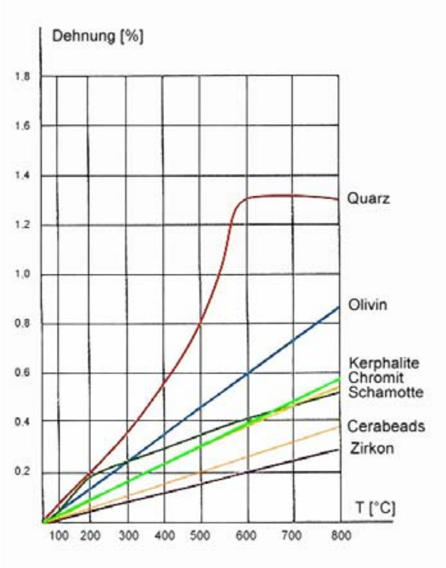
Resin Coated Special Minerals and their Application in Foundries

Introduction

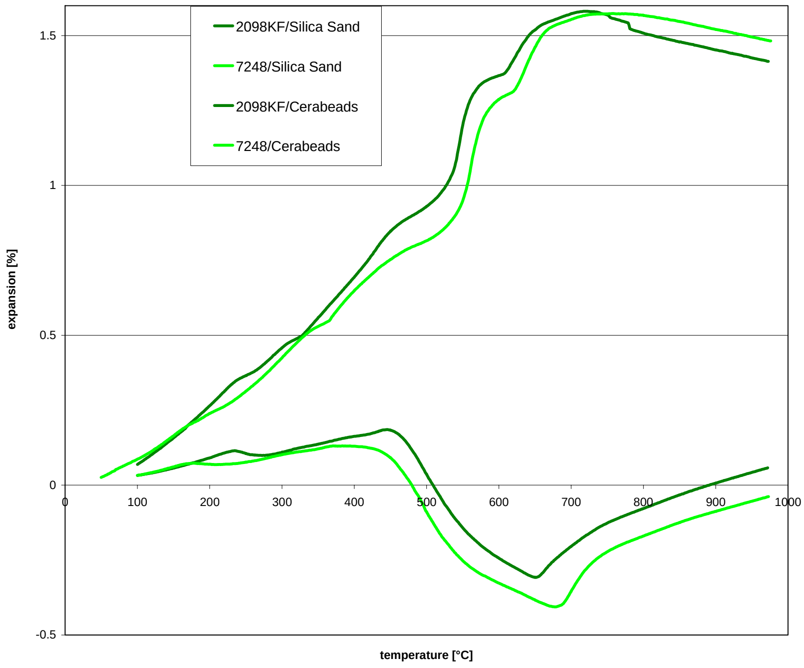
The quality demands on castings are increasing steadily. Reduction of costs for the castings are necessary and can be reached by different ways. Regarding remachining and dressing of castings there is a large potential to reduce the costs. Even a reduction of the tooling allowance can help on this target.
Resin coated sand is commonly based on silica sand and in most cases satisfactory. Regarding high quality castings the use of special minerals in the shell process gets more and more indespensable and useful.
Zircon, chromite and chamotte sand are well-known in foundries and used for many years in the different core and mould making processes. Kerphalite (Andalusite) and Cerabeads become important substitutes and show advantages.
The behaviour on thermal expansion can be visualized by the use of a dilatometer. For this the minerals need to be milled and the test bar is bonded with an ethyl silicate binding system. The influences of the grain distribution and the different binding systems can not be shown by this method.
By the use of a specially prepared dilatometer it is possible to visualize the interplay between coating resins and minerals. Laboratory testing gets a little bit closer to the conditions in foundries.

Thermal Expansion

Silica sand is the most commonly used material in foundries. The SiO_2 content is at least 98%. Due to the Quartz expansion at approx. 573 ° C is silica sand not suitable for all needs of the castings. Defects due to sand expansion cause rework and waste. This negative characteristic can be reduced in applying modified binder systems and/or additives added to the sand mixtures. However, an essential change of the sand expansion characteristics can only be reached by application of special raw sands, e.g. zirconium, chromite and others (picture 1).

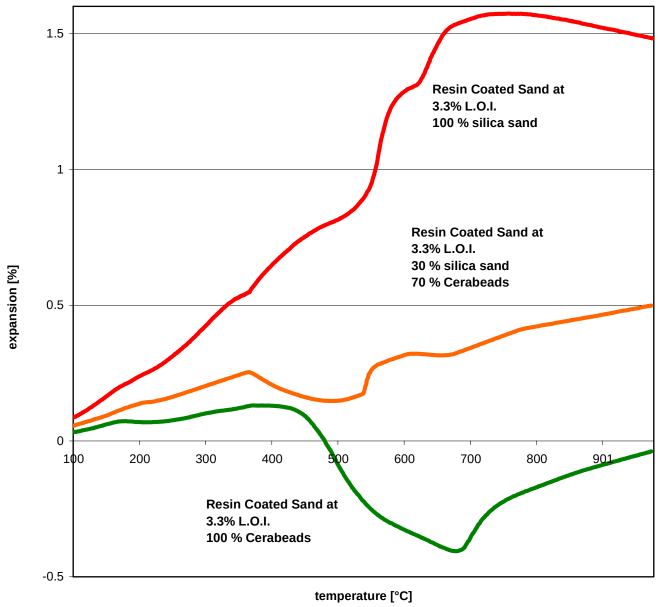


To visualize the influence of the binder systems and the different raw sands the University Duisburg-Essen, faculty 5, professorship “Employment of Energies /Refractory Materials Building” developed a method to measure and describe the thermal expansion under consideration of the grain size distribution of the raw sands and the binder type. The furnace chamber of a Schubstangen-Dilatometer is flooded with inert gas (nitrogen) and the core sample will be heated to approx. 1000 °C with a heating rate of about 10 K/min. The core sample is manufactured by the different process-typical parameters.



Picture 2 shows on the one hand the difference between a highly condensed pure and a modified Novolac, on the other hand it visualizes the significantly stronger influence of the sand base. In employing 100% Cerabeads at a similar loss of ignition / resin input the expansion is reduced so strongly that the core sample shows a shrinkage.

For the application in foundries, by mixtures of special sand (here: Cerabeads) with silica sand can a sufficient reduction of the sand expansion process be reached to avoid sand expansion defects at the core sample (picture 3).



Kerphalite KF (Andalusit)

Kerphalite is characterized by a high temperature resistance and a low linear thermal expansion. Kerphalite KF is used as a substitute for zirconium and chromite sand in mixtures with silica sand from 30 % on up to the pure mineral in the Cold Box, Warm Box und Croning process. Disadvantageous is that Kerphalite KF is a crashed grain (picture 4) and only available in one grain size. Due to the relative high dust loading and the large specific surface is a higher input of binder necessary (up to 25 %) to reach similar strengths.

Zirconium Sand

Zirconum sand has in the past been characterized by the lowest linear thermal expansion and its high temperature resistance. So this zirconium sands were mostly used in hydraulic castings. However, the high bulk density of about 2.7 g/cm³ proved to be a disadvantage, especially resin coated sands that are often used in mixtures of silica and zirconium sands (cost reasons). Due to the big differences between the bulk densities of silica and zirconium sand are segregation effects and other defects during the core manufacturing process possible that lead to rework and waste (picture 5).

Chamotte

Chamotte sand shows a low thermal expansion, too and a higher fire resistance than silica sand. Additionally Chamotte sand has an insulating quality caused by the porosity of the grains. However, this porosity leads to a higher demand of binder (picture 6).

Chromite Sand

Additionally to the known characteristics the chromite sand shows a higher thermal conductivity. It is used where an additional cooling effect should be reached (cooling or chill effect). The disadvantages are similar to the negative characteristics of zirconium sand, caused by the high bulk density. Due to the angular shape of the grains chromite sand leads to a higher tool wear and a higher demand of binder (picture 7).

Cerabeads

Cerabeads are synthetically manufactured and consist of sintered Mullit so that there is a very high temperature resistance. Due to the round grains the Cerabeads show the highest flowability reachable with a sand. The very low thermal expansion (like zirconium sand) makes the application fields comparable. Veining defects and other sand expansion defects can be avoided for sure.

In comparison with zirconium sand show the Cerabeads, with their bulk density similar to silica sand, important advantages. Mixtures of at least 30 % Cerabeads with silica sand show results and allow core sand mixtures at reasonable costs. Such mixtures stay homogeneous while manufacturing.

A good and reproducible gas permeability of the material is reachable due to reproducible sieve analysis. The round grain helps to reduce tool wear (picture 8).

The increasing expectations on casting parts lead to a continuously higher demand of Cerabeads in Germany. Great results could be reached in the field of water jacket cores for aluminium cylinder heads. Just here, the new motor generations need a more and more filigree water jacket design that is even in aluminium casting only possible by using Cerabeads. They keep the tensions within the filigree network of the water jacket cores as low as possible and support an improved gas permeability.

Synopsis

Using the right combination of binder system and „sands“ will enable the foundries to fulfill the highest demands on casting parts and helps to reduce the costs of rework and waste.