device for gas injection in the implementation of the gas-dynamic effects on the solidifying metal casting or ingot outer sealing a refrigerator. The shape, size, material and weight of this refrigerator has a direct influence on the duration and effectiveness of the entire process of gas-dynamic effects.

Analysis of previous publications. The developed technology may be used to produce castings of different configurations, made of different alloys [1 – 4]. For implementation of the process device used structurally tailored molding method, the configuration and mass of the casting material. In this case, all variants of the device suggest a principal elements such as gas pipeline, refrigerator and control system supply of compressed gas (fig. 1). After pouring the metal into the mold on the metal surface is dipped into the melt and the refrigerator produce shutter during a period of time required for the passage of the casting process, the sealing device for gas injection. Compressed gas is then fed. Thus, the liquid metal is cast and solidifies from the external gas source is adjustable pressure until complete solidification. Process occurs when sealing the casting due to the formation on the outer surface of the layer of solidified metal of such thickness that allows for gas-dynamic effects without the risk of breaking the sealing crust created under the influence of gas pressure within the casting.

Urgent task is to determine the thermo-time parameters of the casting process sealing device for gas injection and the degree of influence of external refrigerator [5 – 7]. This is possible when using the results of experimental studies (thermoelectric or pouring liquid residue), as well as in computer simulations that the most promising and effective.

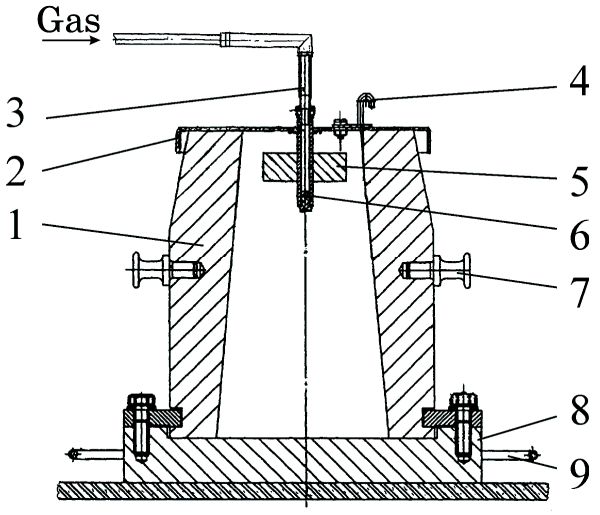

Fig. 1. Schema of the refrigerator with a disk-shaped (plate)
1 – mold, 2 – cover, 3 – gas pipeline, 4 – valve, 5 – fridge,
6 – removable gas supply pipe, 7 – pin, 8 – pan, 9 – staples

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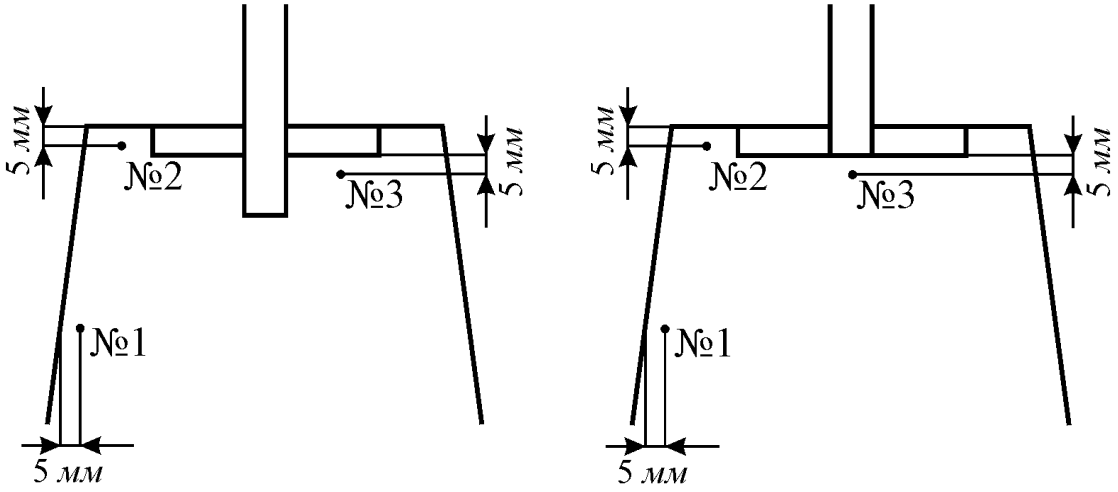
Therefore the **aim of the work is** a computer simulation sealing cylindrical castings of steel 35Л and Х18Ф1Л variations in design and material for the outer fridge.

Main material research. Modeling was performed using computer modeling of casting processes «Polygon». Material steel refrigerator was *35Л* and steel *Х18Ф1Л* respectively. Fridge diameter of 100 mm, 200 mm and 300 mm. Each of the diameters correspond to the thickness of 10 mm, 20 mm and 30 mm. The initial temperature of the refrigerator: steel *35Л* – 400 ^{o}C, steel *Х18Ф1Л* – 350 ^{o}C.

Virtual thermocouples (fig. 2) allow us to study the process of solidification of the melt to determine the degrees of influence size refrigerator, its design features and thermal properties of thermal insulating

material inserts on the sealing process. Thus, the determined location of the casting in which solidification will take place more or less intensely.



a b

Fig. 2. Scheme metal refrigerator on gas supply pipe (a) and the body of the refrigerator with thermal insulating insert (b), and the location of virtual thermocouples (№ № 1 – 3)

For designs with an insert of insulating material the thickness of the refrigerator taken equal to 30 mm with a thickness of insulation material 10 and 25 mm. Materials for the insulating inserts and their heat conductivity are shown in table.

Table

Heaters and their thermal conductivity

№	Material	Thermal conductivity, $(W/\mathrm{m}\,K)$
1	The two-component molding sand fly	0,35
2	Dry sand molding sand (10% clay)	1,28
3	Fireclay high alumina	5,40

On the solidification process is significantly affected by surface area of the metal, lockable refrigerator with the same thickness and the same insulation material: the larger the diameter, the longer the temperature of the metal is stored under the refrigerator, especially when used in insulation compared with its absence (fig. 3, 4). Labels T1, T2, T3 are indicated on the graphs curves corresponding thermocouples № № 1,2,3 respectively.

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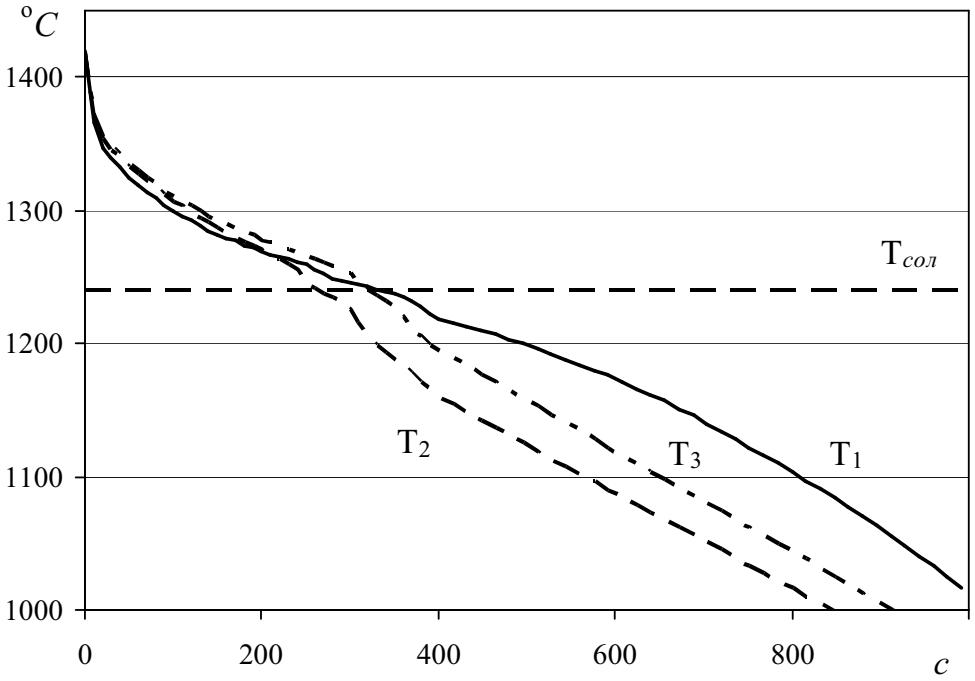

Fig. 3. Cooling curves of steel castings in Х18Ф1Л locations thermocouples number number 1 - 3 using the all-metal refrigerator $\varnothing 100$ mm, $h = 10$ mm

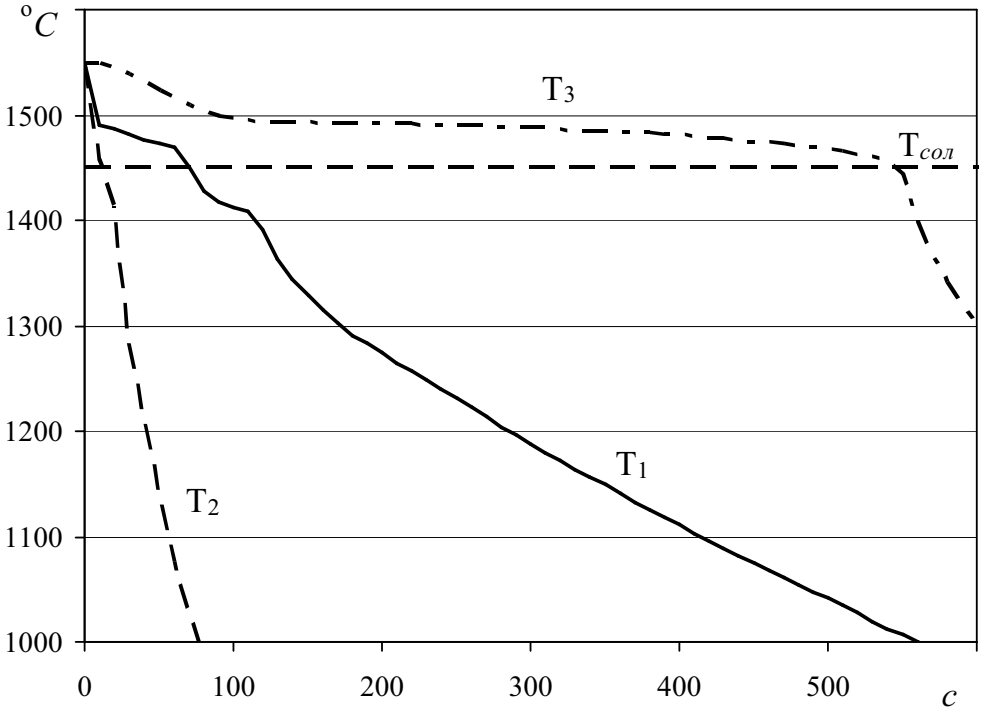

Fig. 4. Cooling curves of steel castings in 35Л locations thermocouples number 1 - 3 using the refrigerator $\varnothing 200$ *мм*, $h = 10$ mm, with an insulator 1 $b = 25$ mm

In the simulation result, it was found that by choosing the design of the refrigerator and with the necessary insulating insert thermal

characteristics can be controlled within wide limits kinetics of solidification of the casting metal. Visualize the results of the calculation of the solidification process of castings and die from carbon tool steel using different design outdoor refrigerators clearly confirm this (fig. 5, 6).

These figures 3 – 6 show a significant difference in the time of solidification of the melt in the case of a refrigerator for use as insulation in a two fly moldable mixture compared to other materials. This reduces the overhead metal loss due to freezing of the surface of the refrigerator, but also significantly improve the thermal regime and solidification of the gas-dynamic effects.

Conclusions

1. The simulation process of sealing the cylindrical form casting of steel 35Л, Х18Ф1Л shake out the chill in the steel with all-metal and composite outdoor refrigerator 100 mm diameter 150 mm, 200 mm, 10 mm, 20 mm and 30 mm with rubber insulating materials with different thermal conductivity thickness 10 mm and 25 mm. Found that choosing a design and a refrigerator box with the necessary thermal insulation thermal characteristics can be adjusted over a wide range of solidification kinetics of metal casting.

2. It has been established that the process of molding sealing device for gas injection is the most effective if the gas supply to the moment on the inner surface of the refrigerator, which covers the mirror metal absent accretion of metal casting, wherein, during solidification of the melt in the gap between the refrigerator and the side surface of the working the mold cavity should be minimal and correspond to the time of formation of solidified metal layer on the rest of the surface area of the casting.

3. Modeling «Polygon» sealing process in the die castings average diameter of 240 mm and a height of 350 - 370 mm and die from carbon tool steel showed the benefits of using a combined outdoor refrigerator with inserts of different insulating materials in comparison with tselnometalevim fridge, as well as efficiency developed a two-component composition of insulation fly moldable mixture with low thermal conductivity (0.35 $(W/\mathrm{m}\,K)$). This helps reduce the metal content of the refrigerator at 20 – 40% while reducing its dimensions, which in turn reduces the metal content of the device for gas injection.

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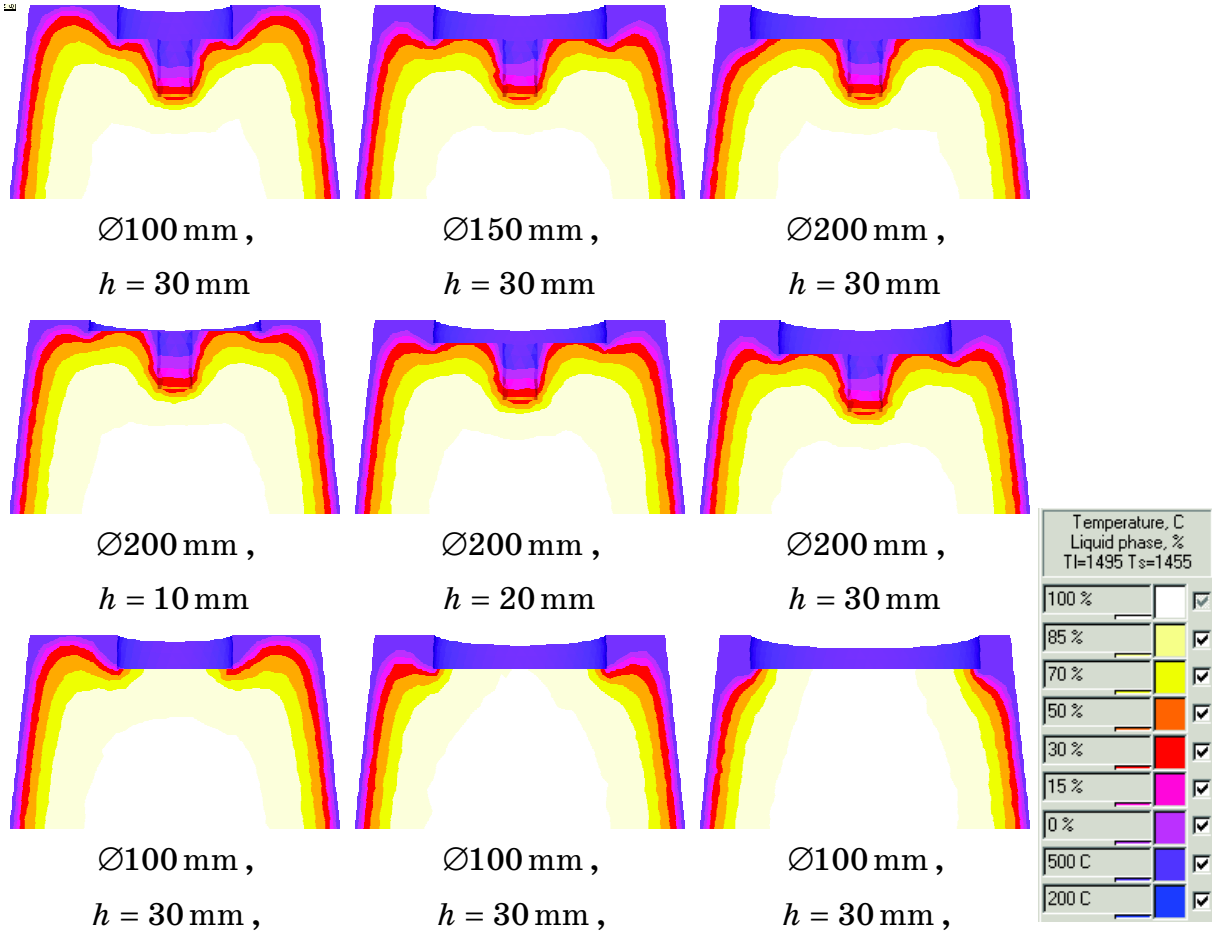


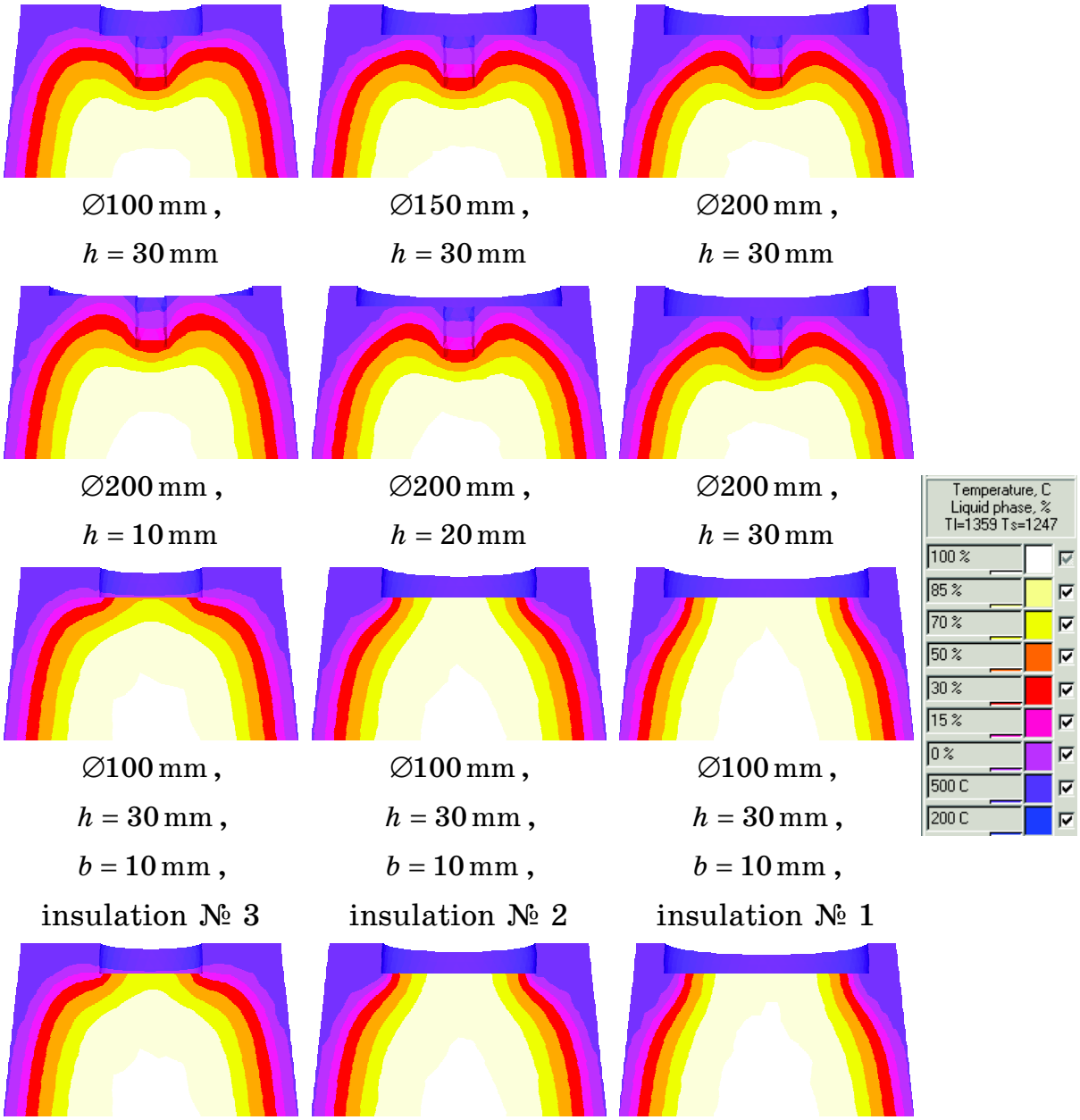
∅100 mm, h = 30 mm | ∅150 mm, h = 30 mm | ∅200 mm, h = 30 mm

∅200 mm, h = 10 mm | ∅200 mm, h = 20 mm | ∅200 mm, h = 30 mm

∅100 mm, h = 30 mm, b = 10 mm, insulation № 3 | ∅100 mm, h = 30 mm, b = 10 mm, insulation № 2 | ∅100 mm, h = 30 mm, b = 10 mm, insulation № 1

∅100 mm, h = 30 mm, b = 25 mm, insulation № 3 | ∅100 mm, h = 30 mm, b = 25 mm, insulation № 2 | ∅100 mm, h = 30 mm, b = 25 mm, insulation № 1

Fig. 5. The temperature distribution in the cross section steel 35Л castings at sealing (80 seconds of the end of the fill) in diameter and thickness variation (h) outdoor refrigerator, as well as the presence (or absence) of insulation layer (b)



∅100 mm, h = 30 mm | ∅150 mm, h = 30 mm | ∅200 mm, h = 30 mm

∅200 mm, h = 10 mm | ∅200 mm, h = 20 mm | ∅200 mm, h = 30 mm

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∅100 mm, h = 30 mm, b = 25 mm, insulation № 3 | ∅100 mm, h = 30 mm, b = 25 mm, insulation № 2 | ∅100 mm, h = 30 mm, b = 25 mm, insulation № 1

Fig. 6. The temperature distribution in the cross section steel *Х18Ф1Л* castings at sealing (300 seconds of the end of the fill) in diameter and thickness variation (h) outdoor refrigerator, as well as the presence (or absence) of insulation layer (b)

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