New possibilities for foundries to increase cast form surface quality and productivity while DECREASING EMISSION GENERATION AND CONSUMPTION

Reduction of foundry emissions has become a predominant issue for the industry. In line with the general rise in awareness of health issues and the environment, foundries are looking for feasible solutions to increasing highly demanding environmental regulations and standards including the 2020 Gothenburg Protocol on emissions.

For many foundries, basalt-based greensand moulding remains the most common method for producing small to medium size iron and steel castings for a wide range of industry sectors. The production demand for cast parts is rising. As liquid iron with temperatures up to 1500°C hits the coal in the green moulding sand volatile organic components are created and dangerous BTX (benzene, toluene, ethyl benzene, xylenes) emissions are inevitable. A further challenge is the high cost for basalt moulding, for example, is four times higher for foundries than for silica moulding.

The ongoing important role of greensand moulding means foundries face the critical challenge of improving the ecological footprint of the system and reducing BTX emissions. At the same time, within operations there is strong emphasis on achieving a potential increase in productivity while maintaining quality. Consequently there is demand from the foundries and related industries for support in realising a practical balance of factors.

To help foundries to address this combination of priorities, Clariant as a worldwide supplier of greensand additives, undertook proactive research into the management of emissions within greensand systems with the aim of creating better understanding of the individual contributions. This information serves as a basis for identifying potential solutions for alternative routes to support the industry.

BTX FUMIGATION SOURCES

First steps were to analyse emission sources. Clariant’s initial in-depth laboratory analysis showed that both the organic binders in the cores, as well as the traditional carbon-based lustrous carbon formers (LCFs) in the basalt-based greensand system contribute to BTX emissions. Coal has the lowest emission level compared to the other types of lustrous carbon formers like resins. The results are presented in Table 1. Within a basalt-based greensand system, LCFS are important for maintaining mould quality. Classic LCFS function by reacting with oxygen to form a reduce atmosphere within the mould. This produces a thin layer of lustrous carbon on the surface of silica grains which prevents penetration of the liquid iron with the greensand and creates a smooth surface (Fig. 2). A greensand coating without LCFS is permeated by the iron, meaning a rough coating surface is created as shown in Fig. 1.

PRIMARY EMISSION REDUCTION TECHNIQUES

There are three possible concepts to reduce emission in a basalt-based greensand moulding system - reduction, adsorption, of emissions, and substitution of the classical lustrous carbon formers.

1. Reduction: use of alternative LCFS with lower emissions. However, there is no alternative LCF to be used directly in the greensand system to coal, which shows the lowest specific emission of aromatics from all traditional LCFS.

2. Adsorption: adsorption of aromatics only shifts the emission from greensand to waste disposal. It needs high investment since only the separation of adsorbent material and greensand is a logical approach.

3. Substitution: emission-free additives for reduction of the LCF content. The most cost effective way is to substitute the lustrous carbon formers with inorganic carbon which does not form any organic volatile species. Graphite is the natural source of inorganic carbon offering similar properties to a lustrous carbon former when combined with special dispersing agents.

As Clariant is an established provider of greensand additives, the focus was placed on exploring options three to determine an alternative effective solution for foundries. A systematic screening of natural carbon materials with a low profile on volatiles creation under casting conditions that can substitute the traditional materials was carried out. Over the course of a long development process it was possible to identify a social grade of graphite fulfilling all required attributes.

This graphite became the source of Clariant’s Low Emission (LE) Technology, the specific details of which are outlined in the coming sections. The graphite is only one part of the technology. In contrast to bentonite, graphite cannot be dispersed very easily in a greensand system, therefore to ensure success it was found that a combination of special graphite and dispersant agents is very important for the application of graphite in a greensand system. The dispersing agents guarantee a homogenous coating of the silica sand particles with graphite plates during the greensand processing (as shown in fig. 3).

DECREASED EMISSION GENERATION / INCREASED PRODUCTIVITY

The LE Technology is available as two unique publications marketed under the names of GEKO® LE and ECOSS® LE (patent filed at the European Patent Office). GEKO® LE consists of an optimum blend of high quality bentonites, selected graphite grades and suitable dispersants. It minimises BTX emissions from the greensand system because it does not contain any volatile and organic compounds. ECOSS® LE combines the properties of GEKO® LE and high-quality coal in a premix form and features carefully selected types of bentonite, coal, graphite and dispersant grades. Both products have high active concentrations.

In a greensand system, the homogenous coating achieved with the innovative graphite-based technology ensures no metal penetration and the creation of a smooth mould surface. Also, the graphite fulfills the role of lubricant and improves the mechanical properties of the greensand mould. These characteristics lead to multiple quality- and productivity-related advantages for foundries as smooth surfaces and low sand adhesion create high precision and perfectly formed castings with high throughput and low defect and scrap rates.

The high concentration of activators and lower BTX concentration in the sand system yield higher sand recycling rates and reduce waste sand. The products are also tested mixing which adds to the other productivity advantages. For ECOSS® LE it should be noted that since lustrous carbon generation is no longer a major requirement of the coal part of the premix, BTX emissions can be drastically reduced while maintaining high throughput and low scrap rates.

UNIQUE TESTING SYSTEM

To obtain an accurate overview of emission profiles, Clariant developed a unique method for measuring and comparing emissions from greensand systems under realistic foundry process conditions. The creation of an application laboratory test rig was necessary to analyse the emission data of a greensand system based on the company’s new technology and to provide support for customers in creating an accurate profile of the BTX emissions of an existing system.

Within the test rig, liquid iron is poured in a standard greensand mould and all the gases are collected in a specially designed absorber trap. The gases are then desorbed from the absorber and analysed both qualitatively and quantitatively with state-of-the-art GC-MS techniques. To prove the efficiency of the LE system to customers and authorities, customers send Clariant a greensand sample from their established process using traditional additives prior to introduction of the LE Technology. The current BTX emissions are measured and the results used as a baseline later. After introduction of the LE technology, the foundry sends a second greensand sample, which is also analysed in the application lab with regard to BTX emissions. The direct comparison of both samples proves the reduction of BTX emissions from the greensand system to the customer. Customers who also need to reduce their emissions from cores can substitute organic with inorganic binder systems.

INDUSTRIAL EXPERIENCE

After the R&D studies, Clariant showed significant success in applying the low emission technology at important European foundries. The comparison of the bennese emission of foundries processing ECOSS® LE shows very clearly that in most of the cases a reduction of the bennese emission by 50 per cent or even more can be realised. If a foundry is starting with a very high level of emissions a reduction of up to 80 per cent is possible.

We can look closely at examples from two foundries.

CASE STUDIES

The first example is a foundry producing brake equipment on vertical flaskless moulding lines. There were official requests from environmental authorities to reduce BTX emissions into the atmosphere. The target was to reduce BTX emissions by using LE Technology while maintaining the same green sand properties (with efficient shake-out) and the same good casting quality level at lower production cost.

Clariant began working with this foundry on LE Technology on one