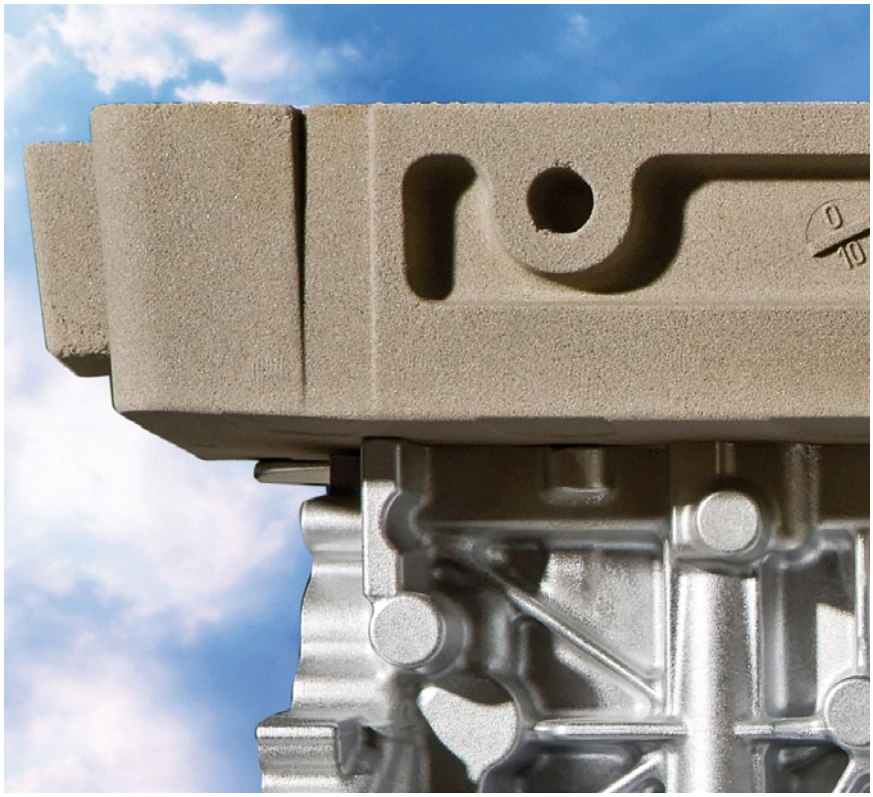
Internet-PDF from "Casting Plant & Technology " 4 / 2013, pages 8 – 10

Authors: Antoni Gieniec, Dr. Jens Müller, Pierre-Henri Vacelet, ASK Chemicals GmbH, Hilden

Innovative binders for eco-friendly and highly productive processes

The continuous evolution of castings with regard to their complexity and increased dimensional accuracy as well as environmental aspects have an impact on the choice of core and molding material, the coating as well as – in particular – the binder. This article provides foundrymen with an overview of recent developments in various binder systems

The foundry industry in Germany has found itself under intense competitive pressure for many years now. Environmental regulations and the interests of local residents often mean that foundries have to implement measures aimed at reducing emissions. Fulfilling these requirements often entails high levels of investment, unfortunately often with little financial payback. Of course, expectations are also increasing in terms of the demands placed on the casted parts. Foundries have to be able to turn the complex ideas of the design engineers into reality. Ultimately, casting buyers ruthlessly choose on price alone when placing contracts, regardless of whether they are buying for the automotive industry or for medium-sized mechanical engineering companies. Good quality and on-time delivery are expected as a matter of course.



Low-emission and high-performance binder solutions promote a sustainable production of sand cores and associated castings (Photo: ASK Chemicals)

Modern emission-reduced cold box HE binder systems

The environmental disadvantages of conventional binders result from their composition, with the main constituents being a phenol formaldehyde resin in solution in part 1 and diphenylmethane diisocyanate (MDI) in solvents in part 2. The pyrolysis triggered by the hot melt during casting causes the release of BTX (benzene, toluol and xylene) and further aromatic compounds from which benzene derivatives arise. The air that is mixed with this must be immediately extracted and purified – a complex and expensive process. For this reason, ASK Chemicals, Hilden, Germany, initiated a series of detailed investigations into the development of new cold box binder systems.

The starting point for the development concept was to improve the efficiency and yield of the system through increased reactivity and therefore reduced use of binders for the core production. This has been achieved with the aid of a newly developed procedure involving resin synthesis with specially coordinated solvent combinations. The resulting reactivity of the binders provides the cores with enough strength to ensure that the subsequent process steps can take place without any problems.

The core strength achieved in this way makes core production more reliable, while at the same time reducing rejection rates (**Figure 1**).

Using less material also means less condensate, which can otherwise be deposited in the molds and then needs to be removed with a lot of care and effort. Cleaning times are significantly reduced as a result. Consequently, productivity is dramatically increased thanks to increased mold availability. In summary, this development will deliver savings and important economic benefits for foundries.

HE (high-efficiency) cold box binder systems are therefore much more efficient than standard binder systems. Although they cost more, the potential savings and additional benefits associated with their use easily recoup this outlay. The additional boost to the availability of the molds, the reduced reject rates and the reduced operating costs for core shooting can amount to several tens of thousands of euros per year.

The advantages for foundries are clear: Emissions are significantly reduced, costs associated with materials, storage and disposal are cut dramatically, and production becomes more efficient overall.

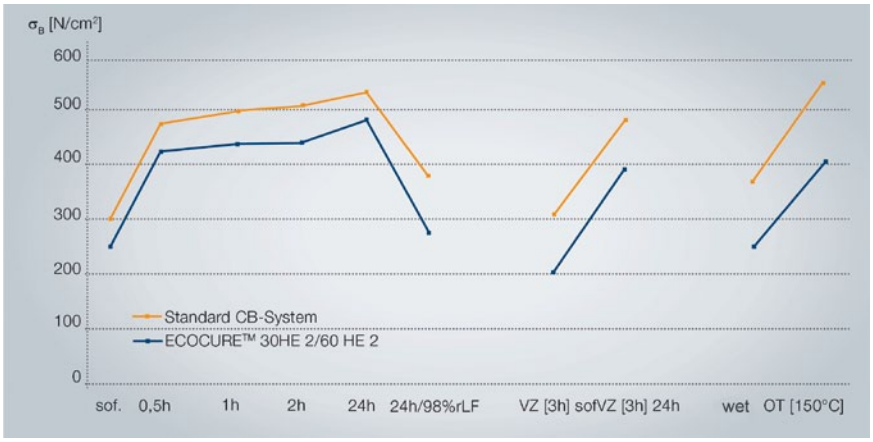


Figure 1: A comparison of strength curves

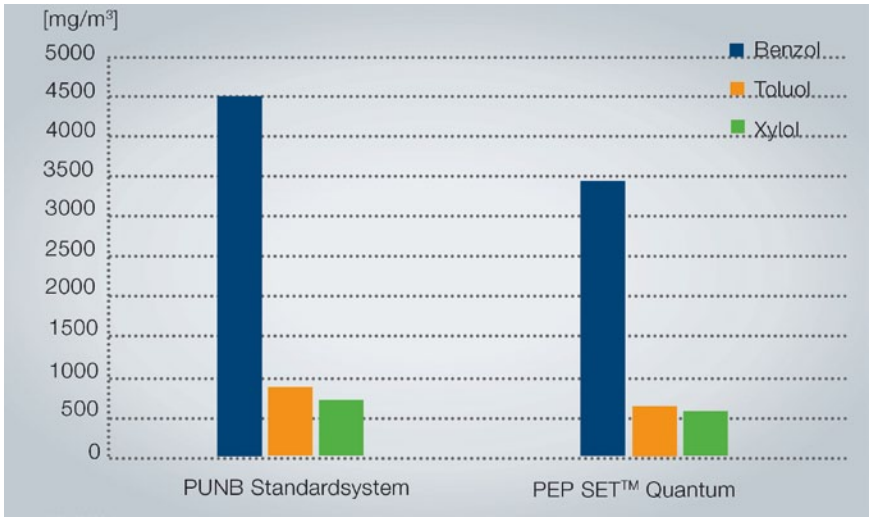


Figure 2: Noxious emissions (BTX) from a PUNB standard system compared with PEP SET Quantum

Innovative polyurethane no-bake systems and furan resin systems with reduced emissions

Of course, the primary concerns when it comes to make the best choice of polyurethane no-bake systems or furan resin systems are performance and cost-effectiveness. But any analysis of the cost-effectiveness of mold production technology must look beyond just the price per unit weight and also consider yield, processing parameters (processing and mold release times) and the quality of the products produced using this binder. Technology is increasingly being assessed in terms of environmental aspects such as emissions during mold production and during casting. The regeneration capacity of the released sand should also be taken into account in cost analyses.

The sand-related technical properties of a polyurethane no-bake system and the resulting strength values are excellent, as is the ratio of sand mixture processing time to mold release time, and this enables a dramatic increase in productivity. One of the strengths of the polyurethane no-bake technology is the excellent surface quality of the cast part, but this is countered by the relatively high emissions (**Figure 2**), the strong odor and the smoke produced during casting. These factors are likely to hinder widespread acceptance of this technology in European foundries. With the development of the PEP SET Quantum Binder, this hurdle has been overcome. Thanks to this new technology, the smoke intensity can be reduced by between 40 % and 50 % compared with a standard polyurethane system. The performance-to-cost ratio of a PEP SET Quantum System is among the best in the field of self-hardening processes.

A latest-generation binder has also been developed in the field of tried-and-tested furan resins. The development of new resin qualities with a level of furfuryl alcohol below 25 % as a monomer was initiated by the classification of furfuryl alcohol as "toxic". The reduction in the proportion of monomer furfuryl alcohol in a furan resin is made possible thanks to a special technique for the condensation reaction. In the process, the sand and casting-related technical properties remain virtually unchanged. By contrast, measurements in a number of foundries have shown that the FA emissions can be reduced by up to 75 % (**Figure 3**).

Potential of inorganic core production

For many years, inorganic core production has been much more than just an alternative to conventional methods. However, the advantages of inorganic binders are not restricted to merely the avoidance of emissions. The omission of complex exhaust air systems, reduced maintenance requirements for tools and machinery, and the resulting increase in productivity in casting processes are just some of the advantages of inorganic technology.

Inotec by ASK Chemicals offers users huge potential in terms of the casting technology and component properties. Instead of the limitations formerly experienced regarding the temperature control of molds in aluminum casting caused by the generation of condensates during the casting process with organic binders, the inorganic system offers whole new levels of freedom and potential [1, 2]. Many OEMs in the automotive sector are already incorporating these findings in their designs for new engines capable of withstanding even higher operating pressures while reducing overall consumption.

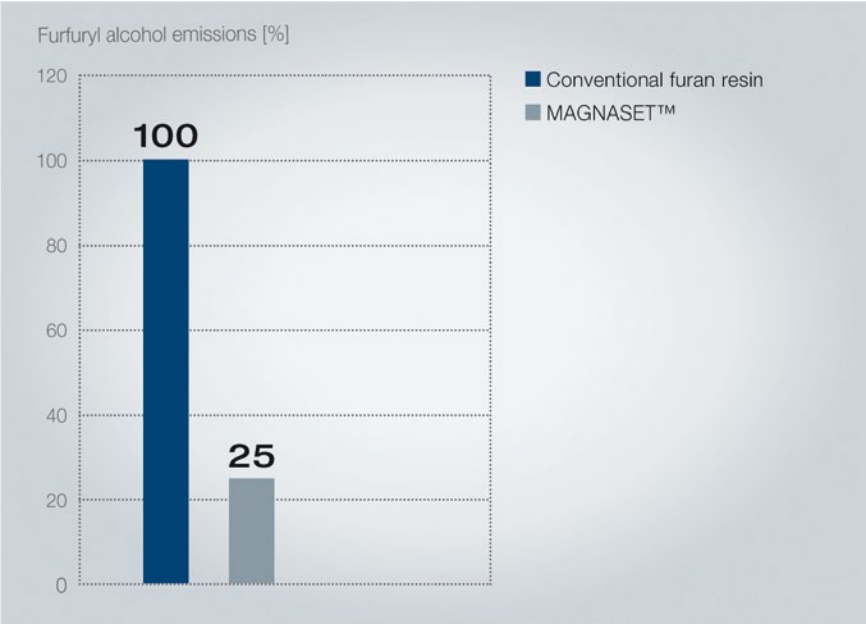


Figure 3: Reduction of FA emissions by up to 75 % due to the use of Magnaset

Summary

The need to reduce emissions while keeping production on a commercially viable footing demands innovative solutions. This is also especially relevant in the field of core production, because the use of suitable binders can deliver high efficiency values.

In this process, the ability of the foundry to compete remains the most important objective: quality and functionality as well as costs are decisive factors. Environmentally friendly conduct is increasingly taken for granted.

One major aspect of research and development at ASK Chemicals are low-emission and high-performance binder solutions that promote a sustainable production of sand cores and castings.

www.ask-chemicals.de

References:

www.giesserei-verlag.de/cpt/references