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Last developments on low-emission additives for molding sand

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In order to reduce emissions from molding sand systems, an innovative environmentally friendly foundry additive was introduced. Essential component of these additives are special natural graphites with which at least a part of the conventional lustrous carbon formers like sea coal and resins can be substituted. In the last years, the practicability of these system, named LE (low emission) technology, was proved in many foundries. In some foundries, the emission of volatile aromatics from the molding sand could be reduced by up to 80 %.

In addition to the reduction of the emission, graphite acts as a kind of lubricant within the molding sand. This leads to a more homogeneous compaction of the mold, related casting defects can be minimized.

Key words
Reduction emission, BTXE, graphite, molding sand, low emission technology

1. Introduction

Strict rules of the Goteborg protocol stipulate that, from the year 2020 onwards, a drastic country-specific emissions reduction of volatile organic compounds has to be followed. Therefore, the foundry industry has to intensify its efforts to lower its emissions, especially those of volatile aromatics. Thereby, the supplier industry is responsible for offering a technology to the foundry industry with which emissions can be reduced without increasing production costs. This concerns emissions from the lustrous carbon formers of the molding sand system as well as the today commonly used organic cold box binders for cores. Therefore it was the goal of a three year development project to develop an emission-free respectively low-emission alternatives for the lustrous carbon formers like sea coal and resins being in use today in the molding sand.

2. Sources of emission in a grey iron foundry

In a discussion about emissions from a grey iron foundry, it is important to focus on the lustrous carbon formers in the molding sand system as well as on the cold box binders for the cores. During pouring of liquid iron, the lustrous carbon formers in the molding sand are pyrolyzed and form low-boiling aromatics like benzene, toluene, xylene and ethyl benzene (BTXE). At the same time, polycyclic aromatic hydrocarbons (PAH) which have with a high boiling point are formed. Therefore, BTXE aromatics are a topic of gaseous emissions, while PAHs are adsorbed by the molding sand systems. These PAHs can create problems during waste disposal.

The cold box core binders also form low-boiling aromatics as well as PAHs during pouring. In addition, certain amounts of phenol are formed.

3. Technologies to reduce emissions from molding sand

Some different technologies are available to reduce the emissions from molding sand.

One technical solution is the adsorption of the aromatics in an external adsorption unit. Such external adsorption unit offers good efficiency, but additional investments are necessary. This leads to higher total process costs.

Other concepts follow the idea to adsorb the emissions in the molding sand system by adding special adsorber materials like zeolite to the molding sand. Such adsorber materials can offer also good efficiency, but transfer the emission problem from the gas phase to the waste disposal.

4. Low-emission (LE) technology

The most efficient way to reduce the level of emissions from a molding sand system is preventing the formation of toxic aromatics during pouring. The LE technology follows this concept. The challenge of such concept is to find a molding sand additive, which can overtake the function of classic lustrous carbon formers without formation of aromatics during pouring.

Graphite is a natural inorganic carbon-based material, which contains between 70 and 95 % pure carbon. This natural material is available with different morphologies and particle size distributions. All graphite grades are completely emission-free.

A special type of such natural graphite is the key component of the LE technology. This special type of graphite forms – like bentonite – very thin layers that can be separated from each other during the reprocessing of molding sand. By applying shear energy to the graphite agglomerates, the graphite can delaminate in very thin single sheets and can surround the silica grains like sea coal with a thin layer of carbon. So, the wetting characteristics of the silica grain by liquid iron is influenced in the same positive way like with sea coal.

While the morphology of graphite and bentonite is very similar, the surface characteristics are completely different. In contrast to bentonite, graphite has hydrophobic surface properties and therefore can be hardly be wetted by water. While bentonite is wetted very well, bentonite can swell in water very easily and forms well-dispersed bentonite layers which act as binders for the molding sand. Unmodified graphite is not wetted by water and swims on the surface in the form of coarse agglomerates. However, as the coverage of silica grains with graphite has to take place during molding sand processing in the mixer, the wetting of graphite by water has a special importance. When suitable dispersing agents are present, the dispersion will be successful like with bentonite.

The combination of special graphites with suitable dispersing agents is claimed in the patent application WO 2011/032668.

5. LE technology in foundry practice

By comparing the emission of benzene as most critical component from 60 different European foundries' molding sand systems, the huge differences in the benzene emission level are remarkable. These huge differences reflect the different levels of lustrous carbon formers in the molding sand systems as well as the different levels of core binders.

The comparison of the benzene emission of currently 15 European foundries processing LE technology shows very clearly that in most of the cases a reduction of the benzene emission by 50 % and even more can be realized (fig. 1). If a foundry is starting with a very high level of emission, a reduction of up to 80 % is possible.

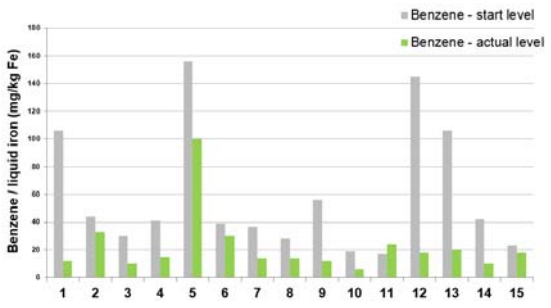

Fig. 1 Reduction of benzene emission by processing LE Technology in 15 European foundries