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Inorganic core production and casting application

Dipl-Ing. Klaus Löchte,
Hüttenes-Albertus GmbH, Wiesenstraße 23/64, 40549 Düsseldorf, Germany

1. Introduction

Inorganic binders for core production are known in the foundry industry for more than 50 years. Their heyday was in the 1950s and 1960s. With the upcoming of the Cold-Box-Process, the Waterglass CO_2-Process stepped back more and more. There are manifold reasons, just to mention a few: flowability of the moulding material as well as the bending strength of the cores were far behind the CB-Process.

Beginning of the year 2000 stricter environmental regulations came into force – particularly the protests by residents were decisive for the foundries to pose the question, if there is a less odour stressed core production process. The first inorganic systems were developed by binder supplier – these systems had taken a rapid development within the last 10 years.

Nowadays the leading german automotive manufacturers with own foundries – but also automotive suppliers – implement inorganic systems for core production.

Bild 15: Detailansicht Greifer.

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Figure 1: Core Package taken to the die by manipulator

2. Basics of the IOB Systems

The Cordis Binder System is a complete inorganic two-component system.

Cordis:

- modificated silicate solution
- solvent water => frost product
- low viscosity (20 – 50 mPa·s)
- Density approx. 1,1 – 1,4 g/cm³

Anorgit:

- Systemic inorganic powder
- Bulk density 400 – 600 g/L
- Store under dry conditions

3. Chemistry of process

The above mentioned substances Cordis and Anorgit will be added to the silica sand und mixed with it. This moulding material will be blown into the core box, the hardening take place by the hot core box (150° - 200°C) while the solvent water is escaping/leaking. However, the more effective way to extract the water is purging with warm air (140°C). The curing takes place by a drying process. The Anorgit contains a reactive part, this cause a chemical hardening reaction. The sand grains will be linked three-dimensional - like the organic systems.

4. Equipment

4.1. Dosage and mixer

Each customary dosing component can be used for dosing the liquid component Cordis. Attention should be paid that Cordis is a highly alkaline liquid! Added amount is 2,0 – 2,6% referring to the silica sand.

For dosing the powder component Anorgit customary dosing screws with upstreaming weighing cell can be used. Please note that an amount of 0,6 – 1,6% must be added referring to the silica sand.

4.2. Core shooter

It is possible to modify already existing core shooter for the inorganic process. In most cases it is better to buy a new core shooter already constructed for the inorganic core production process.

If already existing core shooters are modified, it is necessary to pay attention to protect machine components against thermal radiation. It begins with movable machine components and ends with the storage container for the moulding material. The container should also be water-cooled as well as the shooting nozzles – this prevents the drying of the moulding material during storage. Several

manufacturer of core shooter offer an additional moistening of the moulding material from above, others offer slide controller for the container. If it is possible regarding to the core box design, no shooting nozzles (dipping nozzles) should be used with a smaller diameter than 6 mm. Furthermore the weight of the core box used for the Inorganic is important – this is often higher than the one of a core box used for CB-Process.

4.3. Core boxes

The core box for the Inorganic should be manufactured with a heat resisting material that also withstands the mechanical stress during the core shooting, f.e.
Core box material
Tool Steel Types C45 W3
Material No 1.1730 or X38CrMoV51

The core box design should ensure running temperatures up to 200°C and more as well as a good and quick passage of warm and hot air to achieve short cycle times. This means an even temperature of approx. 140°C during the whole air purging cycle.
The following possibilities are available for heating the core boxes:

- Electric heating
- Steam heating
- Heat transfer liquid

5. Core production

During the core production is to be noted – as in the case of the other hot curing processes – that the thickness of the cured border area is sufficient for transport and moving of the cores. It depends on the used binder – but most of all of the interaction between core box temperature and length of purging time with warm air.
During the core production the thickness of the builded border area should be proved from time to time. If the area isn't thick enough, the core will break while removing of the core box. A sufficiently strong border area contains a part of not cured moulding material in the inner core. If the core is casted shortly after production, the not cured moulding material could lead to gas defects on the casting. If the core is stored (24h) the curing take place.
The curing will be accelerated by conduction of hot air. Thick-walled cores won't be cured during the machine cycle time, otherwise the productivity will suffer. The binder bridge of an inorganic core points a very brittle and glassy look. This brittleness also appears with the Warm Box Systems, which contains a high content of furfuryl alcohol. With these brittle systems a good maintenance of the core shooter is absolutely necessary.

6. Core storage

The inorganic core gets his bending strength by extraction of moisture. We are talking about a physical hardening. This factor has an influence on the core storage during the different seasons. During the winter the air can't store as much moisture as in the summer. So one could abandon a climatic core storage in the winter. During summer the inorganic cores should be stored under climatic conditions that means RH < 50%, better < 30% with a temperature of 20° - 25°C. Under these conditions and with the modern Cordis / Inorganic Systems the storage for five working days is guaranteed.
With the implementation of the Inorganic in the foundries the operating procedures also changed. For example the total linked inorganic core production for the cylinder head production at VW (Article Gießerei 07/2014).
During the past the work in this foundry was done like in any other foundry: the cores were produced and stored up to the time of need. The Inorganic changed this procedure. Today the core shooters are situated close to the casting table.
The cores will be removed by manipulators, another manipulator deburrs the cores. At the end of this process the core package will be manually assembled by employees. The tablet with the core package will be moved to the casting table where it is inserted into the die by manipulator and casted. There is no traditional core storage with this procedure. It is a just-in-time-production or a total linkage.
The above mentioned way of core production without core storage is not necessary to use the advantages of the Inorganic. Most of our customers are working with the climatic core storage.

7. Advantages of the Inorganic

- No emission => smaller extraction units
- No condensation in the die
- Less tool wear
- Extended die lifetime