ASK METALLURGY

MOLD INOCULATION MACHINE MOLDED – with cast blanks

Application method for machine-molded castings

Technical properties & economic benefits

- Inoculation amount coordinated to casting mass
- Subsiding effect practically zero
- Very good dissolution behavior
- Improvement of the mechanical properties
- Increased process stability and quality

Properties

- Casting weights up to 220 kg
- Inoculant: approx. 0.10 %
- Usual casting temperatures: 1.370 – 1.410 °C.

Basic Considerations

During mold inoculation, the inoculation treatment occurs within the gating system or in the sprue with the aim of suppressing the solidification after the metastable system and influencing the graphite precipitation in a targeted manner. In this regard, the dissolving behavior, composition and dissolution time of the mold inoculant are of crucial importance.

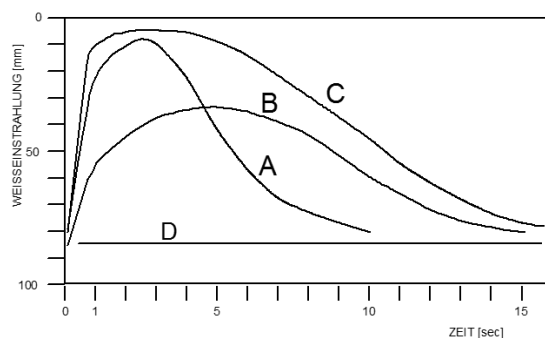Figure 1 schematically shows the significance of these influence variables for mold inoculation:

Figure 1: Chill in the casting wedge

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Inoculant A:
Rapid dissolving and intense, but only short-lasting inoculation effect.

Inoculant B:
Slow dissolving and moderate inoculation effect over a longer term.

Inoculant C:
Optimal inoculant with rapid dissolving commencement and max. inoculation effect during the entire casting time.

Line D:
Without mold inoculant

Application method for machine-molded castings with horizontal box division

The results of the mold inoculation shown in Figure 1 curve C can be achieved in practice by using monolithic blanks with definite analyses (GERMALLOY, OPTIGRAN).

The use of these blanks in the foundry for more than two decades has shown that as a result of the optimal inoculation effect, a quality improvement not achievable with any other product can be obtained if the process engineering described below is observed in all points.

In the gating system shown (Figure 2), the cross section graduation from gate cross section E to run cross section L1 to run cross section L2 to the total of all ingate cross sections A is specified at the ratio 5:4:8:3. This causes congestion of the inflowing iron at two points in the gating system without using a casting filter. The first congestion in run 1 behind the inoculant space is intended to prevent an intake of air and enable a short dwell time in the inoculant space for the iron.

The second congestion, which occurs in the ingate cross sections, serves to ensure that the high slag run remains filled with iron, if possible from the start of casting – irrespective of the casting height – thus enabling it to fulfill its task as a slag separator.

The iron guidance in the mold is also significant, i.e. slag particles carried along and dissolving or not yet dissolved inoculant particles must be able to be easily separated. The run (L1) is therefore initially located in the lower box and is guided in the upper box as a slag run (L2).

The deflection in the transition from L1 to L2 occurs at an angle of approx. 45°. The cross section in the transition corresponds to the cross section in run 1.

A minimum spacing of approx. 100 mm to the first ingate must be complied with. The gating system described is suitable for casting weights of around 10 to around 200 kg per mold box.

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The following generally applies: The shorter run L2 is, the longer the dwell time of the liquid iron should be in run L2, or: The longer run L2 is, the shorter the dwell time of the liquid iron can be in run L2.
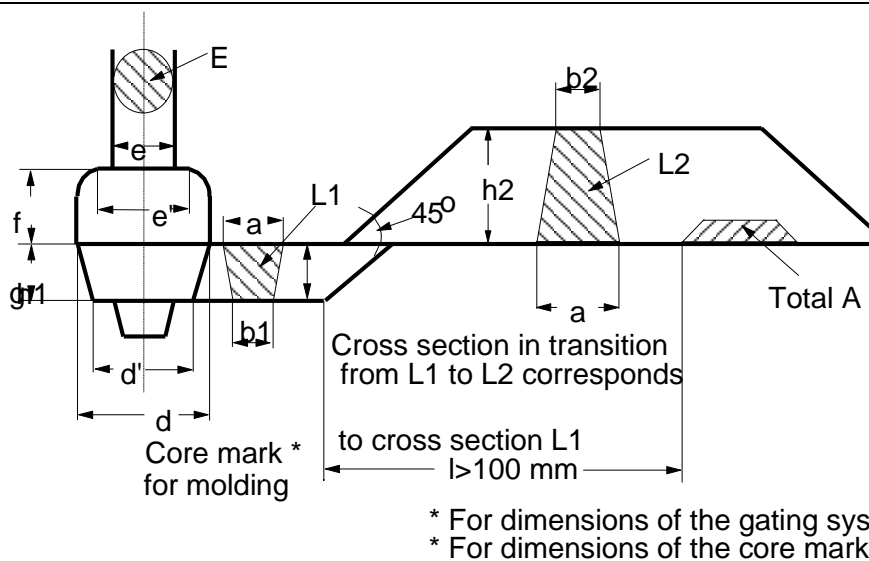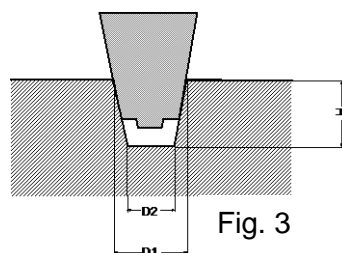
The gating system for the mold inoculation

Figure 2: Gating system for the mold inoculation

Anchoring the blank in a core mark

The prerequisite for the uniform dissolution of a cast blank during

the entire casting time is its anchoring in a suitable core mark in the casting system (Figure 3).

Fig. 3

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Dimensions of the core mark in mm:

Blank	K 15	K 20	K 40	K 60	K 80	K 110	K 150	K 200
D1 Ø	18.7	20.5	24.5	27.1	30.8	30.9	37.5	40.0
D2 Ø	16.4	19.1	22.0	26.3	27.8	25.6	34.3	36.3
H	18.0	15.6	17.8	23.1	24.3	27.0	28.3	34.4

The core mark can be located in the gate pouring basin or in the lower box centrally below the gate. Placing the blank without anchoring in a core mark does not yield any reproducible inoculation effects. Moreover, there is the risk that the blank can then find its way into the run and possibly the mold without having dissolved in part.

Gating system for vertical box partition

Owing to the fundamentally different casting system for vertical box partition, the gating system described on page 1 and 2 cannot be applied here.

When retooling the model equipment to mold inoculation, placing the inoculant on a filter has proven effective.

Dissolution time of the blank

The use of a blank with definite dissolution time into the core mark is determined by the ascertained casting time of the casting. The surface of the blank projecting out of the core mark must be dimensioned so that the dissolution time of the cast blank is ideally equal to the casting time of the mold.

The practical application involves a procedure whereby a blank is chosen whose dissolution time is somewhat longer than the casting time as, especially when casting from mobile ladles, minor differences in the casting time are possible, depending on the filling level of the ladle.

The above dissolution times of the blanks K 15 to K 200 apply for a casting temperature of 1.370 °C – 1.410 °C. For thin-walled castings, the casting temperature should be 1.410 °C or higher depending on the wall thickness.

Selection of the blank

The blank is selected using the diagram "Selecting the K Blanks" shown in Figure 4.

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If the casting time of the mold is 12 sec., for example, the blank K 40 must be used according to Figure 4. At 13 seconds, its dissolution time is somewhat longer than the familiar casting time. This therefore ensures that the total inflowing amount of iron is sufficiently inoculated.

At a casting time of 17 sec., blank K 80 provides a blank whose dissolution time is just as long as the casting time of the mold. A good inoculation in the mold is ensured in this case as well. Compliance with these criteria results in an inoculation amount of approx. 0.1 %.
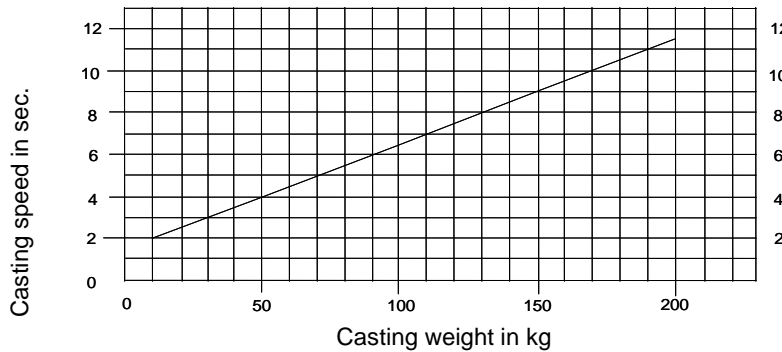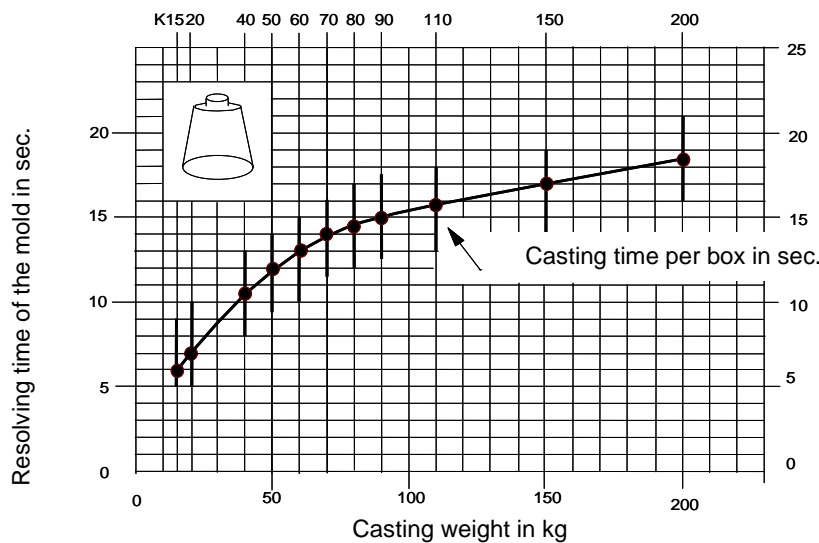
Mold inoculant process:
Casting time per box and resolution time of K-moldings as per Mr. K.-H. Kleemann

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Calculation and determination of the gating system

The first step is the exact determination of the casting weight (kg) including circuit material. The associated casting time is taken from Figure 4. This is followed by calculation of the requisite ingate cross section, with which the predetermined casting time can be complied with.

The following formula 1) applies for calculation of the ingate cross sections:

$$\sum A = \frac{22{,}6 * G}{\gamma * t * \xi \sqrt{h}} \quad (cm2)$$

Here:

$\sum A$	= total ingates (cm^2)
G	= casting weight (kg)
γ	= spec. gravity of the liquid iron (depending on analysis and temperature 6.8 – 7.0 g/cm^3)
t	= specified casting time (sec.)
h	= casting height (cm) or spacing between ingate level and metal level in the gate pouring basin or ladle spout
ξ	= speed factor
22.6	= factor resulting from the acceleration due to gravity with the dimension (sec * $cm^{-1/2}$)

The "speed factor" expresses the flow losses for various types of gating systems and also depends on the casting temperature. Every foundry should subsequently determine this factor for its conditions at comparably gated castings. The following value can be used for calculation before empirical values are available:

Data for the "speed factor" is provided 1) for casting temperatures of 1.370 – 1.410 °C:

Falling casting	= 0.80 – 0.85
Side casting once bent at right angles	= 0.65 – 0.70
Side casting multiply bent at right angles	= 0.55 – 0.60
Rising casting	= 0.35 – 0.50

The ingate cross section determined in this way is then used to find the associated cross sections and dimensions for the remaining elements of the gating system from the following table:

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Dimensions of the gating systems for casting weights from 10 kg to 200 kg																						
Gate			Inoculation space					Run 1				Run 2 *				Ingate cross sections ** for number of ingots			
Casting weights kg	$\varnothing$ mm	Cross section mm²	mm					Cross section mm²	Dimensions mm			Cross section mm²	Dimensions mm			mm²			
	e	E	d$\varnothing$	d'$\varnothing$	f	e'$\varnothing$	g	L_1	a	b_1	h_1	L_2	a	b_2	h_2	1	2	3	4
To 15	20	315	50	40	25	35	18	235	16	10	18	490	16	12	35	190	100	70	-
To 30	25	490	50	40	25	35	20	400	25	15	20	800	25	15	40	300	150	100	-
To 50	30	710	50	40	25	35	22	550	30	20	22	1120	30	15	50	420	210	140	105
To 80	35	960	75	65	30	55	25	750	35	25	25	1520	35	20	55	580	290	200	150
To 120	40	1260	75	65	30	55	30	1050	40	30	30	1950	40	25	60	750	380	250	190
To 200	45	1590	75	65	30	55	35	1310	45	30	35	2440	45	30	65	950	475	320	240

* In general, the following applies for run L2 : h2 = a + b2
** In the case of above-average intense congestion in the ingate cross section
e.g. caused by cores, the ingate cross sections must be increased by approx.
10 – 20 %

1) from: Atlas zur Anschnitt- und Speisertechnik für Gusseisen by A. Holzmüller, L. Kucharcik, edited by VDG, Gießerei-Verlag, Düsseldorf 1969

The following framework analyses apply for the cast GERMALLOY and OPTIGRAN blanks

GERMALLOY   OPTIGRAN

% Si   68 – 76   % Si   68 – 76
% Al   3.2 – 4.5 *)   % Al   0.8 – 1.8
% Ca   0.3 – 1.5   % Ca   0.3 – 1.4
% Mg   traces   % Mn   3.5 – 4.5
% Cer-MM   traces   % Mg   traces
% Fe   residual   % Cer-MM   traces
                                % Fe   residual

*) on request also separate analyses

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Sizes

- K 15, K20, K40, K60, K 80, K 110, K 150 and K 200

Quality Control

As part of the quality control, the analysis values of the molten metal of the cast blanks is determined, saved and evaluated.

A label is attached to each packing unit. This contains the data on the content, sorting and testing.

The dimensional inspection is conducted regularly by the checking the so-called "immersion depth". A gauge whose sizes D1, D2 and H are identical to the dimensions of the core marks is used to check whether the specified fit of the blank in the core mark is ensured.

Advice

The Technical Service of ASK Metallurgy GmbH is available for all questions associated with the application technology, the calculation of the casting systems and temperatures as well as the selection of the blanks.

Packaging, identification and storage

GERMALLOY and OPTIGRAN are usually packed in vats at 100 kg or cartons at 20 kg. The packaging is identified by clearly legible lettering in the model colors of the corresponding casting materials:

Inoculant:	GERMALLOY	OPTIGRAN
Application:	Mold inoculant for cast iron with nodular graphite	Mold inoculant for cast iron with lamellar graphite
Color code:	Purple	Red

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The inoculants must be stored in dry and ventilated rooms and protected against moisture and humidity. They must not be brought into contact with acids or acid fumes. Our Shipment Handling department can provide further information. GERMALLOY and OPTIGRAN are not a hazardous substance as defined by transport regulations.