VEINSEAL™

The development of *Veinseal* as a revolutionary core additive followed a 6-7 year path, involving the testing of many different materials, in addition to requiring a bit of serendipity. Before recounting its discovery, a background of conventional core additives is necessary.

Core additives are used to control two major defects in gray & ductile iron castings: veining and gas porosity. Veining defects can be a major problem for many foundries. It is a very difficult defect to control, because some casting designs can actually accentuate veining. Veining is caused by a sharp rise in temperature of silica sand used in the making of the core. As temperature rises, the silica goes through a rapid phase of expansion, causing cracks in the core or mold. This allows the molten metal to flow into these cracks, forming veins in the casting. Veining in the metal must be removed in the finishing room. The additional handling associated with the removal of veining adds significant cost to the entire process. Removal of veining from internal passageways can also be extremely time consuming, and, in some cases, even requires special tools, causing a high level of frustration in the vein removal process.

Traditional ways of controlling expansion defects have previously centered on two products: iron oxides (red & black), and burnout additives, which contain a variety of combustible materials. Both of these types of additives have had measures of success. However, they also create other problems. Iron oxides can be effective up to a point, but with extensive veins, the amount of iron oxide required increases, creating other problems, such as decreasing sand flowability and a general lowering of the sand refractory quality. Burnout materials can cause the surface area to increase dramatically, necessitating the addition of even more binder to coat the increased surface. In addition to the cost of adding more binder, it can also create more gas during the casting process, increasing the chance of gas porosity defects.

Specialty sands, such as zircon, chromite, alumino-silicate, olivine and fused silica, have also been used to control expansion defects. These sands are effective because of their very low thermal expansion characteristics, but are very expensive and need to be used at a minimum of 25-50% of the sand mix.

Development of Veinseal

Ronald Kotschi, Ph.D. and John Brander began working with traditional core additives in the mid-1980's, experiencing the same successes and failures as those types of additives allowed. In the early 1990's, it became their goal to develop a new type of additive that would not severely affect the binder performance, but would interact at a more consistent level, thereby eliminating veining. **IGC TECHNOLOGIES** (originally known as Industrial Gypsum Company) was very fortunate in being able to establish a partnership with a large foundry that was also seeking a solution to costly veining defects.

Their first step was to develop a testing procedure that would allow for proper analysis of the veining results. **IGC TECHNOLOGIES** worked for over a year to develop and construct a mold that would reliably show the results of different additives. The new mold used AFS Standard 2 x 2 sand specimens. This mold could contain up to eight samples, allowing eight results to be compared at one time. The resulting test casting weighed approximately 120 pounds. The new test mold not only allowed **IGC TECHNOLOGIES** to analyze veining but also check for the possibility of penetration.

Over the next four years, many different materials were tested. While some showed promise, they were never consistent in performance. Several others had very deleterious effects on the performance of the binder systems. Eventually, the focus was narrowed, and with a little luck, the test sample provided perfect results. Refinement on that original formulation followed and *Veinseal 14000* was born.

Veinseal works by fluxing the sand mixture, forming a viscous surface that holds the sand mixture together through the rapid temperature rise and expansion of the silica. *Veinseal* undergoes a very slight negative expansion, which also assists in moderating the rapid expansion of silica. In addition, *Veinseal* helps seal the sand face, which aids in trapping gases inside the core, thus reducing gas defects. The casting finish is greatly improved, and in certain applications, core coatings are minimized or altogether eliminated.

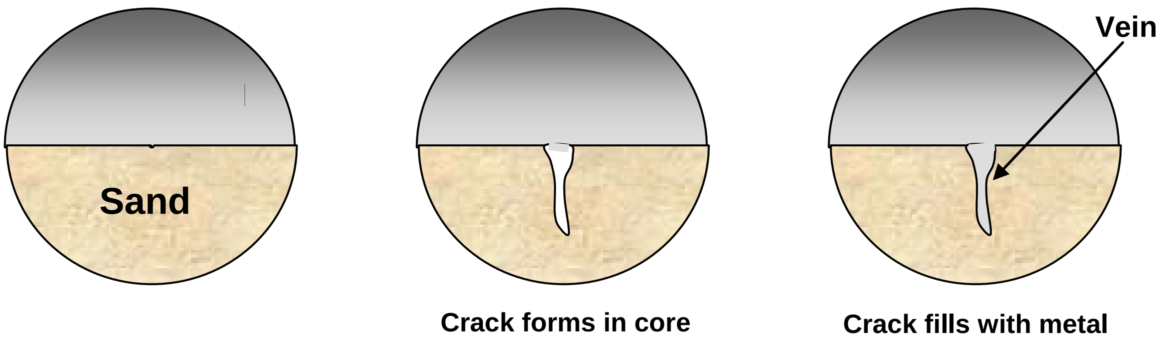
In summary, *Veinseal* provides the following advantages:

- Eliminates or greatly reduces veining, thus improving cleaning room throughput.
- Improves casting finish, reducing or eliminating coatings.
- Reduces gas defects.The following pages contain diagrams illustrating the effectiveness of *Veinseal* in controlling the expansion defects in gray iron castings.

Veinseal User's Guide

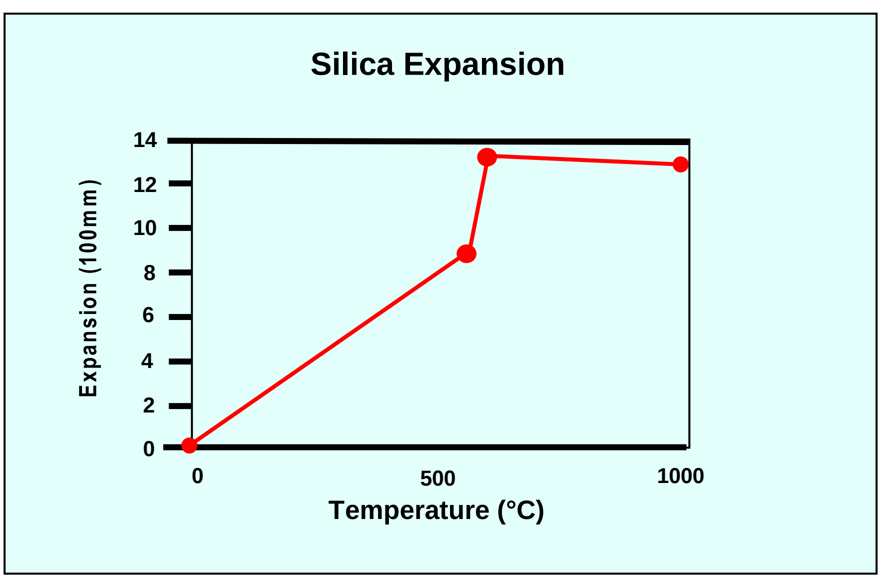
What is veining?

Veining appears as a thin fin on a casting. It results from a crack formed in a sand core or mold component forming a thin cavity into which liquid metal penetrates. Upon solidification of the casting, the resulting vein can be seen.



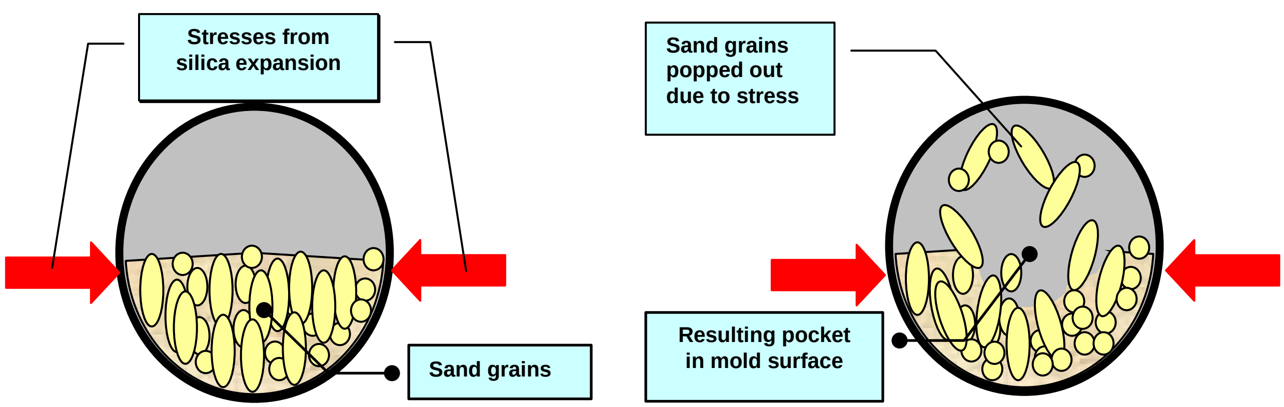
Why are silica sand mold components so susceptible to veining?

The use of SiO (silica sand) creates a magnifying effect on the occurrence of veining. This is due to the expansion of the silica.



The previous chart shows initial heating of the sand causes a steady increase in the sand size up to approximately 1067°F (575°C). From this temperature to 1112°F (599°C), there is a sudden expansion of the sand. It is usually this sudden expansion that is the major cause of stress in sand mold components. Because the stress builds suddenly and is difficult to relieve quickly, it can lead to mold or core cracking, resulting in veining as shown earlier.

The stresses build up in sand mold components as a result of heating by the application of liquid metal can also lead to rough surface finishes. This fact is often overlooked by foundrymen and is related to the popcorn effect:



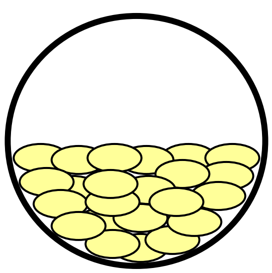
Because the grains that pop out as a result of the stress leave a rough cavity behind which is filled by liquid metal, the resulting casting surface will be rough in appearance. Since the now free silica grains will become captured in the solidified metal, other casting defect non-metallic inclusions will also arise. Thus, two casting defects are created, namely rough surface finish and its naturally associated companion non-metallic inclusion. Note that burn-on, burn-in, etc. are also associated with this same phenomenon.

What techniques can be used to correct these problems?

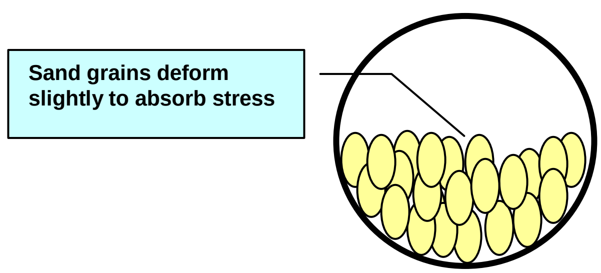
Prior to the development of *Veinseal 14000* and *15000,* there were two techniques commonly used to combat these effects:

Sand Fluxing Method

Possible the best and most commonly used additive for this purpose is the addition of iron oxides. Both forms of black and red are used nearly interchangeably for this purpose. It has long been recognized that iron contamination in sand exemplified by dark brown colors results in lower melting point of the sand. It should be remembered that sand is like glass (made from sand) and does not have a distinct melting point. This material exhibits more of the softening point (i.e., the sand becomes soft and flexible) but not necessarily a mix of solid liquid. By increasing the amount of softening the sand experiences as a function of the metal heat, the resulting increase in the plastic nature of the sand will allow more stress absorption.



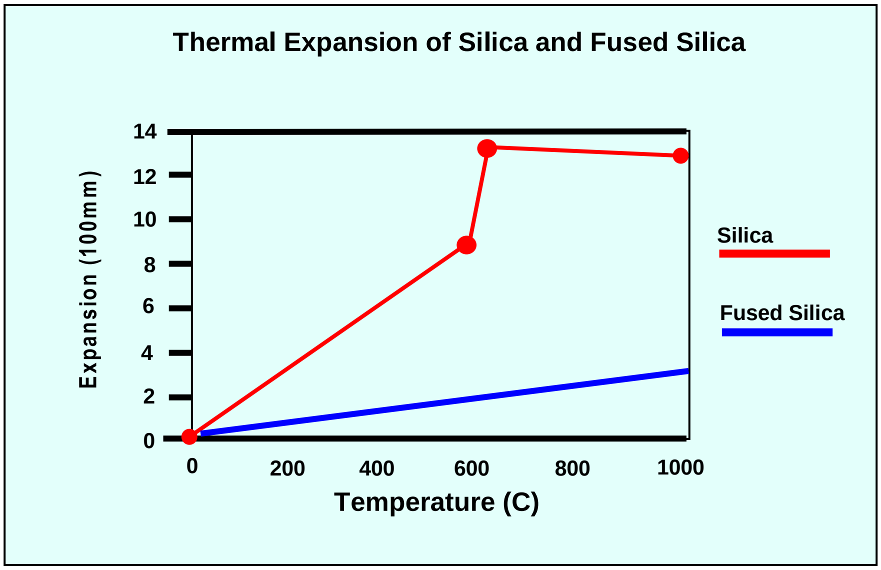
Sand grains prior to heating



Because of fluxing, sand is more plastic

The problem with this technique for the prevention of veining and poor surface finish is that there is a limit to the amount of iron oxide that can be added to sand. When too much oxide is added, the sand becomes sticky, and difficulties in blowing result. The upper limit for such additions is usually about 2% oxide. It should be noted that fluxing effects often improve the casting surface finish by forming a glassy glaze layer at the mold component surface. This produces a surface that is smoother and somewhat less susceptible to metal penetration defects.

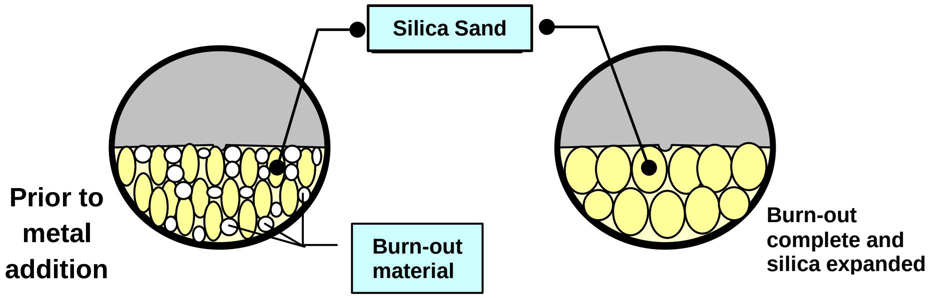
This method employs the use of materials that are less susceptible to expansion as a result of metal heating. A further improvement can be attained using materials that can absorb much more heat than silica sand because of their increased density. Examples of such materials are fused silica, zircon sand, and chromite sand. Fused silica or quartz glass, although made from silica sand, has a lower expansion characteristic than that of silica sand, as shown below:



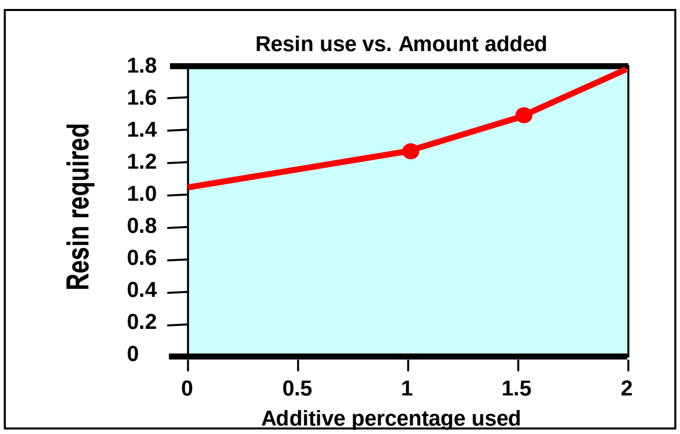
Materials with high density such as zircon and chromite sands can also improve the veining and surface finish of castings. Such high-density materials are also able to absorb a great amount of heat. Their expansion is quite low and little stress is developed. Unfortunately, these materials are rather expensive in comparison to silica sand. They are often 20 to 30 times the cost of silica sand and are used conservatively.

Burnout Materials

This method of silica sand expansion control depends on the use of organic materials that burn up after ignition by the incoming liquid metal.



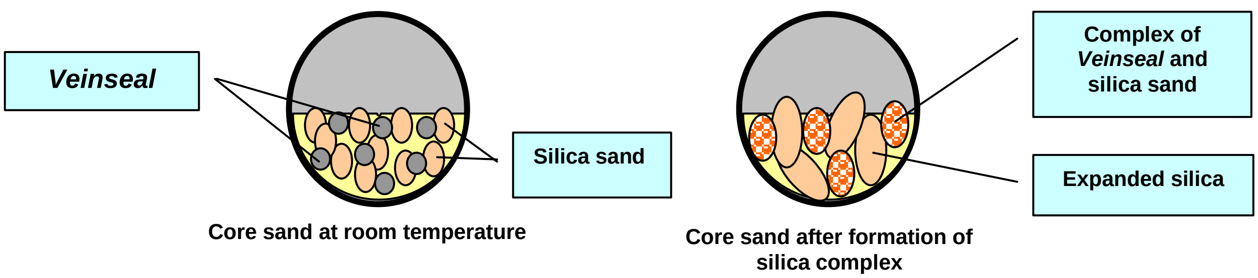
This is the basis for most of the other core additives traditionally used by foundrymen. The problem with the use of these materials is twofold: Gases are evolved because these materials burn up during the casting process. This can lead to the creation of some harmful organic chemicals in addition to the gases evolved. The large quantities of gas produced can cause various gas related casting defects. The other problem with the use of such materials is their small size. Because of the large amounts of surface area they represent when added, there is an economic limit to their use of approximately 2 - 3%. This is particularly important when the various cold setting plastic bonding core making processes are employed.



Although individual resin usage levels vary, this general trend is typical. It should be noted that increased resin usage promotes veining and several other defects, and merely accomplishes an increase in the handling strength. The use of burnout material can be an economical method of controlling veining. However, it can do little for reduction in or need for core washing.

THE UNIQUE ACTION OF *VEINSEAL 14000* AND *15000*: A NEW METHOD OF CONTROLLING SILICA EXPANSION

The ingredients in **IGC TECHNOLOGIES'** *Veinseal 14000* and *15000* react with silica sand to form a ternary complex compound. This occurs at approximately 1021°F (550°C) to 1207°F (650°C), which is also in the form of the sudden silica sand expansion as discussed above. The reaction that forms this complex silica is unusual in that it is accompanied by a negative volumetric expansion. Thus, the formation of this material causes a reduction in volume, just as the silica sand expansion is taking place. This offsetting effect reduces the stress of expansion and thus the tendency to form a vein.



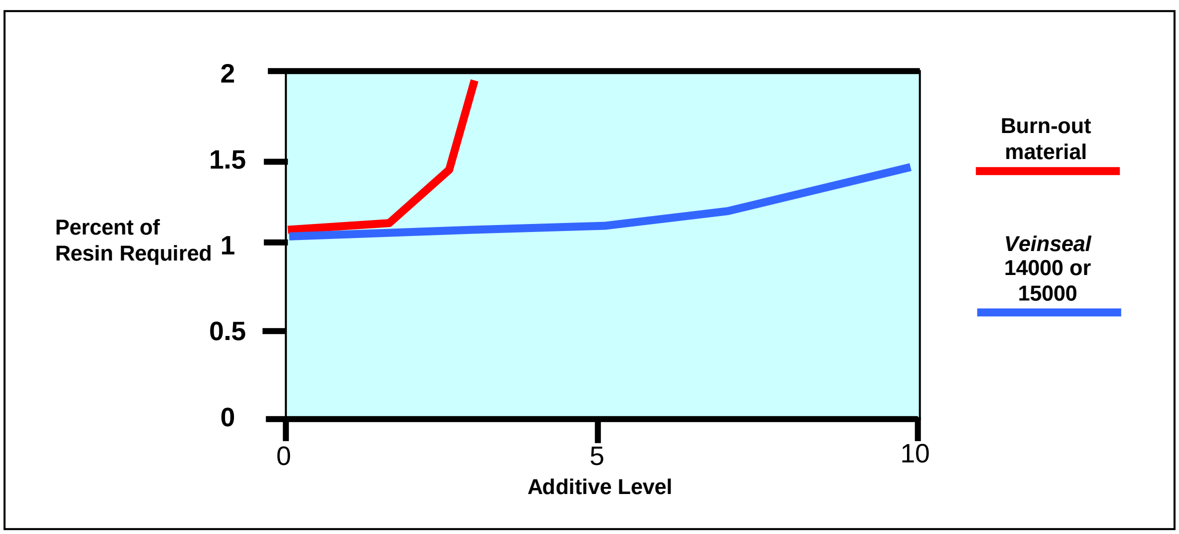
This is the unique feature of the advanced formulation of **IGC TECHNOLOGIES** revolutionary *Veinseal 14000* and *15000* products. However, these products do not depend on this single factor alone. These products are a mixture of several different materials designed to attack the problem of casting production on several fronts. Other ingredients in *Veinseal 14000* and *15000* act as fluxing agents on the silica sand, much like that of the iron oxide effect discussed earlier. Other ingredients are high-density materials that absorb heat in the same as zircon sand. Still other ingredients contain titanium that helps absorb gases, particularly N_2 or $NO_{1,}$ that are extremely difficult to remove in any other way. Testing of *Veinseal 14000* and *15000* has also indicated that the material's absorption promotes a reduced tendency for carbon pickup in gray or ductile iron.

The lack of organic material in these products can be seen in a Loss On Ignition (L.O.I.) test. The results of such a test will indicate losses similar to those of silica sand itself in which almost no losses are detected. Since the material does not create any gases itself and has ingredients to absorb the other sources of gas, the use of these products is effective in reducing such defects. The absence of organic materials that absorb resin and coat core boxes mean that the tooling requires less cleaning, reducing this costly maintenance problem.

The presence of high-density materials in *Veinseal 14000* and *15000* also improves the blowability of a core. This occurs because of the hammering effect.

What do foundrymen need to know for effective use of these products?

Using *Veinseal 14000* and *15000* represents a revolution in core making for the foundry industry. It is a complete process change, *NOT* just the use of a different core additive. Unlike any of the other types of products available, *Veinseal 14000* and *15000* dramatically decreases the amount of resin needed for core making.



Our product only slightly increases the amount of resin needed, in comparison to the instant increase of burnout material needed. Another factor to consider when employing these materials into a core process is the amount of material to use. This factor is the major reason that the use of these materials is a process change rather than merely a change of core additive. Because of the unique way these materials work, typical additive levels of .5 - 2.5% are not extremely effective.

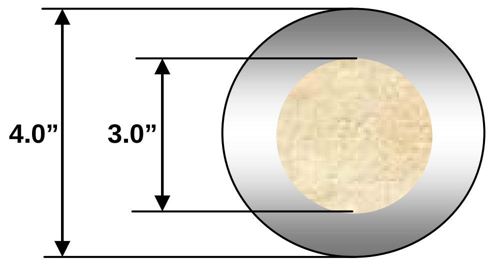
What amount of *Veinseal 14000* or *15000* should be used?

The amount of additive to use is dependent on the type of binder used. An **IGC TECHNOLOGIES** representative will recommend guidelines for your particular application. Usage typically ranges from approximately 3 - 10%.

This range is meant to outline a starting point from which you first begin addressing a particular difficulty. Clearly, the actual amount used should be as low as possible to solve the problem. This amount will also depend on the severity of the problem, considering these variables:

- The casting design
- The type of material being poured
- The gating system
- The surface finish required
- The type of sand and its size distribution
- The pouring temperature used
- The head pressure experienced in the mold

Many of the factors above deal with the amount of heat and the rate of heating seen by the mold components involved. These factors depend on the casting design, gating, type of metal, and the amount of pressure head experienced in the mold. For purposes of simplifying these issues, consider a 3" diameter core with a ½" of ductile iron surrounding it, as shown below:



The portion of the casting does not have metal impingement problems from the gating system, and the metal is poured at approximately 2458° F (1325°C). Keep in mind that with this standard casting section, the addition of *Veinseal 14000* or *15000* as shown above will show some success. The levels mentioned here are only suggestions to start testing for effectiveness. The actual amount required to solve a particular problem is dependent upon the peculiarities of the given problem. The amount needed should be as low as possible to avoid excessive cost.

Current customers use *Veinseal 14000* and *15000* over a range of amounts, depending on the significance of their casting problem and the specific concern to be addressed:

Type of Binder	**Amount of *14000***	**Amount of *15000***
Cold Box	**3.5 - 7.0%**	**5.0 - 9.0%**
Warm Box	**1.25-7.0%**	**1.25-7.0%**
Hot Box	**2. 0- 9.0%**	**3.0-12.0%**
Shell Sand	**2.50-7.0%**	**3.5 - 9.0%**
Baked Oil Sand	**2.5-7.55%**	**3.5-12.0%**

Why aren't these products used at levels below 2% in cold box core making processes?

In tests done at **IGC TECHNOLOGIES**, additive levels below 2% in cold box showed no measurable effect compared to using no additive at all. It must be remembered that the manner in which these additives work is far different from the conventional additives used in the past. The use of these additives requires a process change and is not merely the use of a different additive.

When should *Veinseal 14000* and *Veinseal 15000* be used?

Within both formulas, there are ingredients that act to resist veining, and ingredients that resist penetration defects. In lighter weight castings, where veining is usually the greater concern, *Veinseal 14000* is the product to use. For heavier section castings, or castings in which penetration is the major problem, *Veinseal 15000* is the product of choice.

Because of the revolutionary nature the use of *Veinseal* involves, we at **IGC TECHNOLOGIES** provide our customers with this User's Guide. Thank you for your attention and interest in our products and please contact us with your questions and comments.

IGC TECHNOLOGIES continues its development of custom core additives for the metal casting industry. For pricing and more specific technical information on this product and its applications, please contact a sales representative at
(800) 877-8917.