Core and mould production from furan resin moulding material for castings from grey and ductile cast iron

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Content

Preface to the 1st edition

In today‘s world of steadily declining numbers of trained specialists in the foundry sector, especially in the hand mould sector, this user manual is intended to support the foundry employees in the processes of optimum core and mould production.
The manual provides essential background information, describes the basic work steps and shares valuable tips with the reader.

At the same time, the explanations can help to standardize the processes in the core shop and moulding shop and thus make them more controllable.
I hope you enjoy our user manual for core and mould production from furan resin moulding material and it helps you in your daily work.

I wish you a lot of fun reading it and remain with a hearty Glückauf!

Jörg Brotzki
Executive Vice President EMEA

Foreword by the author to the 1st edition

The present manual deals with the production steps of core and mould making which can be found in most hand moulding shops.
The first part provides general information about furan resin moulds and reclaimed sands.
Next, the individual work steps from core production to the casting of the mould are described in more detail.

This manual does of course not claim to be an encyclopaedia of mould making. Our intention was not to create an extensive textbook or reference book, but a small manual aimed at helping to produce faultless castings – starting with the core and mould production.
Numerous in-depth details associated with the furan resin moulding process were deliberately omitted to emphasise the fundamentals. Nevertheless, I also hope for the interest of my colleagues, who as readers might be able to benefit from this or that bit of information.

Compiling such a manual requires quite some effort and the extensive work could not have been carried out successfully without the support of colleagues, who I would like to thank. In particular, I would like to thank Mr Antoni Gieniec from ASK Chemicals for his support. This cooperation resulted in numerous suggestions regarding content and execution.
The same applies to the critical review, editorial revision and layout design by Ms. Verena Sander from ASK Chemicals.

Of course we are interested in any critical hints and additional improvements you may have for the following editions.

Glück auf!
Ulf Knobloch

Before getting started

Tidiness is a prerequisite for proper work. Always keep the workplace clean. Tools (sleeker, rammer, hammer, strickle board, sanding block, sandpaper, etc.) must always be ready to hand.

The mixers must be checked at the beginning of each shift:

- Is the mixer shaft clean?
- Are all blades fixed and in the cor rect position?
- Is the resin and acid supply guaranteed?
- Are the sand bunkers filled?

Any deviations at the mixer must be reported to the maintenance department in good time and eliminated. The same applies if you have the impression that the mixer settings have changed – as can be seen e.g. from the curing speed.

General information

Compared to iron casting, the furan resin moulding process is a relatively new process.

The process is characterised by the fact that after mixing the components moulding sand, binder and hardener, the curing takes place automatically. The reaction taking place here is called polycondensation (Figure 1).The foundry lexicon describes the polycondensation process as follows:

Polycondensation process:

Accumulation of basic molecules to a macromolecule accompanied by the elimination of a low-molecular weight by-product[1], which is usually water.

The chemical reaction starts immediately after bringing together the components moulding sand (reclaimed and/ or new sand), binder (furan resin) and hardener (acid). Nevertheless, the moulding material can still be processed. The time available for processing depends mainly on the binder system used (resin and hardener) and the ratio of binder to hardener. This time is called „processing time" or „bench life time".

The range of pre-curing or partial curing is measured by compressive strenght.

After the transition from closed to open curing, it is possible to measure the bending strength.

[1] Giesserei Lexikon (1997), 17th edition, p. 953

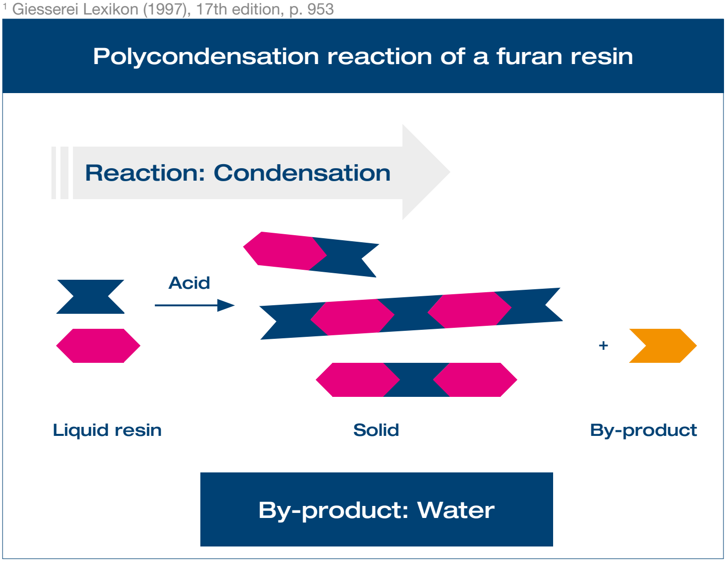


Figure 1 Polycondensation reaction of a furan resin

Processing times of furan moulding materials

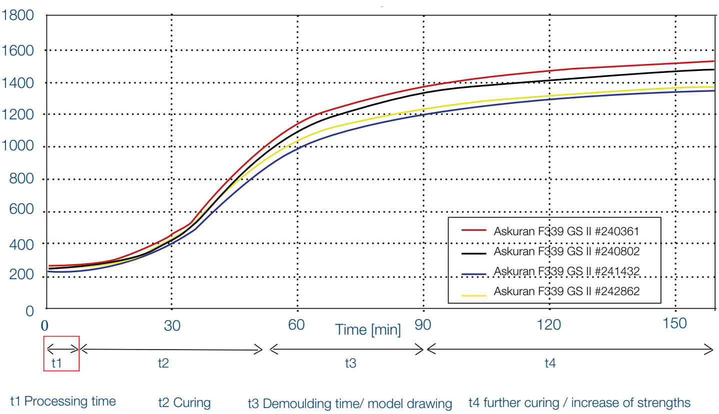


Diagram 1:
Basic
curing process of
furan resin moulding material
Ultrasonic measurement

Once the processing time has elapsed, the curing reaction must no longer be disturbed.

All partial and full curing processes are carried out according to this diagram. This also means, however, that the processing of the moulding material is bound to these time windows and that the work processes must be geared to them!

The short processing times available to the worker for processing the moulding material are of particular note. In addition to compaction defects due to poorly accessible core or mould sections, the main cause of casting defects, such as mineralisation or burning, is the processing of the moulding material beyond its processing time which results in the destruction of the already formed binder bridges.

Important factors that influence the curing of the moulding material are:

- resin and hardener content
- proportion of reclaimed material
- quality of reclaimed material
- moulding material temperature
- moulding material moisture
- ambient temperature
- ambient humidity

Depending on the external conditions, each resin quality requires a certain amount of hardener for optimal cross-linking of the binder components. If the hardener content is too low, the hardener reaction is too slow and the attainable final strength is not achieved. Too high hardener content leads to rapid curing of the moulding material and thus reduces the processing time. Furthermore, the binder bridges are not optimally formed. In addition, too high hardener content increases the water content in the moulding material, which also reduces the final strength. Any casting defects caused by the moulding material can impair the usability of the casting and lead to considerable reworking.

A not negligible prerequisite is the use of dry sand.

Moist sand has an extremely negative effect on the attainable final strength of the moulding material. This can even result in the moulding material not hardening at all.

Sand temperatures that are too high lead to fast and uncontrollable curing, the processing time is considerably reduced, the important and necessary compaction work can no longer be carried out professionally or can lead to other defects in the casting (e.g. erosion, swelling or reduced edge strength). Temperatures (of sand and/or environment) that are too low delay the curing process and cause a loss of productivity. This is reflected both in the bending strengths and in the attainable mould hardnesses.

The optimum sand and environment temperatures should be between 20 and 25 °C, but not less than 15 °C and not more than 30 °C. Outside those temperatures, the process can no longer be controlled reliably.

From 30 °C, the processing time is so short that there is no time for compacting, setting the chills, setting the risers or other time-consuming work. The moulding material has reached the end of processing before completion of the necessary work.

Reactivity & Strengths

RT = room temperature
LF = air humidity
VZ = processing time
AZ = stripping time
QB = bending strength

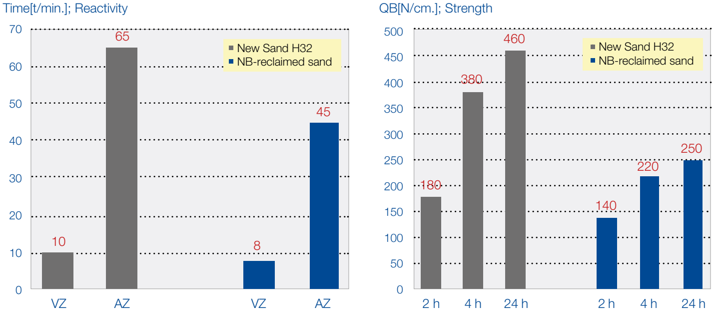


Diagram 2: Reactivity and strength of new or reclaimed sand

Sand mixture: 100%; 0,4% hardener (65% PTS); 1.0% resin;
RT = 20°C; sand temperature = 20°C; rel. LF = 50%

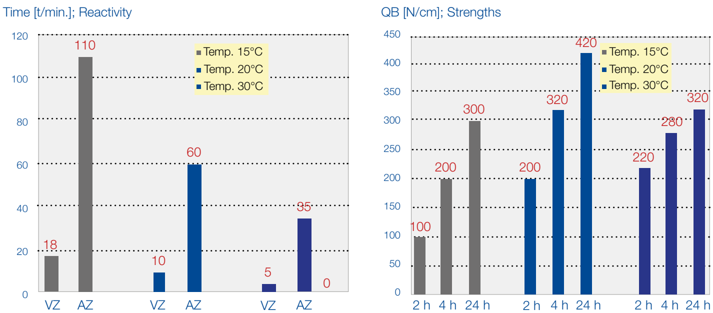


Diagram 3: Reactivity and strength in relation to sand temperature

Sand mixture: 100% Silica sand H32; 0,4% hardener (65% PTS); 1,0% resin;
RT = 20°C rel. LF = 50%

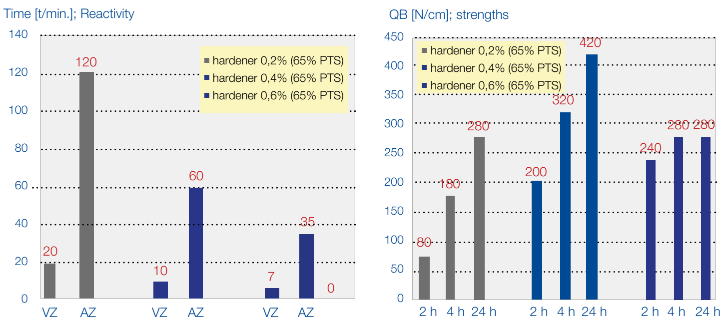


Diagram 4: Reactivity and strength in relation to hardener content

sand mixture: 100% silica sandH32; 1,0% resin;
RT = 20°C; sand temperature = 20°C rel. LF = 50%

Diagrams 2-4 illustrate the influence of key parameters, namely the use of reclaimed material, temperature or hardener content, on the reactivity and strength of a furan resin moulding material.

It is strongly recommended to check processability, as short-term fluctuations in moulding material temperatures or reclaimed material quality cannot be ruled out and are difficult to react to.

A moulding material cone can be used to determine whether the processing time has elapsed. If the sand literally rolls off, the processing time is over.

Figure 2:
Testing the processability of the moulding material with a moulding material cone

If the processing time is not observed or exceeded, there is a risk that the binder bridges will be destroyed.

Control is also possible by installing systems that react fully automatically to changing temperatures. The range of such systems extends from simple systems, which only react to the respective inlet sand temperatures and control the acid addition following a simple straight line, to individually adapted systems, which not only permit detailed temperature gradations, but also control the acid quantities and the binder quantity temperature-dependently while taking into account the ambient temperatures.

The principle of this control is based on an automatic adjustment of the hardeners for temperature compensation. Two hardeners (strong and weak) are dosed in such a way that temperature fluctuations during the processing time do not affect the process and always the same time is available for processing the moulding material. Non-compliance with these fluctuating processing times will result in defects such as penetration (Figure 3).

Affected casting
Clearly recognisable sand adhesion

Penetration at the hottest point near the gate (casting after sandblasting)

Figure 3:
Real penetration[2]

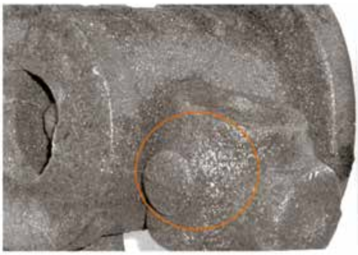
Affected casting

Conglomerate of iron/sand on a casting of GGL grey iron (casting before sandblasting – white spots = reaction of moulding material & melt)

Figure 4:
Mineralisation[2]

[2] IKO-Erbslöh: Handbuch der Gussfehler (2008) 3rd edition

Careful compaction of moulding materials

Compaction is of great importance in the process, as it can prevent casting defects and expensive reworking or even rejects when basic measures are followed.

Compaction of the moulding material by gravity is not sufficient. A sufficiently dense grain packing must be ensured by using aids and additional measures such as manual compaction, vibrating or jolting tables.

If a vibrating or jolting plate is used, a short application time of approx. 5–10 seconds is usually sufficient for achieving adequate compaction. It should be noted that the mould must always be moved in the vertical direction. Otherwise, on the one hand, the mould material introduced is not compacted and,on the other hand, the chills, risers and gate pipes can „float away".

Lately, moulding boxes with bars close to the contour have frequently been used in hand moulding shops. The aim is to reduce the amount of moulding material and to accelerate or even halve the cooling time of the casting. It is not easy for the moulder to ensure sufficient compaction, as the bars hinder free access. In this case, the use of vibration or jolting plates is also advisable. Vibrating motors mounted on the outside of the moulding box also help achieve very good mould compaction. The vibration energy is transferred to the moulding material via the bars running through the moulding material. This generally leads to a very uniform moulding material compaction and thus to a high mould hardness.

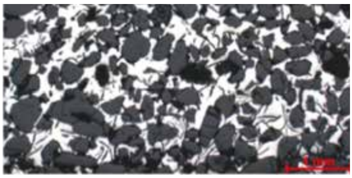


Figure 5: Left good compaction – little iron penetration, right poor compaction – strong iron penetration

Examinations show that the causes of these penetrations (Figure 5) can be clearly identified. A lot of iron can be seen between the quartz sand grains, which indicates a low compaction of the moulding material as the cause. The iron easily penetrates into the cavities between the sand grains thus causing this type of penetration.

The lower the compaction, the greater the risk of penetration.

Ensure good compaction, as this will reduce rework or scrap.

Quality of the reclaimed sand

A good reclaimed sand quality is decisive for a good moulding material quality. A low content of fines is an important criteria here.

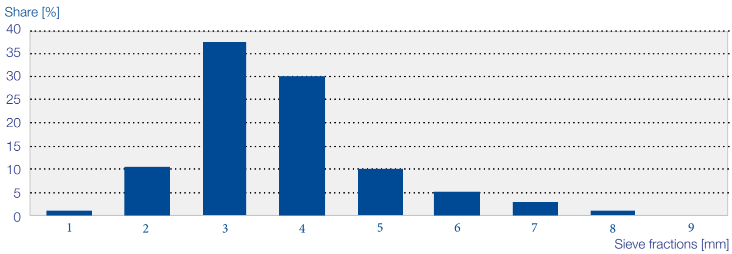
Figure 6: Mechanically well reclaimed sand

Experience values from ASK Chemicals for characteristics of mechanically reclaimed used sand:

- Fine grain </= 2 %
- Dust content* </= 0.1 %
- Loss on ignition </= 3 %
- pH value 3-3.5

Due to its high specific surface area, the fine grain and dust content should be kept as low as possible. Likewise many unwanted other chemical elements accumulate in the dust, however this issue will not be further discussed here.

Typical quality of recleimed sand[3]



	Sieve fraction [mm]	Reclaimed sand
1	> 7,10	1,4
2	0,710-0,500	10,9
3	0,500-0,355	37,7
4	0,355-0,250	30,5
5	0,250-0,180	10,2
6	0,180-0,125	5,2
7	0,125-0,090	3,0
8	0,090-0,063	1,0
9	< 0,063	0,1

Characteristics / Parameters	Reclaimed sand
average grain size [mm]	0,25-0,35
proportion of fines (< 0,125) [%]	2,0-3,5
AFS number	31-46
pH-value	2,8-3,5
electrical conductivity [mS/cm]	200-1000
loss of ignition [%]	2,5-3,5
residual acid [mg NaOH/100g]	80-200
clay content [%]	0-1,0

Diagram 5: Typical reclaimed material quality

* Dust is present with a particle size of ≤ 63 μm

[3] VDG Merkblatt R93: Reclaimed sands as moulding base material (1992)

Core production

First, the core box is inspected to see how the finished core can be stripped or how any associated loose pieces can be demoulded. The core storage must then be determined:

- Where's up and where's down?
- Where are lifting eyes needed?
- Where are eyelets needed for tying?

In the next step, the core box is coated or sprayed with release agent.

The core box may only be filled after the release agent has completely dried.

At the same time, the necessary core iron inserts can be prepared. Cast iron rods must always be given priority over steel inserts, as these can be more easily removed from the casting cavity by breaking them. The thickness of the iron depends on the size of the core. Please do not use irons like tree trunks and an excessive number of reinforcements! The moulding material shrinks on the insert, which promotes crack formation. Connect core wires with wire if necessary. Another important aspect is the removal of core gases. Vent ropes can be tied to the core iron. Make sure that the ropes are not too close to the outer contour of the core, but at least 15 mm of sand are lying over them.

Another possibility is to pierce holes using a vent wire. When using this method, it is essential to pay attention to how the air in the mould can be discharged. It happens regularly that air is pierced into casting contours.

Before filling the core box, read the corresponding working paper again:

- Which moulding material?
- Are risers required?
- Are chills prescribed, if so, where?
- Are there any other production specifications?

Ensure that the release agent is completely dry.

The filling of the core box must not be started until the release agent has completely dried.

After completing all preparatory tasks, the core box is filled. Compact the core sand carefully with the aid of ramming tools. When filling and ramming, always make sure that the core irons, vent ropes, risers and chills are seated correctly. Many cavities in the casting are difficult to access. Penetrations or rough surfaces can only be removed very laboriously and with great effort. For this reason, the casting often has to be sorted out as scrap.

Figure 7: Penetrations in the core area caused by insufficient compaction

The following applies to core sand as a moulding material: Only as much resin and hardener as necessary and not as much as possible!

Cores that are too hard prevent shrinkage and thus lead to cracks in the casting.

After a sufficient curing time, the core is stripped, loose pieces are drawn, resulting burrs are plastered and sanded.

Sometimes the marking on the casting is located in the core box on the pattern contours. If this is the case and more than one part has to be produced, the working papers specify whether the marking on the second core needs to be changed. In any case, a consecutive part number must be changed.

If the core box is no longer required for another core, it must be cleaned and prepared for pattern transport for storage. Contaminated and dirty core boxes must not be stored!

The core should be left to dry for a sufficiently long time before coating.

The casting surface is only as good as the cleanliness of the core surface permits!

Mould production

First read the work regulations (working papers, production instructions, work plans) and then start the preparatory work.

In some companies, the work regulations are already available on terminals where the respective employee can call up the necessary information „online" from the company's own network. Often current drawings, pictures or photos are also stored here, which additionally contributes to a better understanding. All relevant data such as gating system, chills, risers, hints and much more should be made available. The pattern marking must be compared with the working paper.

If the marking of the patterns is correct, the pattern is placed on a sufficiently large plate or level surface. If loose pieces are part of the pattern, they will be attached. If the loose pieces are secured with screws for pattern transport, they must be unlocked before moulding. The pattern must be sprayed or coated with release agent before moulding. The release agent must be completely dried and hardened before filling can start. Dry blowing is not sufficient, as only the surface appears dry.

The casting system, chills, heating plates, filter patterns, etc. are created according to the work plan. Special attention must be paid to the sprue pipes – if ceramic pipes are to be used – or the runner. If possible, avoid fixing the pipes with adhesive – crepe tape is a suitable means. Under no circumstances must the adhesive penetrate inwards into the pipe cavity.

Chills must be created according to working instructions or pattern drawings. The chills must be checked for damaged areas (fire cracks, holes, bubbles, etc.) before putting them on. They must be free of scale and rust, otherwise they will burn and can usually only be removed with increased cleaning effort. Sometimes they adhere so firmly that the casting has to be sorted out as scrap. Damaged chills must therefore be sorted out. Depending on the intended use and the wall thickness to be cooled, it may be advisable to apply a coating to the chills prior to storage.

Apply coating to chills

Finishes or other coating materials are used. It is advisable to carry out appropriate tests beforehand.

When selecting the correct moulding box, sufficient space should be left between the pattern and the edge of the box. With the drag box height, it must be ensured that there is sufficient sand under the casting after the box has been turned in relation to the casting height.

Drag box height

As a rule of thumb: At least 100 mm sand under the pattern or the sprue pipes.

Coating of cores and moulds

For coating, observe the relevant valid work instructions. These instructions should be available at every workplace and known to every worker.

Moulds and cores must be free of dust and other impurities before coating. It is advisable to allow the moulds or cores to be coated to evaporate for a certain time beforehand. Otherwise, moulding material-related casting defects may occur if the iron can react with potentially enclosed reaction products.

We recommend drying the moulds or cores in a furn- ace at approx. 70-80 °C for a short time.

Hardening in the furnace accelerates the curing process, and the water produced during the reaction evaporates in zones close to the surface. The changed conditions for subsequent coating must then be observed on a case-by-case basis.

Figure 8:
Flooding a core

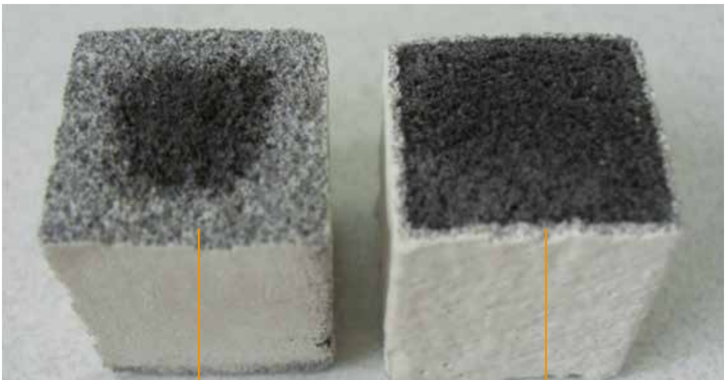
The use of penetration coatings or pre-coatings can make it more difficult for the iron to penetrate into the moulding material and may also partially conceal insufficient compaction. Flooding with a topcoat is possible at any time (Figure 9).

The coating must be checked regularly for the prescribed density or viscosity. The control shall be documented. The values are specified in the work instructions. The density is measured with a Baumé spindle (Figure 10). The viscosity is measured with a flow cup (Figure 13).

The density is decisive for the layer thickness of the coating on the mould. A coating that is too thin causes the moulding material to burn, a coating that is too thick can cause scabbing. Both casting defects can lead to rejects.

If the mould is flooded, the gate pipes are closed beforehand with plugs in order to prevent coating from entering inside the pipes. After flooding, fat edges should be levelled immediately with a brush.

The selection and application of the right coating is of great importance. After all, it is the raw materials that determine the essential properties of the coating. Table 1 summarises the most common raw materials and their properties.



High level of coating penetration into the core, which prevents the liquid metal from penetrating into the moulding material.

Low level of coating penetration so that liquid metal can penetrate into the cavities between the sand grains in the moulding material.

Figure 9:
Bar samples with different coating penetrations

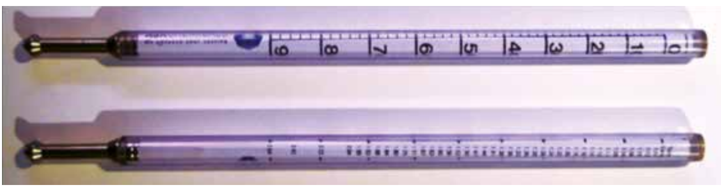


Figure 10:
Density determination with Baumé spindle;
©Ulf Knobloch, ASK Chemicals

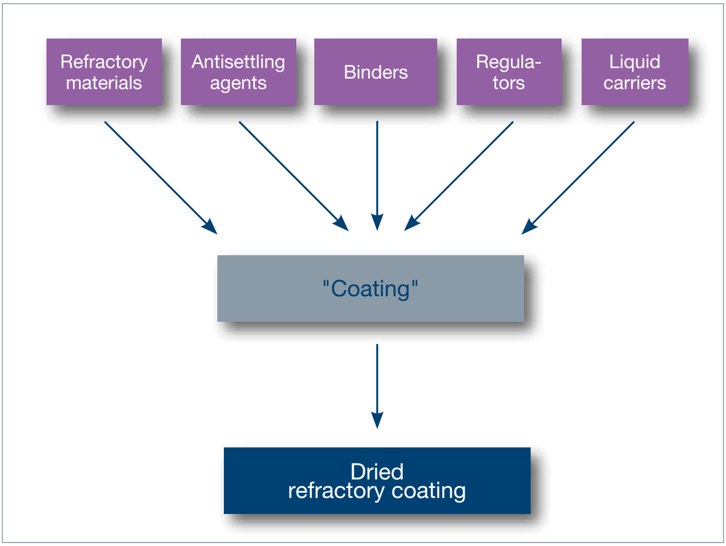


Figure 11: Basic coating composition

Refractory material	Density g/cm³	Melting Point °C	Appearance	Chemical formula
Zirconium silicate	4,6	2200	angular	$ZrSiO_4$
Mullite	3,16	1700	angular	$3Al_2O_3$ 2 SiO_2
Kaolinite	2,65	> 1700	platelet	$Al_2((OH)_4/Si_2O_5)$
Pyrophillite	2,8	1600	platelet	$Al_2((OH)_2/Si_4O_{10})$
Talc	2,8	> 1000 max. 1430	platelet	$Mg_3((OH)_2/AlSi_4O_{10})$
Mica	2,85	> 900	platelet	$KAl_2((OH)_2/AlS_3O_{10})$

Table 1: Refractory solids in a coating[1]

Raw material	Suitability for cast material
Graphite Coke Olivine Talc	• GJL • GJS • GJM • Cu alloys • Al alloys
Chamotte	• Cast steel
Zirconium silicate	• GJL • GJS • GJM • Al alloys
Quartz	• GJL • GJS • GJM
Magnesite	• Cast steel • Mg alloys
Corundum	• Cast steel • Al alloys

Table 2:
Coating base materials[1]

Carrier liquid	Application	Drying
Water	• Water-based coating	• air drying • drying oven • microwave
Isopropanol, Denatured ethanol e.g. alcohols	• Alcohol-based coating	• air drying • burning off

Table 3:
Carrier liquids1

[1]VERLAG EUROPA-LEHRMITTEL-Nourney, Vollmer GmbH & Co.KG; Fachkunde für gießereitechnische Berufe; 4th edition; p. 248;

Alcohols or water are used as carrier liquids. Usually water-based coating is used, but alcohol is still used as a liquid carrier (Table 3).

Depending on the size and contour of the core/mould, the coatings can be applied by brushing, dipping, spraying or flooding. It is equally important for all processes that the prescribed layer thickness of the coating is adhered to on all contours.

Please note that the layer thickness of the coating must not be less than 300 µm = 0.3 mm, mea- sured in wet matt condition, depending on the thickness of the casting wall and material.

If the coating is applied with a tassel or brush, work must be carried out quickly and efficiently. The coating must be stirred well and prepared in such a way that it is easy to spread. Under no circumstances should the coating be too thin.

If the coating is dry, do not sand the surface with abrasive paper. This will damage the protective layer.

When coating by flooding or by hand, always make sure that the marking is not filled with coating. The marking must also be completely covered with coating to prevent the sand from burning. Otherwise the marking is not legible!

Figure 12: Correct drying of the coating

The casting and gating system must be coated as carefully as the casting contour! This is a quality-determining factor!

The layer thickness must be checked with a layer thickness gauge in a wet-matt condition.

The coating buckets must be cleaned daily before starting work, old and already hardened coating residues must be disposed of. Eyelets of larger cores should be closed with paper, sponges or similar. Under no circumstances may puddles remain in these openings. If it is not possible to prevent the eyelet openings from filling up, they must be emptied manually.

The viscosity is usually adjusted with a clean outlet cup DIN 4 mm. The manufacturer's recommendations must be observed here.

Figure 13: 4-mm TQC outlet cup; ©Ulf Knobloch, ASK Chemicals

If coating remains in the openings, the underlying moulding material can soak up the carrier liquid. There is no guarantee of complete drying until casting. In the worst case, an eruption of liquid metal occurs during casting due to evaporation of water or alcohol. The repair must be carried out in such a way that the filled moulding material can still harden and is only then overcoated. This is the only way to ensure a faultless contour. Later, the moulder cannot reliably guarantee that the entire moulding material wetted with liquid and not yet completely dried will be replaced.

After flooding of the core, fat edges must be brushed immediately with a brush or carefully blown using compressed air.

When coating – whether painting, dipping or flooding – care must be taken to ensure that the core prints are free of coating. In addition to fixing the core in the mould, the core prints serve to remove the gases produced by the combustion of the resin during casting. The coating prevents the gases from escaping. If excessive coating of the core prints cannot be avoided, the coating must be removed from the core print subsequently. It is often sufficient to remove the coating with a sponge or rubber squeegee while still wet.

After coating, the core must be checked to ensure that all areas are covered with coating. The core is then prepared for drying and storage.

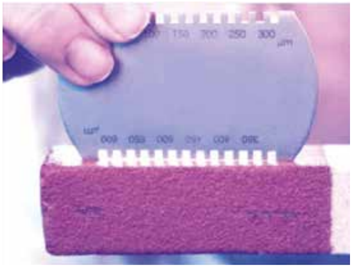


Figure 14: Coating thickness

Always make sure that any marking on the cores is not filled with coating and is always legible!

Further processing after coating needs to be accurately documented. At best, this documentation should reflect every step of the process. This is the only way to ensure traceability of the individual products and to determine the causes of defects.

The drying times must be precisely specified, adhered to and checked. The time and moisture control of the cores should be carried out by an authorised person.

Figure 15: Moisture measuring device for determining a guide value of the mould or core residual moisture; ©Ulf Knobloch, ASK Chemicals

Mould filling

Before starting to fill the mould, the drop height of the sand must be estimated. It should not exceed 1.5 m. A pipe extension, which can be hung under the mixer outlet, can help to prevent the sandblast from dispersing. At the same time, this helps to reduce the spread of the fine particles of the mixed moulding material and emissions of pollutants in the ambient air.

The first sand from the mixer should usually be emptied into a bucket or into a sufficiently large corner of the moulding box.

The first discharge sand does not usually have the required quality. It can then be used later as backfill sand. Some mixers of special design mix the first sand against a so-called „closed trough". Here the mixer outlet is opened with a time delay. In this case, the moulding sand can be used immediately. Now the moulding box is filled layer by layer (bead thickness approx. 200 mm). The sand must be pressed firmly against the pattern and compacted with a rammer. Care must be taken not to let the sand layers run up too thickly, as otherwise continuous compaction is not possible and loose areas form.

The main reason for penetration and swelling are usually loose, insufficiently compacted points!

Figure 16: Surface „burning

Figure 17: Penetration due to insufficient compaction 4

[4] Stephan Hasse; Guss- und Gefügebilder; Verlag Schiele&Schön; Berlin 1999; p.266

During further filling, care must be taken to ensure that the position of the riser attachments or risers and chills is not compressed. The sand between the chills must also be thoroughly compacted. As a rule of thumb for the minimum distance between the chills, the thickness of the chills can be used. If required by the feeding technology and the cooling irons have to be placed „joint to joint", the direction of conicity must be observed. Wrongly executed, sand residues remain between the chills, which can get back into the mould cavity and lead to sand inclusions. Compaction must also be carried out well under the inclines of the riser necks. Due to the high thermal load during solidification, the risk of mineralisation at these points is particularly high. The riser can then only be removed in the fettling shop under difficult conditions; the breakoff notches provided no longer work. In the case of loose pieces, the pins must not be pulled out until the sand has been pressed down well and offset of the pieces is ruled out. The mould is now to be filled further in layers and must be compacted well. Work must be carried out quickly and efficiently. If the mixer is switched off, the process starts anew. When the moulding box is filled, the back of the mould is pulled straight off. Whistlers and box guides must be loosened.

With large and complicated patterns, strong mineralisations and swelling can frequently be observed as defect patterns after casting. This is usually caused by inadequate compaction of the moulding material. It is therefore important that large moulds on which several moulders are working are sufficiently compacted. It makes sense to divide the moulding area into several not too large sections. Each moulder then specifically ensures that his section is compacted properly. Special attention is paid to undercuts, fractures and riser attachments.

Once the sand has reached sufficient strength, the patterns can be drawn. It is recommended to draw the pattern on the same day as it was filled into the mould!

Stripping and pattern drawing

The pattern is easier to draw if the sand is still slightly plastic. An aid for testing the mould hardness can be a sleeker or a sufficiently large mould nail, which must not penetrate into the moulding material under strong pressure. Experience has shown that this corresponds to a mould hardness of approx. 100 N/cm² compressive strength

After removing the box, it has also proved useful to carve the time into the sand. If sand other than the backfill sand is applied to the pattern, it is recommended to put a handful of moulding material aside as a sample to check the curing speed.

First the cope box of the mould is lifted, turned and put down.

Before the pattern can be drawn, the moulding sand, which can protrude over the parting surface of the pattern, must be removed by carving around the pattern. This also prevents the sand from growing into the mould cavity due to sand expansion during casting.

Next, the drawing screws are screwed into the lifting plates. Small patterns are drawn by hand and can be hammered off with a hammer. Large patterns are

attached to a crane (with threaded screws and S-hooks).

If the pattern is pulled by crane, a large spreading angle on the rope or chain must be avoided. It is bet- ter to use a traverse.

If the pattern is knocked off, pieces of hardwood must always be placed on the pattern, otherwise the partial surfaces of the patterns can be damaged. If there are still loose pieces in the mould, they must be drawn in the marked sequence.

If pieces break out of the mould, these fragments are stuck on again immediately and not simply placed next to the mould and left to themselves!

If no further moulding is to take place, the pattern must be cleaned of adhering sand before it is taken to the storage facility! This is not a transport or pattern making task, rather it falls into the area of moulding.

Once all pattern parts have been drawn, the moulded parts are prepared for coating. Transitions from attached loose pieces are also ground or a radius is added.

The drilling of air holes in the risers must not be forgotten either.

These holes are to be blown out very thoroughly, otherwise sand can trickle back into the mould cavity.

Once all the work has been completed, coating can take place.

The mould should evaporate for some time before coating.

Mould assembly and core setting

Once the moulds have been coated, the sprue or gate pipes are cleaned. Ensure adequate core venting via the mould joint by carving air vents away from the core prints towards the mould joint.

The drag box is now ready to be placed on the pouring area. The casting bed must be carefully prepared. The dry sand must be raked out for this purpose. Lumps, pieces of iron etc. must no longer be in the sand!

The moulding box must be rubbed firmly into the sand while suspended from the crane. This ensures that the mould is held downwards and cannot break through.

Extremely severe burns due to leaking iron can occur as a result of a mould fracture. Fractured moulds always lead to rejects!

Now the mould is carefully blown out and cleaned. According to the work plan, it must be checked how many cores belong in the mould.

Even before setting the cores, it is important to observe the following points:

- Define sequence of cores
- Clean cores
- Check if the cores are properly coated
- Control of the coated cores:
  1. No fat edges?
  2. All burrs removed?
  3. Partial surfaces plastered?
  4. Core prints for core venting free of coating?
  5. Marking correct (compare with working paper), cleanly coated and legible?

When installing the cores, always make sure that they are seated correctly. Wall thicknesses must be checked with the probe or by pressing. If cores wobble, they must be supported or tied. Do chaplets have to be set to secure the core against buoyancy during casting?

The most important thing when setting the cores is the careful removal of air.

If the gases produced during the binder combustion process cannot escape freely and unhindered from the mould, the mould „boils“ in the worst case. This inevitably leads to poor quality and, as a rule, to rejection!

Moulds and cores must always have the same temperature.

Once the cores have been set, the mould is carefully blown out and then checked to see whether there are still any impurities in the mould cavity. In the case of undercuts that are difficult to clean by blowing out, the mould must be cleaned by suction with a flexible hose.

Preparing mould for casting

Moulding material residues in the mould lead to the most frequent reworking expenses. Similarly, unclean moulds are one of the main causes of scrap in hand moulding shops.

If inoculating stones are to be inserted into the mould according to the work plan, this must be done now at the latest.

Now the mould should be checked one last time. Any areas that may have been damaged during core setting must be recoated if necessary. Finally, the wall thicknesses must be checked and the cope box pressed down. This should ensure a tight fit of the cope box on the drag box. It must also be ensured that the core prints in the cope box are well sealed and that no burr can form.

If everything is in order, the cope box can be put on. Be sure to use a box guide and guide pins. The mould must be marked with the material and casting weight. Finally, the mould must be weighed down using the weight specified in the working instructions.

Once moulds have been prepared for casting, they may no longer be moved.

During casting, the casting gases produced and escaping must be ignited with a suitable medium (glowing slag skimmer or a long gas lance). In this way, a sudden ignition („banging“) can be prevented, which would possible create such a pressure that could result in mould runout. At the same time, the combustion of the casting and reaction gases prevents the formation of unpleasant smelling and possibly harmful gases.

When the load release time specified in the work instructions has been reached, the weights can be removed. The mould may only be transported to the cooling surfaces after the specified manipulation time (work instructions) has been reached.

Sources and literature

- Gießerei – Lexikon, various editions
- „Formstoffe und Formverfahren“ Flemming, Tilch; Deutscher Verlag für Grundstoffindustrie, Leipzig 1993; ISBN 3-342-00531-9
- Various training documents
- „Guß- und Gefügefehler: Erkennung, Deutung und Vermeidung von Guß- und Gefügefehlern bei der Erzeugung von gegossenen Komponenten“; Stefan Hasse; Fachverlag Schiele & Schön GmbH Berlin; 1999; ISBN 3-7949-0639 X

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Appendix

Coating

Our coatings are much more than a pure release agent between sand and metal. They are high-tech systems that decisively determine the surface quality of the casting and specifically eliminate typical surface defects on the casting.

Water-based coatings

Product	Color	Application: Dipping	Application: Flowcoating	Application: Spraying	Application: Brushing	Binder: Epoxy-SO_2	Binder: Cold Box	Binder: Hot Curing System	Binder: Silicate / Resol-CO_2	Binder: No-Bake	Metals: Steel	Metals: Manganese steel	Metals: GI	Metals: DI	Metals: Copper	Metals: Aluminium	Application: Typical application	Properties: Solvent	Properties: Veining suppression	Properties: Metallization protection	Properties: High gas permeability	Properties: High layerforming possible	Properties: Matting time	Properties: Special effects	Properties: Density (undiluted) g/cm³
CERAMCOTE AL-Series		▪	▪	▪	▪											▪	Full Mould and Lost Foam Process	W	▪	■	▪	■	•	Excellent application properties	1.4
CERAMCOTE FS 402		▪	▪	▪	▪								▪	▪			Full Mould and Lost Foam Process	W	▪	■	▪	■	•	Excellent application properties	1.7
CERAMCOTE FS 503		▪	▪	▪	▪						▪	▪	▪	▪			Full Mould and Lost Foam Process	W	▪	■	■	■	•	Excellent application properties	1.8
MIRATEC AC 503		▪		▪			▪	▪								▪	Aluminum casting (e.g. engine blocks)	W					●●	Excellent release properties	1.5
MIRATEC BD-Series		▪					▪							▪			Automotive casting (e.g. brake disks)	W	■	▪	■	■	●	Short matting time	1.3
MIRATEC TS 416		▪					▪							▪			Automotive casting (e.g. brake discs, cylinder heads)	W	■	▪	■	■	●	short matting, reduced retaining dust in casting	1.3
MIRATEC DH 402		▪	▪				▪	▪						▪			Universal coating (e.g. housing elements)	W	▪	▪	■	▪	●	Enhanced refractoriness	1.4
MIRATEC GH 401		▪					▪	▪						▪			Universal coating (e.g. gearbox housings)	W	▪	▪			●		1.4
MIRATEC HC 501		▪					▪	▪						▪			Automotive casting (e.g. engine blocks & hydraulics castings)	W	▪	■			o		1.4
MIRATEC HY-Series		▪				▪	▪	▪	▪	▪			▪	▪		□	Automotive casting (e.g. cylinder heads, engine blocks)	W	■	■	▪	▪	●	Alcohol-dilutable	
MIRATEC MB 422 / 522 / 622	div	▪		▪		▪	▪	▪					▪	▪			Universal coating newest generation	W	■	▪	▪	▪	●●	with / without grafit content available	1.3
MIRATEC MB 501		▪					▪	▪						▪			Automotive casting (e.g. cylinder heads, engine blocks)	W	■	▪		▪	●		1.4

E = ethanol, I = isopropyl, W = water, □ = partly suitable, ▪ = suitable, ■ = particularly suitable, •• very slow, • slow, o medium, ● fast, ●● very fast

Water-based coatings

Product	Color	Applica-tion				Binder					Metals						Application	Properties							
		Dipping	Flowcoating	Spraying	Brushing	Epoxy-SO_2	Cold Box	Hot Curing System	Silicate / Resol-CO_2	No-Bake	Steel	Manganese steel	GI	DI	Copper	Aluminium	Typical application	Solvent	Veining suppression	Metallization protection	High gas permeability	High layerforming possible	Matting time	Special effects	Density (undiluted) g/cm³
MIRATEC TS-Series		▪					▪	▪		▪			▪	▪			Automotive casting (e.g. cylinder heads, engine blocks)	W	■	■	■	■	●●	Reduced retaining dust in casting	1.3
MIRATEC TS 417		▪					▪	▪		▪			▪	▪			Automotive casting (e.g. cylinder heads, engine blocks)	W	■	■	■	■	●●	Reduced retaining dust in casting	1.3
SOLITEC AD-Series				▪	▪											▪	Aluminum - permanent die casting	W						Long life of die; clean casting surfaces	
SOLITEC CC-Series				▪	▪				▪	□	▪	▪		▪	▪		Centrifugal casting	W		■	▪	▪		Different insulating properties adjustable	
SOLITEC HI 703		□	▪	▪	▪	▪			▪	▪			▪	▪	▪		Heavy casting (e.g. wind power rotor hubs, water- and steam-operated turbines)	W		■			●	High degree of refractoriness; disables grafite degeneration; zircon-free	1.8
SOLITEC HY-Series			▪	▪	▪	▪	▪	▪	▪	▪			▪	▪		□	Universal coating (e.g. machine housings)	W	■	■			O	Alcohol-dilutable	
SOLITEC IM 702		▪	▪	▪	▪	▪	▪	□	▪	▪	▪	▪	▪	▪	▪		Steel- & Heavy casting (e.g. machine platforms, naval Diesel engines)	W		■			●●	Impregnating coating; zircon-free	1.9
SOLITEC MS-Series		▪	▪	▪	▪								▪	▪	▪		Ladle and pouring spoon	W						Reduces slag adherence	
SOLITEC ST 901			▪	▪	▪		▪	▪	▪	▪	▪	□	▪	▪	▪		Heavy casting (e.g. wind power rotor hubs)	W	□	■			O		
SOLITEC ST 801		▪	▪	▪	▪					▪	▪	□	▪	▪	▪		Heavy & steel casting (e.g. pump housings)	W	□	■			O	Zircon-free	2.0
SOLITEC WP 401			▪	▪	▪		▪	▪	▪	▪			▪	▪		□	Heavy casting (e.g. wind power rotor hubs, water- and steam-operated turbines)	W	■	■			O	Fastened drying on air; disables grafite degeneration; zircon-free	1.5

E = ethanol, I = isopropyl, W = water, □ = partly suitable, ▪ = suitable, ■ = particularly suitable, ●● very slow, ● slow, O medium, ● fast, ●● very fast

Alcohol-based coatings

Product	Color	Application: Dipping	Application: Flowcoating	Application: Spraying	Application: Brushing	Binder: Epoxy-SO_2	Binder: Cold Box	Binder: Hot Curing System	Binder: Silicate / Resol-CO_2	Binder: No-Bake	Metals: Steel	Metals: Manganese steel	Metals: GI	Metals: DI	Metals: Copper	Metals: Aluminium	Application: Typical application	Properties: Solvent	Properties: Veining suppression	Properties: Metallization protection	Properties: High gas permeability	Properties: High layerforming possible	Properties: Matting time	Properties: Special effects	Properties: Density (undiluted) g/cm³
VELVACOAT AC 501 / 503		▪	▪			▪	▪		▪					▪		▪	Aluminum casting (e.g. housing elements)	E	▪	▪			●●	Retarded flaming	1.1
VELVACOAT CC 601		▪	▪	▪	▪	▪	▪	▪	▪					▪			Universal coating (e.g. socket cores)	E		▪			●	Excellent release properties	1.2
VELVACOAT GH 501 / 502		▪	▪	▪	□	▪	▪	▪	▪	▪				▪	□	□	Pump housings, counterweights, gearbox housings	I/E	■	▪			●●	Cold Box universal coating	1.2
VELVACOAT GH 701 / 702		▪	▪			▪			▪	▪				▪			Electric motor housings	I/E		▪	■		●●	Extreme high permeability; IPA-free availablle	1.1
VELVACOAT HI 602 / 605			▪	▪	▪				▪	▪			▪	▪			Universal coating (e.g. counter weights, wind power rotor hubs, gearbox housings)	I/E	■	▪			●	High yield; IPA-free available	1.5
VELVACOAT HI 704 / 707		▪	■	▪	■	▪	▪	▪	▪	▪				▪			Universal coating (e.g. medium-sized gearbox housings, pump housings)	I/E	▪	■			●	Improved remixing; less setting property	1.5
VELVACOAT HI 703 / 733		▪	■	▪	▪	▪	▪	▪	▪	▪			▪	▪	□		Heavy casting (e.g. wind power rotor hubs, water- and steam-operated turbines)	I		■			●	High degree of refractoriness; diables grafite degeneration; zircon-free	1.6
VELVACOAT IM 701			▪	▪	▪	▪	▪	▪	▪	▪	▪	□	▪	▪	▪	▪	Universal coating (e.g. medium-sized gearbox housings, pump housings)	I		■			●	Impregnating coating; zircon-free	1.8
VELVACOAT IM 801		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪	▪	Universal coating	I		■			●	Impregnating coating	1.8
VELVACOAT IM 801 (DOSE)		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪	▪	Universal coating	I		■			●	Impregnating coating; ready to use in spray cans	1.8
VELVACOAT RP 901		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪	▪	Rapid Prototyping, all alloys	I		■			o	Excellent application properties; water-free system	1.9
VELVACOAT ST 603 / 606		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	▪	Heavy & steel casting (e.g. pump housings)	I		■			o	Excellent flooding properties	1.7
VELVACOAT ST 702		▪	▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪	▪	Heavy & steel casting (e.g. pump housings)	I		■			o	Excellent flooding properties; water-free system	1.9
VELVACOAT ST 701 / 707			▪	▪	▪	▪	▪	▪	▪	▪	▪		▪	▪	▪		Heavy & steel casting (e.g. water- and steam-operated turbines)	I		■			●	High degree of refractoriness	2.2
VELVACOAT ST 801		▪	▪	▪	▪	▪			▪	▪	▪	▪	▪	▪	▪		Heavy & steel casting (railroad switches, mill work parts)	I		■			o	Manganese steel / universal; water-free system	1.8

E = ethanol, I = isopropyl, W = water, □ = partly suitable, ▪ = suitable, ■ = particularly suitable, •• very slow, • slow, o medium, ● fast, ●● very fast

Auxiliary materials product range

Release agents and auxiliaries from ASK Chemicals are characterised by their performance and efficiency. ECOPART release agents are environmentally friendly and extremely safe to use.

	Product	
Release agents	**ECOPART 24**	Free of chlorinated and fluorinated chlorinated hydrocarbons
	ECOPART LP 89	Release agent containing aluminium pigments with excellent release effect
	ECOPART 80 S	Blue colour shows where release agent has already been applied.
	ECOPART 84 S	Blue colour shows where release agent has already been applied
	ECOPART 102 C	Release agent with 100 % active substance
Adhesives	**ASKOBOND CG 16**	Highly refractory paste on aqueous basis
	ASKOPASTE GF 2	Adhesive, core lubricating paste and "liquid" cope seal
Cope seals	**ASKOROPE**	Plastic, asbestos-free moulding box sealing ropes

Mini risers and riser caps

Mini risers and riser caps from ASK Chemicals stand for highest quality and process reliability in the foundry. Our patented exothermic technology is unique in terms of its efficiency – in conjunction with developments increasing productivity, it can even be considered a leader in the industry. Our products are available both as inorganic and cold box versions.

cast material	Molding process	Application	EXACTCAST mini risers: ADS and KMV	ADS and KMV with breaker core	FDS	KMV QT	BKS and KMV QM	KIM	KIM QM	OPTIMA KL and KMV CC	EXACTCAST caps and tubes: KP	KP with breaker core	KI	KI with breaker core	KT (insulating)
GI	Machine molding	put on mold	▪	▪	▪	▪	▪	□	▪	■	▪	▪	▪	▪	□
		insert in mold						■			▪	▪	▪	▪	□
	Hand molding	put on mold	■	▪		▪		▪			▪	▪	▪	▪	□
		insert in mold						■			▪	▪	▪	▪	□
DI	Machine molding	put on mold	▪	▪	▪	▪	▪	□	▪	■	▪	▪	▪	▪	□
		insert in mold						■			▪	▪	▪	▪	□
	Hand molding	put on mold	■	▪		▪		▪			▪	▪	▪	▪	□
		insert in mold						■			▪	▪	▪	▪	□
CGI	Machine molding	put on mold	▪	▪	▪	▪	▪	□	▪	■	▪	▪	▪	▪	□
		insert in mold						■			▪	▪	▪	▪	□
	Hand molding	put on mold	■	▪		▪		▪			▪	▪	▪	▪	□
		insert in mold						■			▪	▪	▪	▪	□
GS	Machine molding	put on mold	▪[1]	□	□	□	□	□	□	□	▪	■	▪	▪	□
		insert in mold						▪			▪	▪	▪	■	□
	Hand molding	put on mold	▪[1]	□		□		▪			▪	▪	▪	■	□
		insert in mold						▪			▪	▪	▪	■	□

□ = partially suitable, ▪ = suitable, ■ = recommended

1 = the big KMV risers are particularly suitable, 2 = FDS risers in a special version for Al are possible

Filters

With UDICELL and EXACTFLO filters, foundries use an efficient filtration technology that guarantees the highest casting quality thanks to cleaner cast metals. Our filters are recommended tor steel and iron casting as well as for non-ferrous metals.

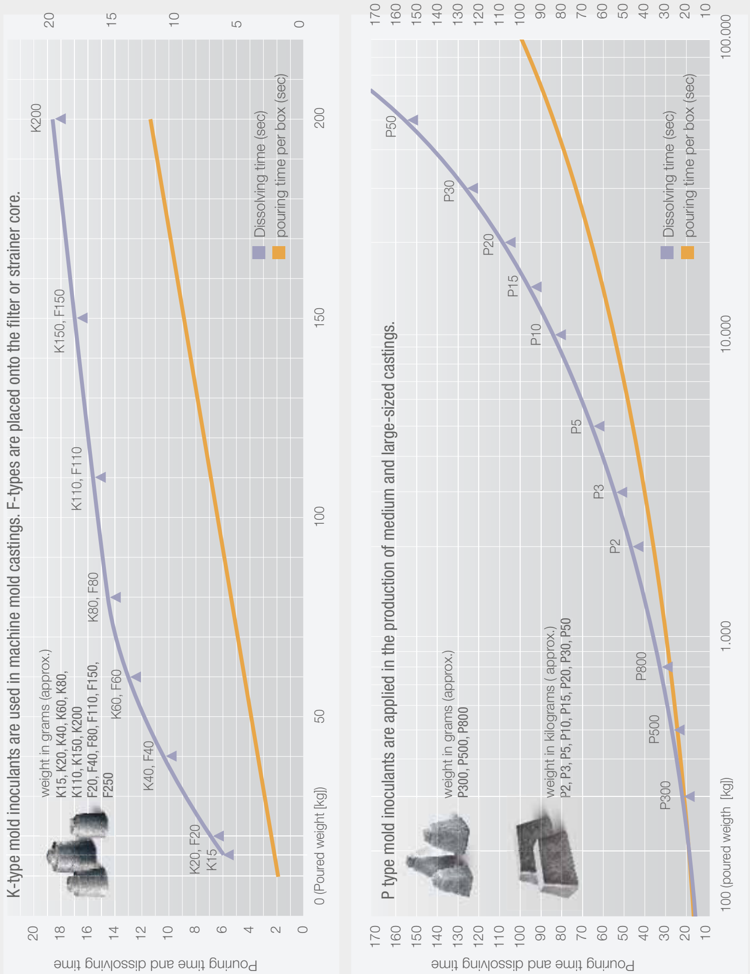
Rough classification	Material	Molding process / alloy	Typical filter qualities used	UDICELL PSZT	UDICELL PSZM	UDICELL CB	EXACTFLO SIC	EXACTFLO Alumina	EXACTFLO P
Ferrous and steel casting	GI	Machine molding	Silicon carbide (SiC), pressed filter				■		▪
		hand molding / large castings	Silicon carbide (SiC), pressed filter	▪	▪		■		▪
	DI	Machine molding	Silicon carbide				■		□
		hand molding / large castings	Silicon carbide (SiC), pressed filter , Zirconia filter, carbon-bonded filter	▪	■	▪	▪		□
	CGI	Machine molding	Silicon carbide (SiC), pressed filter				▪		▪
		hand molding / large castings	Zirconia filter, carbon-bonded filter	▪	■	▪	▪		□
	GS	non- / low-alloyed	Zirconia filter, carbon-bonded filter	■	▪	■			□
		high-alloyed	Zirconia filter	▪	■	□			□

□ = partially suitable, ▪ = suitable, ■ = recommended

Mould inoculants

GERMALLOY and SMW inserts are solid cast inserts used for the mould inoculation of ductile iron. They are placed either in the gating system of the mould or, in the case of large casting moulds, in the pouring basin. GERMALLOY is used to improve the nodule count of graphite within a casting, as well as enhance its mechanical properties. SMW inserts in combination with GERMALLOY further increase the nodule count and prevent the formation of chunky graphite. OPTIGRAN is the mould inoculant for grey cast iron. A finer, evenly distributed A-graphite can thus be achieved.

Pouring and dissolving time of ASK Chemicals mould inoculants*



Dissolving time depends on poured weight.

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