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Inorganic Technology – The End of Shell Sand?

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The Inorganic Technology (INOTEC) has proven to be especially suitable for aluminum casting applications, particularly for the manufacture of aluminum engine blocks and cylinder heads in permanent mold casting.
Odorless core production, no harmful emissions during casting, less cleaning of machines and tools, the resulting higher output and productivity, and the advantages in terms of casting, such as faster solidification due to reduced die mold temperatures – these benefits of INOTEC are already well-established when compared to classical organic binder technologies.[1-2] More and more foundries are converting from organic to inorganic binder systems – and there are several reasons for this trend.

Keywords: *INOTEC, Inorganic Binders, Shell sand, odorless, no emission, aluminum castings*

1. Introduction

Shell sand is a resin coated sand – typically silica sand but also more special ceramic sands.

INOTEC is an inorganic binder system which is based on two different components – a liquid INOTEC binder and a solid component – the so-called INOTEC Promotor. The latter component is not just an additive but rather a part 2 of the binder system as important properties are associated with it – such as initial strength, thermal stability, shake-out etc. Both of these components are mixed together with the refractory material in a mixing unit prior to their use.

2. Core manufacturing – similarities and main differences

Both binder systems are cured in a hot core box. Shell sand requires typically temperatures of higher than 250°C which are usually realized by electrical heating or gas burning heating.

INOTEC is typically cured in the temperature range between 150 and 210°C depending on the core geometry – significantly lower than that of shell sand, thereby offering the chance for energy and cost savings. Furthermore, the heating can be done electrically but, however, oil heating would be the method of choice due to the fact that the temperature only varies in a very narrow temperature range and therefore makes the process more stable. One crucial aspect for INOTEC is the hot air purging to accelerate the curing process. Such a purging is missing in the Shell-sand process.

There is a potential to decrease cycle times when using INOTEC compared to the traditional shell sand process. This may offer great opportunities to increase productivity in the core production.

Strengths values (both hot and cold) are high enough for the INOTEC cores to be handled. Care must be taken only in regard to the brittleness which is typically higher than that of shell sand cores. In this way INOTEC is rather comparable to glass, while shell sand is comparable to plastic. Once this is known in the core shop, core handling should not be a problem. Additionally, it must be noted that inorganic cores have – by nature – a higher affinity to water. Thus storage stability is more critical than in case of shell sand cores. Inorganic cores need to be protected from long exposure to high humidity. However, by recent product developments, ongoing efforts in research and development as well as the choice of proper storage conditions, significant improvements could be made to improve the humidity resistance of inorganic cores.

Shell sand has – by nature of this material – probably the best flowability properties of all sand/binder systems – there are almost no limitations in geometry. However, complex core geometries like water jackets of cylinder heads are also successfully produced in series production every day using the INOTEC binder system. This is thanks to both continuous product optimization and to substantial technical adjustments in terms of core box design but also in the core print design which is nowadays especially suited for the needs of inorganic binders systems.

One thing is without any doubt: INOTEC cores do not lead to any smoke or odor formation during core manufacturing which is in great contrast to shell sand cores.

3. Casting production

In case of shell sand there is a significant amount of smoke and gas that is generated during the casting process. Such a smoke formation is a result of the thermal decomposition of the organic resin leading to all different kinds of toxic organic substances which are emitted to the environment. Such a gas/smoke evolution could also generate some gas defects inside the casting if such gases are not properly driven out by vacuum systems. Furthermore the generated smoke leads to a tar build-up not only on the die molds but also in the air cleaning systems – thereby leading to additional cleaning efforts.

In case of the INOTEC binder system there would be no smoke formation as the nature of the binder can be entirely inorganic. As a consequence there is no tar formation on the die molds leading to less cleaning efforts and consequently less costs. However, it has to be noted that inorganic cores also generate gas to some extent during the casting process. This is related to the fact that inorganic binders still contain some residual water content to keep the silicate gel structure and therefore the binding properties “alive” and is further related to the core gas that will expand when exposed to heat. In particular for water jackets in cylinder heads such gas needs to be driven out by a proper vacuum system – similar to the shell sand but significantly less gas formation.

Due to the missing condensate build-up the die mold temperatures may be reduced leading to reduced solidification times of the liquid aluminum. All this can lead to an increase of productivity in the casting process – so there is a potential to produce more castings within the hour in case of INOTEC.

Furthermore, it has been shown that – as a result of faster solidification – secondary dentrite arm spacings are reduced which leads to better strength properties of the castings. Thus, inorganic binder systems offer great opportunities for future developments.

Just recently, a German automotive company revealed a new central feeding concept which is only possible when using inorganic binder technology because of the missing smoke and condensate formation. [2]

Shell sand is usually known for its high thermal stability leading to dimensional accuracy of the casting. INOTEC basically offers the chance to adjust the thermal stability according to the specific needs of the cores because the thermal stability is directly dependent on the chemical composition.

Last but not least, in case of inorganic binders no air cleaning systems and no after-air treatments are necessary due to missing smoke formation during the casting process. This is a great advantage to protect the environment and the employees working in the foundry.

4. Conclusion

“INOTEC – the end of shell sand?” is quite a provoking question. Certainly, INOTEC cannot outperform shell sand in every regard, but for sure in many ways. Given that the general trend towards green technologies holds on and governmental restrictions regarding emissions become stricter, more and more foundries will be converting from organic to inorganic binder systems.

But is not just the environmental aspect but also other potential benefits like increased productivity during core manufacturing and the casting process as well as new technological possibilities.

INOTEC has certainly proven to be more than just an alternative in aluminum die mold applications – such as the manufacture of cylinder heads.

References

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