

Mold Inoculation

with Cast Blanks

Mold Inoculation

Germalloy® blanks for GJS castings

Optigran® blanks for GJL castings

SMW blanks for GJS

Application method for medium-sized and large castings

The use of cast, monolithic molds with definite analyses (Germalloy and Optigran) in the foundry has demonstrated for more than three decades that a quality improvement unattainable with any other product can be achieved as a result of the optimal inoculation effect.

In addition to the two Germalloy and Optigran mold types, the SMW blanks for GJS, if used optimally and in combination with Germalloy, make it possible to restrict or totally prevent the occurrence of chunky graphite.¹ An optimal inoculation effect can be achieved if the process engineering described below is observed in all points, depending on the gating system. The mold inoculation offers the following positive effects:

- The inoculation is coordinated fairly accurately to the casting mass
- The subsidence effect of the inoculation is practically zero
- The dissolution of the inoculant occurs under air exclusion
- The mold inoculation increases the number of graphite spheres or promotes a fine A-graphite formation for GJL
- Production of GJS-400-15 or GJS-400-18 or GJS-400-18-LT or GJS-400-18-RT in the cast state is possible by increasing the ferrite content (saving thermal treatment processes)
- The formation of segregations is counteracted
- The mold inoculation is advantageous for feeder-free casting

Mold inoculation block method with inoculant blocks in the casting box or pouring basin

For medium-sized and large castings, the arrangement of the inoculant blocks in the casting box or pouring basin is available if using the mold inoculation block method, although an arrangement in the direct vicinity of the downpipe is to be avoided (Figure 1 and Figure 2).

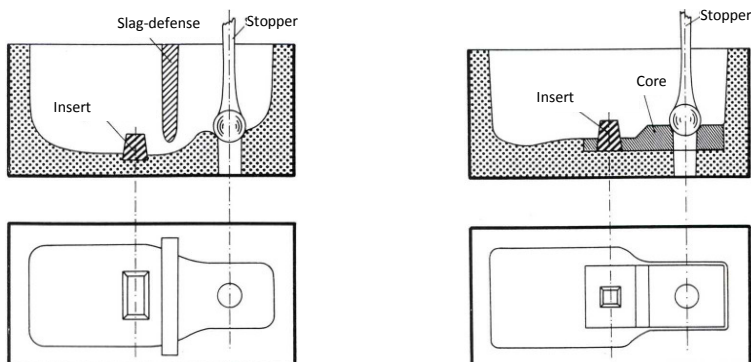


Figure 1: Casting box with slag weir

Figure 2: Casting box with inserted core

¹If SMW blanks are used, the Application Engineering department of ASK Chemicals Metallurgy GmbH must be consulted.

Technical properties & economic benefits

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

Properties

- Capacity of the casting box: 20 – 30% of the liquid iron volume
- Inoculant amount: approx. 0.20%
- Molten metal blanks: 1210 – 1240°C



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The volumetric capacity of the casting boxes should be big enough that the iron comes to rest despite rapid casting and no suction effect occurs. Likewise, the casting box must be able to be kept permanently full for the available casting performance of the ladle. It would be advantageous if the volumetric capacity of the casting boxes is over-dimensioned. The dimensioning of the casting pouring basin is highly significant for the success of the mold inoculation method. Its dimensions are oriented to the total cross-section of the sprues. The casting pouring basin is also a component of the gating system. The volumetric capacity of the casting pouring basin should be min. 20 – 30% of the amount of iron to be cast.

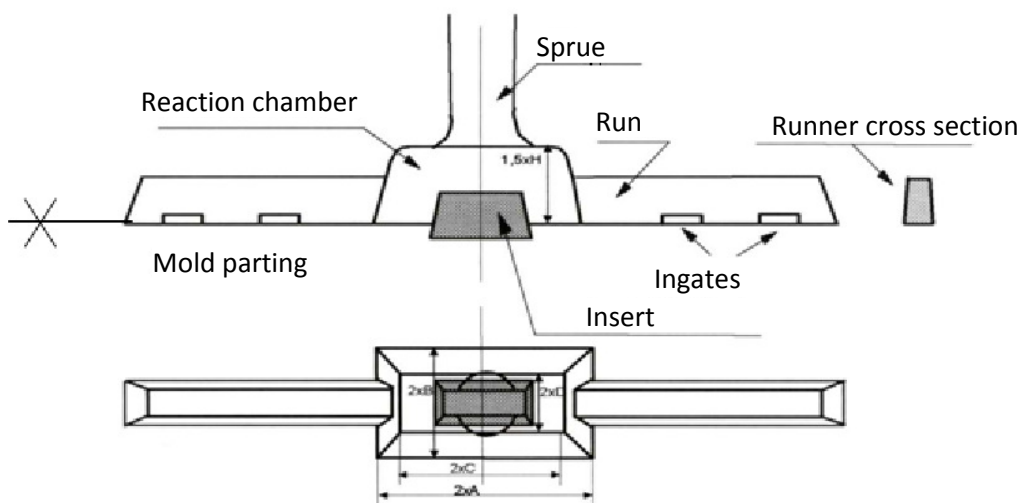
Casting with stoppers and converters has proven effective, i.e. the sprue is closed with a ball-shaped stopper and opened after the casting box has been filled. In the case of smaller and medium-sized castings, the sprues can also be closed with a steel plate. The thickness of the plate must be such that it only melts through after the casting box has been filled.

If the casting pouring basin is lined with cold-resin-bound sand, the blank will be molded so that it is anchored after hardening of the sand (swallowtail principle). In this working technique, the large base area of the pyramid-stump-shaped blank is embedded in the sand, whereby it has to be ensured that the blank stands freely in the casting box with 2/3 of its height.

If working with a “slag weir”, the inoculant block must be molded, as shown in Figure 1.

Arrangement of the inoculant blocks on the base of the sprue in the transition to the run

This method is available for medium-sized and large casting if an arrangement of the inoculant blocks in the casting box or casting pouring basin cannot be performed for certain reasons. The inoculant is flushed well by liquid iron there as well and becomes dissolved under air exclusion. The runs are trapezoidal and the ingates flat in design. The spacing of the first ingates from the inoculant space must be minimum 120 mm (see Figure 3).



The dimensions for the reaction room can be found in Figure 4 (the dimensions of the blank are to be used in place of the letters).

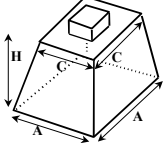
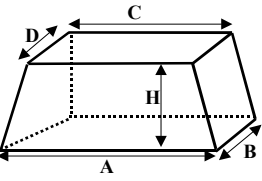
	Blank	A	B	C	D	H
	P 300	50		30		60
	P 500	60		32		69
	P 800	79		35		83
	P 2	165	75	133	45	75
	P 5	221	101	170	53	110
	P 10	260	135	210	85	140
	P 15	330	150	295	120	120
	P 20	310	170	260	115	165
	P 30	350	195	295	135	190
	P 50	340	250	270	175	250

Figure 4: Dimensions of the P blanks (mm)

Two gating systems separate from one another can also be used, if e.g. the casting is cast with two ladles. In this case, an inoculant block must be used for each gate.

Inoculant quantity, casting time, casting temperature, dissolution times of the blanks and choice of blanks

The following points must be observed when mold inoculation is used in the manual casting area:

- Inoculant quantity to be used
- Casting time
- Casting temperature
- Dissolution times of the blanks
- Selection and positioning of the necessary blanks

Amount of inoculant

The amount of inoculant should be approximately 0.2 percent by weight for Germalloy and Optigran, with the result that a silicon pickup of 0.15% is to be considered.

The amount of inoculant for the SMW blanks should be $\leq 0.10\%$ in combination with 0.10% to 0.15% Germalloy. This results in a silicon pickup of 0.15% to 0.17%.

When casting manually molded castings, we particularly recommend installing "starters" (small blanks, e.g. P300, P800 or P2) additionally for casting times longer than 50 sec. These smaller blanks have a dissolution time about as long as the filling time of the casting box. This ensures that well-inoculated iron is located in the casting box before the converter is drawn.

Casting time

If no casting times have been determined, the guide values for casting times can be taken from Figure 5. The values determined in the diagram are based on a variety of test results. Of course, in individual cases, it may be necessary to cast more quickly or more slowly.



Casting temperature

Normal casting temperature ranges are 1320 – 1380°C. The smelting range of the blanks is between 1210 and 1240°C

Dissolution times of the blanks

The dissolution times of the blanks can be derived from Figure 6 (e.g. P 2 is dissolved after 45 sec.). The dissolution times are to be extensively adapted to the casting times. It is always better if the casting time is less than or equal to the dissolution time. The casting time must never be longer than the dissolution time.

Selection of the blanks

Taking the above points into consideration, it should be ensured that the iron is continuously inoculated during the entire casting process. This means that in most applications the total of 0.2 percent by weight of inoculant comprises several blanks, e.g. casting 5000 kg, casting time approx. 48 sec. 1 x P 300 + 1 x P 800 + 2 x P 2 + 1 x P 5 (see example, Page 9).

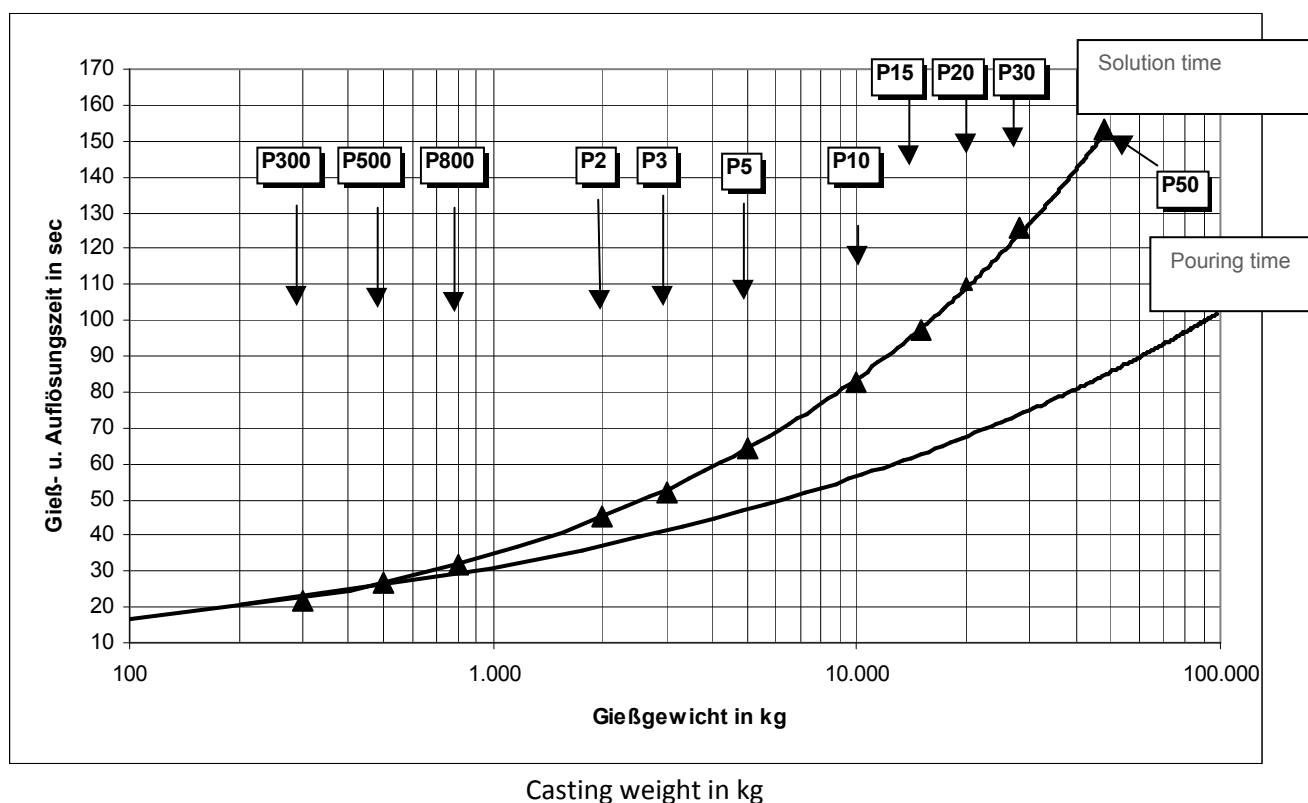


Figure 5: Guide values for casting times up to casting weights of approx. 50 t



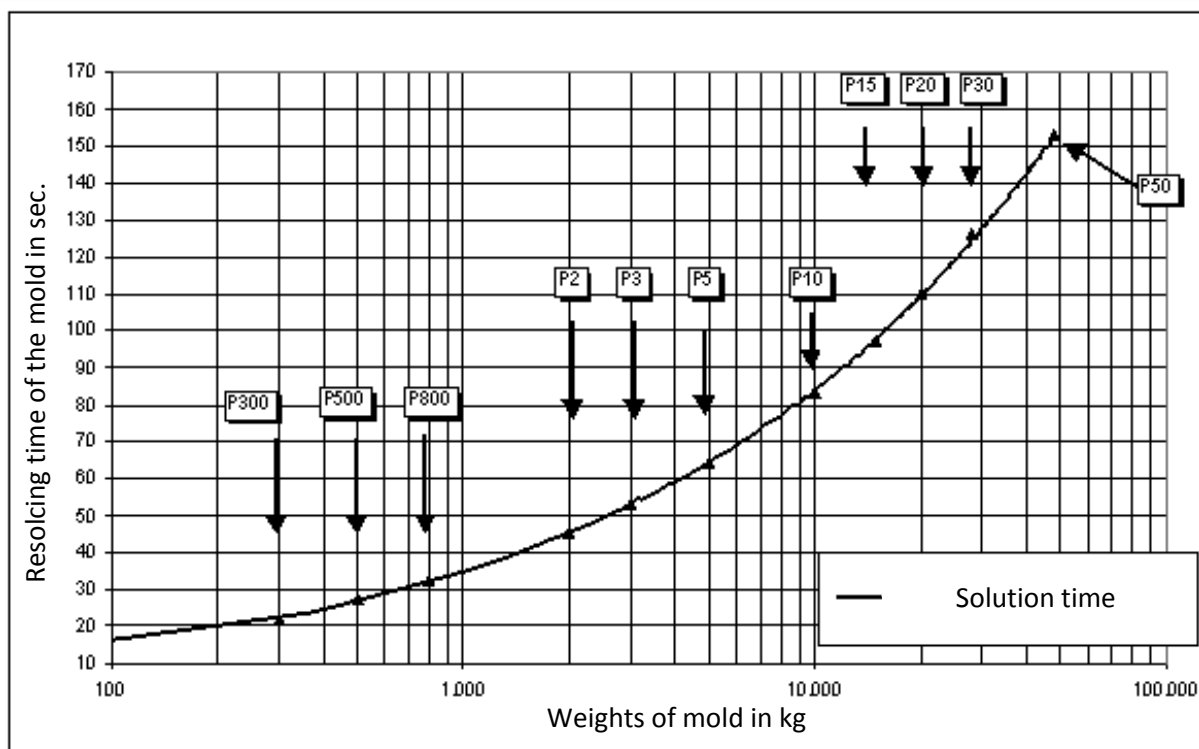


Figure 6: Dissolution time of the blanks

The analytical composition of the blanks

The following framework analyses apply:

Germalloy: % Si 68 - 76
 % Al 3.2 - 4.5
 % Ca 0.3 - 1.5
 % Mg traces
 % SE traces
 % Fe residual

Optigran: % Si 68 - 76
 % Al 0.8 - 1.8
 % Ca 0.3 - 1.4
 % Mn 3.5 - 4.5

SMW : % Si 65 - 72
 % Al 0.8 - 1.2
 % Ca 0.8 - 1.2
 % Bi 0.8 - 1.2
 % SE 0.8 - 1.2
 % Fe residual

The relevant actual values can be found in the test certificate. This also applies for special analyses according to customer requirements.



Quality control

As part of the quality control, the analysis values of the molten metal of the cast blanks are determined, saved and evaluated. The surface integrity of the blanks is inspected according to internal sorting guidelines or standards. A label is attached to each packing unit. This contains the data on the content, sorting and testing.

Calculation and determination of the gating system

In the case of medium-sized and large casting, the influential variables such as casting height, casting type and casting temperature are very different and correspondingly have a major effect on determination of the ingate cross-sections.

We recommend proceeding as follows:

1. Determination of the casting weight including the circuit component in kg.
2. Determination of the casting type and casting temperature, according to which the "speed factor" is determined. To gain your own experience on this, the values of the speed factors should also be determined subsequently once again. Speed factor values for casting temperatures from 1340 to 1400°C are indicated¹.
3.

Falling casting:	0.75 – 0.85
Side casting bent once at right angles:	0.60 – 0.70
Side casting bent multiply at right angles:	0.50 – 0.60
Rising casting:	0.30
4. Selection of the required casting time from the diagram
5. Calculation of the ingate cross-sections according to the following formula¹:

$$\Sigma A = \frac{22.6 * G}{\gamma * t * \xi \sqrt{h}} \text{ (cm}^2\text{)}$$

ΣA	=	total ingates (cm ²)
G	=	casting weight (kg)
γ	=	spec. weight 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})

¹ From: Atlas zur Anschnitt- und Speisertechnik für Gusseisen, A. Holzmüller, L. Kucharčík edited by the VDG Giesserei Verlag Düsseldorf 1969.



6. For the remaining elements of the gating system, the requisite cross-sections according to the calculated ingate cross-sections can be taken from the following table. The cross-section graduation of gate cross-section: Run cross-section: Ingate cross-section follows the ratio 1:2:0.75 – 0.90.

Other cross-section graduations are possible, in particular with the use of casting filters in the ingate system.

Table: Dimensions for gating system

Gate diameter mm	Cross section mm ²	Run cross section mm ²	Ingate cross section mm ²
50	1960	3920	1470 - 1760
60	2830	5660	2120 - 2550
70	3850	7700	2880 - 3460
80	5030	10060	3770 - 4540
2 x 60	5660	11120	4250 - 5100
2 x 70	7700	15440	5800 - 6900
2 x 80	10060	20120	7550 - 9100

Examples for the calculation casting systems

Example 1:

Casting weight: 2000 kg
 Casting height: 60 cm
 Speed factor for side casting: 0.60

A casting time of 37 sec. was determined from the diagram. An ingate cross-section of 38 cm² is calculated according to the ingate equation.

The associated cross-sections are:

* Gate: 50.3 cm² = 80 mm
 * Run: 100 cm² = 2 runs per 50 cm²

The gating system (Figure 3) with a gate diameter of 80 mm, trapezoidal runs with the dimensions (1 = 55, b = 45, h = 100) and 4 ingates with the dimensions 16 x 60 mm was selected.

Two Germalloy P 2 blanks + one P 300 blank are used when applying the mold inoculation method for GJS.



Example 2:

Casting weight: 10,000 kg
 Casting height: 250 cm
 Speed factor for side casting: 0.40

A casting time of 60 sec. is desirable. The calculated ingate cross-section is 87 cm².

The associated cross-sections are:

* Gate: 100.6 cm² = 2 x 80 mm
 * Run: 200 cm² = 2 runs per 100 cm²

A gating system with two sprues of 80 mm, the dual-trapezoidal run with the dimensions

(a = 60, b = 50, h = 85) ($\Sigma L = 187$ cm²) and 8 ingates with the dimensions 16 x 70 mm ($\Sigma A = 89.6$ cm²) was selected.

One P 5 + two P 2 + one P 300 blanks are used when applying the mold inoculation method for GJS.

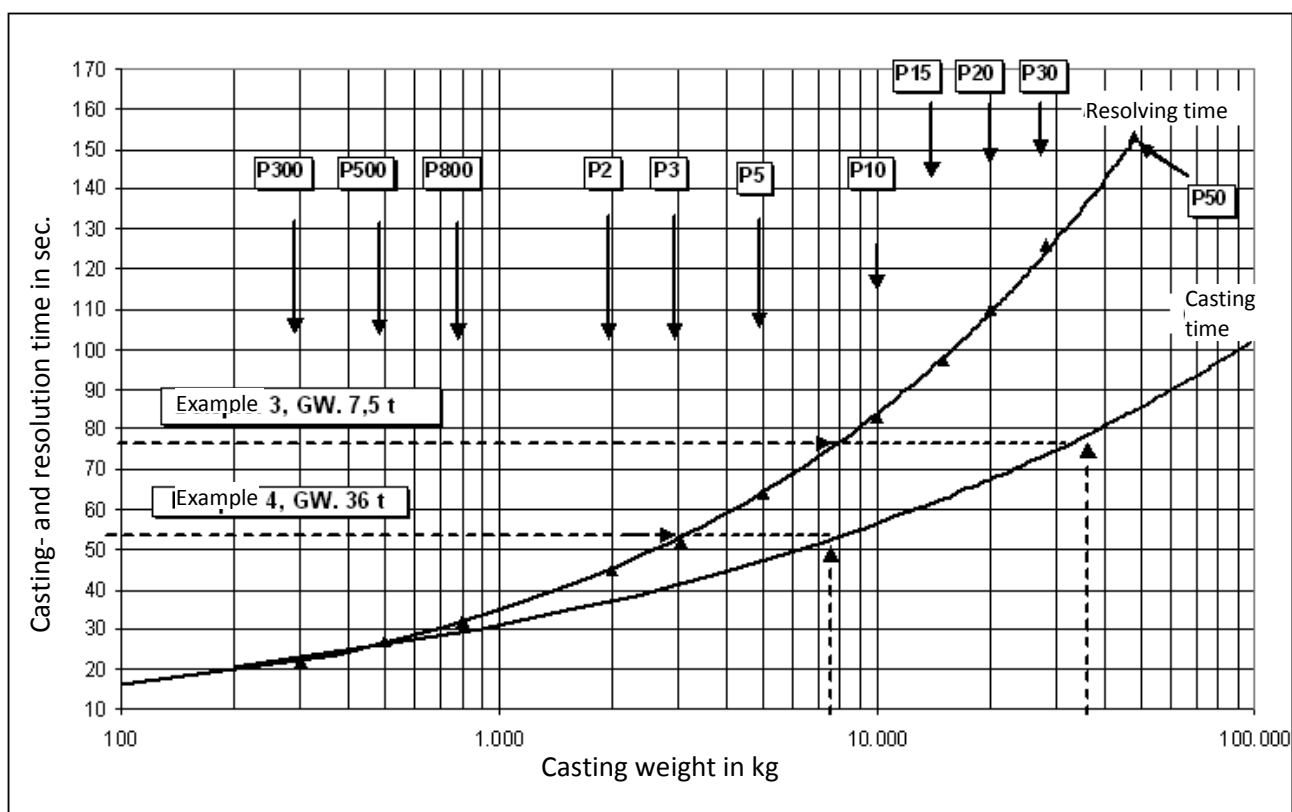


Figure 7: Casting time and dissolution time of the blanks in relation to the casting weight



Example 3: (cf. Figure 7)

Casting weight:	7500 kg
Casting basin	1
Casting time:	approx. 52 sec.
intended inoculant amount:	0.2% = approx. 15 kg inoculant

The casting time of approx. 52 sec. is between the dissolution times of the blanks P 5 and P 2, with the result that both blanks are necessary for this use. Owing to the long dissolution time of 82 sec., a P 10 is not considered. To reliably inoculate the first iron as well, a P 500 is recommended as a starter. This results in the following for this casting:

two P 5 + two P 2 + one P 500

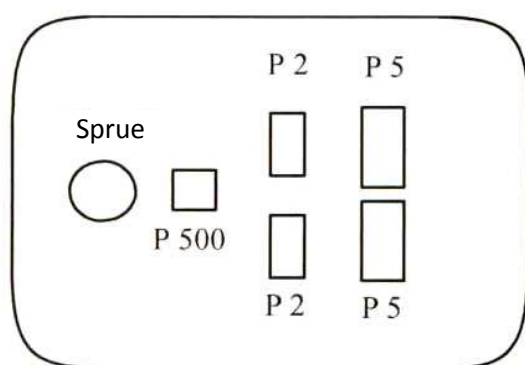


Figure 8: Arrangement of the inoculants in the casting box

Example 4: (cf. Figure 7)

Casting weight:	36,000 kg
Casting boxes:	2
Casting time:	approx. 78 sec.
intended inoculant amount:	0.2% = approx. 36 kg per casting box

The casting time is close to the dissolution time of the P 10, with the result that this is used. In addition, the following combination of inoculants is to be selected for a continuous inoculation process from the start of casting:

three P 10 + one P 5, one P 800, one P 300

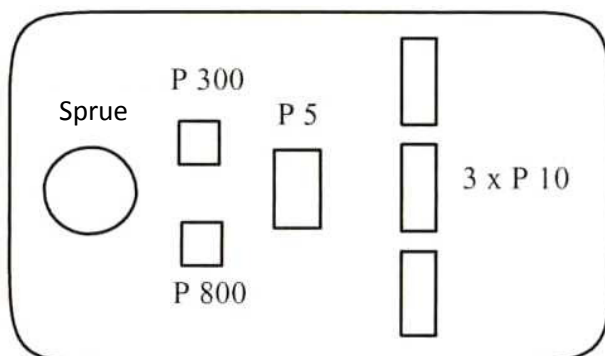


Figure 9: Arrangement of the inoculants per casting box





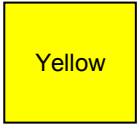
Advice

The Technical Service of ASK Chemicals 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 of 100 kg, cartons of 750 kg or crates of 1000 kg. The packaging is identified by clearly legible lettering in the model colors of the corresponding casting materials:

P 300 to P 10 SMW blanks are packed in yellow cartons of 100 kg. The P 15 and P 20 blanks are packed in black in cartons of approximately 250 kg with a yellow band. The P 30 and P 50 blanks are packed in cartons of 1,000kg with a yellow band.

Inoculant :	Germalloy®	Optigran®	SMW - Formlinge
Application :	Mold inoculant for cast Iron with nodular graphite	Mold inoculant for cast iron with lamellar graphite	Mold inoculant for thick-walled cast iron parts with nodular graphite
Color code :	 Purple	 Red	 Yellow

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.

The data in this information sheet corresponds to the current state of our knowledge and is intended to provide information on our products and their potential applications. It is not therefore sufficient to assure certain properties of the products or their suitability for a concrete intended use, and does not contain any complete instructions for use. It also does not represent any guarantee of condition and durability and the user is not exempted from testing the suitability and potential applications for the intended purpose. Any extant intellectual property rights must be taken into account. The Environment and Quality Management of ASK Chemicals Metallurgy GmbH is certified and fulfills the requirements of ISO 14001 and ISO 9001. This information sheet shall cease to be valid if a new version is issued.

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