Expansion Characteristics of Silica Sands — Part 1 of 3

Silica sand is the most widely used molding aggregate by the foundry industry. A common mistake by foundry men, and even researchers, is the concept that all silica sands possess the same physical properties and will behave the same during the casting process. Unfortunately, silica sands were not created equal. Because of slight chemical alteration of silica sand, the performance and casting reliability is tremendously affected from different sources. Part one of this three-part series discusses the differences in silica sand and how they can influence core production and defect prevention.

Two basic types of silica sand are commercially available for foundries. The first type is the round grain silica sand containing roughly 99% or higher of silica with minimal amounts of trace materials. The second type is the lake and bank sands. These sands contain approximately 94% silica with the balance containing iron oxide, lime, magnesia, and alumina. Since impurities are removed, round grain sands possess higher refractoriness than the lake sands. However, because the higher refractoriness of the round grain sands, this can result in a higher propensity for veining and metal penetration defects. Lake and bank sands have lower refractoriness but also have a lower tendency for casting defects.

Even within these groups of classifications, slight variations depending on source location impart slight measurable difference in sand performance. It is difficult to say which sand is best, round grain or lake sand. Sand selection is determined by casting application, availability, and cost. The focus of this article is to disseminate the differences between the varieties of silica sand and learn how impurities influence these properties. Though a foundry might not consider a lake sand, understanding how the impurities affect casting quality will assist foundries in selecting core sand additives for round grain sands to reduce the risk of veining and metal penetration defects.

Defects associated with expansion are veining and, to a minor degree, penetration. Generally, round grain sand users will combat penetration and veining problems by adding additives in the core sand mix. Typical additions include iron oxide, Veinseal™, and Macor™. However, these additions mimic the properties of lake sand. The effect of natural impurities in silica sand is illustrated below. Both the round grain and bank sand expands at the same rate up to 1100oF, the point where quartz rapidly begins to change crystalline shape. Beyond this point, noticeable expansion characteristics can be observed. At approximately 1200oF, the linear expansion levels off. The bank sand has an expansion of 1.3% where the silica sand has an expansion of 1.6%, an appreciable difference. Also, notice the difference in the expansion curve for the lake sand. Expansion for the lake sand appears to occur earlier but at a lower total expansion than the bank sand. These differences between the sand can be attributed to the impurities in the lake and bank sand. Research work at the Metal Casting Center exploring sand additives and blends have observed this similar behavior when “different” materials are added to round grain silica sand.

Casting trials have shown that the bank sand has a lower propensity for veining defects compared to the round grain silica sand. Comparing the expansion characteristics between the two sands and the effect of veining, the rate of expansion and the total amount of expansion have an influence on controlling veining defects. The Metal Casting Center, along with sand suppliers, are developing a research program to obtain a better fundamental understanding of the expansion characteristic of sand. Key points, similar to that observed in cooling curve analysis, can indicate the performance of the sand. This can lead to the exploration of low cost sand additives to alter the expansion curve to prevent veining defects.

This article was co-authored by Scott Giese and Jerry Thiel

Future articles will discuss the effect of commercial sand additives and sand blends on the expansion characteristics.