Reducing Surface Defects With Proper Vein Reduction

While vein reduction compounds can lead to improvements in iron castings—such as reduction in metal penetration and core erosion—they can result in varying degrees of tensile property reduction.

Victor S. LeFay and Stephen L. Neltner
Hill and Griffith Co., Cincinnati

As casting surface quality becomes increasingly important to end-users, foundries have to find new and effective methods of eliminating surface defects in iron castings.

One method—vein reduction compounds—is used primarily to reduce or eliminate expansion defects, which show up as "veins" on the surface of the casting. Foundries have achieved reductions in expansion defects and imprints in casting quality with mixtures of 90% prepared sand and 10% vein compounds.

However, the key to vein reduction compound use is to be careful when adding the compounds into core sand mixtures, as they can result in varying degrees of reduction in mold tensile properties. This reduction is due primarily to the composition of the materials and the sizing.

This article will take a look at the process of vein reduction and what casting surface quality improvements can result.

From Reduction to Elimination

Veining is an undesirable casting defect that occurs on the cored surface of the casting (Fig. 1). Due to thermal expansion of sand grains, a separation (or stress crack) will occur during mold fill, and with continued separation, metal will be allowed to infiltrate the separation, resulting in the veining defect. Veining reducers have been specifically formulated to relieve the stress that occurs in the cured core sand mixture by positioning itself between the sand grains and acting as a buffer.

In order to meet the goal of vein reduction or elimination, the selected vein reduction compounds must produce a high quality casting with sufficient economics for profitability. Vein reducing compounds are typically added to the sand prior to the addition of the binders at 2-10%.

The quantity of the material used depends upon a number of conditions, including the tensile and/or strength characteristics for the mold, the desired improvement in casting quality (reduction in veins), resistance to erosion, surface characteristic of the casting (metal penetration and others) and a possible reduction in porosity. With this understanding in mind, the material selection and quantity can be determined.

Producing a High Quality Core

The first consideration with vein reduction compounds is producing a high quality core. Foundries therefore must make sure that they are utilizing the correct compounds, as they can result in a reduction in tensile properties.

Figure 2 is a graphical representation of the reduction of tensile strength of a coldbox core sand mixture (1% binder by weight) with varying levels of vein reduction compounds. Vein reduction materials are intended to be consumed at higher concentration levels in the prepared sand mixtures (2-10%) without a dramatic reduction in tensile properties of the cured sand mixture. The variation in tensile strengths is dependent upon a number of sources (sand type, resin selection, resin concentration and the quantity/sizing of vein reduction compound).

As a rule of thumb, vein reduction compounds will work to varying degrees in all of today's core processes. The core processes that appear to have the least reduction in tensile properties are coldbox and nobake. The core processes that have the greatest reduction in tensile properties are warmbox and hot-
box. In terms of metal success with vein reduction compounds, it has been investigated for both gray and ductile iron. Limited testing has been done with steel.

Presently, there is limited application in nonferrous foundries. Most aluminum foundries can reduce and/or eliminate vein characteristics through formulation changes in the core mixture. However, brass and bronze foundries can benefit from the use of vein reduction compounds in core sand mixtures.

**Applications**

When implementing vein reduction compounds into the foundry, the materials are added to the base sand prior to the addition of the binder system. For experimental use, a foundry can hand mix a batch of vein reduction compound and sand and add it to the mixer without a major disruption to the process. Since this prepared sand mixture has a different appearance (color or texture) it is easy to identify which cores contain the vein reduction compounds and which do not.

It is recommended to vary application rates of the vein reduction compounds. This is usually determined by the density of the compound, design of the core or severity of the defect (vein or other expansion defect). However, a good starting concentration for these families of products is between 3-5% based upon the weight of the prepared sand mixture.

One example of the application of a vein reduction compound was completed in a ductile iron foundry that produces automotive castings with a phenolic urethane coldbox binder.

The castings in Fig. 3 were produced with and without the vein reduction compounds. On the right is a ductile iron casting that was prepared with a coldbox core that was rather “chunky”. This core had a tendency to vein because of the heavy metal sections surrounding the core.

Vein reduction compounds strongly influence the expansion characteristics of the prepared core. By reducing the expansion characteristics of the core a reduction (or elimination, in this case) in vein was the result.

**Differences in Compounds**

Vein reduction can cause significant variances in the physical properties of a casting. While these properties may have little or no contribution to the final performance of the product, it will have an impact on quality assurance systems, which set specifications on in-bound materials.

All vein reduction compounds have one thing in common—they reduce veins in metal castings. But what makes these compounds different?

**Density**—The density of the material will have an impact on the handling of the product. Since vein reduction compounds have to be dry blended with the sand, the density of the material handling is affected because of the delivery system.

While these materials are usually added by weight for consistent quality, the volume has a great deal of fluctuation because of the varying density in different vein reduction compounds. This impact could affect the flow rate of the mixer versus the hopper or delivery system of the vein reduction compound. There must be sufficient volume in the hopper to accommodate the required quantity of material to achieve the desired application.

**Sizing**—The sizing can affect the
handling characteristic of the product. Generally, the finer materials are “dusty” compared to the coarse family of products. Also, if the product is a mineral blend, a segregation of the material is possible.

Since many of the materials have multiple minerals of varying density and sizing, the products will have different handling characteristics that may require anti-segregation devices in the foundry facility that consumes the product.

**Color**—This is a characteristic that is under appreciated. Many foundries like to see a variation in the color of the finished cured core. If the color of the prepared core containing the vein reduction compound is different in the core storage area, the material may or may not be present at the desired concentration.

**Future Applications**

Foundries want to use vein reduction compounds as a “cure all” for various casting defects that occur from cored surfaces on a casting. In addition, many foundries use vein reduction compounds “just in case” a vein defect could occur. It is important to realize that vein reduction compounds only should be used when necessary and at the least quantity of material required.

The compounds are designed to complete their required task with a minimum reduction in physical properties, such as tensile strength.

However, as an offshoot to casting defect elimination, vein reduction compounds also can provide other benefits, including:

- acting as a colorant to cores;
- reduces the need for a refractory coating. The materials added to the prepared sand mixture can change the dynamics of the prepared core;
- reduce erosion characteristics of prepared sand mixtures during the metal casting process;

In addition, the compounds do not have negative side affects to green sand molding return core sand.

As a result of investigations in foundry applications, it appears that some vein reduction compounds could have a positive affect on the emission characteristics of prepared core sand mixtures. The fact that the vein reduction compounds are formulated into prepared core sand mixtures at higher concentrations (2-10%), these materials could change the dynamics of the emission characteristics during the pouring, cooling and shakeout phases of the metalcasting process.

Vein reduction compounds have gone through a transition in the recent years, as newer compounds have achieved surface quality improvements without a dramatic decrease in physical properties (such as tensile strength). As this trend continues, it will make vein reduction a more viable low cost solution to removing casting surface defects.

**About the Author**

Victor S. LaFay is vice president of research and technical development and Stephen L. Neltner is manager of product development at Hill and Griffith Co., Cincinnati.

**For More Information**