Use Fabric, Breaker Cores to Cut Ductile Iron Finishing Cost

By inserting a silica mesh fabric filter into its runners and riser contacts, Grede-Pryor has increased finishing room efficiency.

Jay Hitchings, Ametek, Inc., Wilmington, Delaware
Andy Porter and Allen Richardson, Grede Foundries, Inc., Pryor, Oklahoma

Finishing techniques using manipulators, grinding machines, cut-off saws and blades are labor-intensive and time-consuming processes that constitute a large percentage of the cost of a casting for many foundries. In addition, due to these techniques, workers are more susceptible to injuries resulting from vibration, high noise, dusty working conditions and heavy lifting.

For ductile iron foundries, desirising and runner segmentation is one particular area of the finishing room that has caused frustration for workers and foundry management. Larger castings require manipulation or positioning so that risers can be cut off by abrasive wheels or knocked off by hydraulic rams. This adds to the cost of the casting because of the time involved and the special equipment required.

A solution that has been integrated by Grede Foundries, Pryor, Oklahoma, is the use of silica fabric filters in its gating system for easier knockoff. This article discusses the desirising and runner segmentation of ductile iron castings via a fabric filter technique and relays the benefits experienced by Grede-Pryor.

Techniques for Desirising Applications

The use of silica fabric filters to aid riser knockoff can take two forms: insertion of the fabric by itself or in conjunction with a breaker core. Generally, the riser contacts are calculated first without any fabric addition, and this is the situation presented when modifying an existing riser contact that has proven to perform successfully. By placing the fabric across the established contact, the open area is reduced, which can result in a restriction of metal flow (Fig. 1).

The general rule used to counter the loss in open area is to increase the contact cross-sectional area by 50%. This sounds like a considerable increase, however, if a 1-in. diameter circle is increased by 50%, the resulting diameter is only 1.23 in.

Since iron riser contacts are generally calculated using moduli values from 0.67-1.1 times the casting modulus, the resulting contacts are usually large enough that the introduction of the fabric has minimal effect on metal flow or solidification. However, if the metal flow is reduced, shrinkage may occur on the casting side of the fabric. A solution is to make a hole in the center of the “live area” of the fabric to increase flow from the riser. The fabric is so thin that there is no heat subtraction from the metal, and, therefore, its greatest effect is on metal flow.

An important factor to consider when using silica fabric filters for ductile iron desirising applications is the residual magnesium (Mg) content of the iron being poured. In general, a value of 0.030-0.045% Mg in the casting is considered normal. If the Mg residual is higher, there are larger amounts of Mg reaction products such as oxides (MgO), silicates (Mg2SiO4), and sulfides (MgS) present in the metal.

These reaction products will collect on the fabric filter and restrict metal flow. This is important when considering the use of the fabric in hot riser applications where it acts as a filter and desirising aid.

Hot and Cold Riser Applications

For the majority of breaker applications, the fabric is used in a semi-rigid form. The rigidity is provided by a thermal setting coating that is applied during its manufacture. Once molten metal contacts the fabric, this coating burns off, leaving the fabric in a soft, flexible form. The fabric in the live area will then deflect slightly in the direction of metal flow.

Hot risers are defined as those that receive hot metal from a runner and then pass it into the casting cavity (Fig. 2a). This application is one of the most demanding on the fabric because more metal passes through the contact where it is located. In this case, the fabric acts as a filter and desirising aid, so it
will collect slag and impurities and present more resistance to metal flow. Thus, the fabric will deflect more toward the casting (Fig. 2b).

Cold risers receive metal after it has entered the casting cavity. This is one of the most successful applications in using the fabric for desiring. Cold risers utilize both top and side-type risers (Fig. 3a). Since the metal is entering the riser from the casting, it does not have much velocity and is not passing as much metal. Therefore, the deflection of the fabric is less and is away from the casting (Fig. 3b). The exception to this is when the cross-sectional area of the contact is large, and a large riser is employed. In this case, the deflection may reverse direction toward the casting because of the large amount of metal feeding back into the casting from the riser as it solidifies.

In order to minimize fabric deflection in any application, it is necessary to hold the perimeter or border of the fabric as tight as possible.

In those applications where deflection is unavoidable, the amount of deflection must first be determined by trial and error. Once the deflection distance is known, the fabric is offset the proper distance from the casting.

For the majority of breaker applications, the core-framed fabric has proven to perform the best.

**Breaker Core Applications**

Breaker cores are used between the riser and the casting to facilitate the removal of the riser during shakeout. By incorporating a small section of the fabric filter material into a breaker core, a cleavage site is introduced, allowing for a uniform fracture surface that does not cause a jagged surface that might break into the casting.

The modification of a corebox to incorporate a section of the fabric into the core is easy. The material removed at the live area of the core equals the thickness of the fabric, so that when the box is closed, the fabric is not crushed, and sand cannot get into the live area. The edges of the fabric should protrude halfway into the core frame while a pin is employed to hold the fabric in place during closing of the box.

Breaker cores containing silica mesh fabric are used at the contact of side risers and also may be glued onto the bottom of riser sleeves (insulating and exothermic). Top risers can utilize cover cores that incorporate the fabric in the feed through or in combination with riser sleeves.

---

**Green Sand and Nobake Applications**

Silica fabric filters have been used for desiring and runner segmentation in both green and nobake sand molds. Green sand molds generally require breaker cores containing the fabric instead of a cut piece because the contacts are usually very short, and the sand does not have enough strength between the fabric and casting to hold it in place during pouring. When the breaker cores containing fabric are glued to riser sleeves, the sleeves may be inserted into prints in the mold or placed onto patterns with the sand rammed up around them.

Nobake molds provide some of the easiest and most successful applications for using fabric filters. Breaker cores containing the fabric are placed into prints at the desired location for both desiring and runner segmentation.

Another technique is to cut a slot in the pattern in a runner or contact and place a small section of the semi-rigid fabric into it. A small border is allowed to protrude outside the runner so that the sand can adhere to it and hold the fabric in place when the mold hardens (Fig. 4a). After the pattern is removed, the fabric is locked in place and ready for use. This technique is popular, especially in runner segmentation, due to its simplicity and success in filtration and runner breakup. For breaker applications, it is not necessary for the fabric to completely cover the total contact cross-section, as long as at least 20-30% is covered, a notch or cleavage plane is produced (Fig. 4b). More force, however, will be required to break this type of contact than if the total cross-section had been covered with fabric.

If a wash is to be applied to the mold, a small, folded piece of paper is placed over the fabric before it is applied. In certain applications such as nobake molds, the fabric can be held in place by stapling it to the mold.

**Use at Grede-Pryor**

The initial use of the silica mesh fabric filter at Grede-Pryor was to aid in the removal of risers from ductile iron castings, many of which were over 1000 lb. Since the large risers were attached by riser necks with large cross-sectional areas, these castings required desiring with a cut-off wheel, which was expensive and time-consuming. In some instances, two necks attached the risers. Following are three examples of Grede-Pryor's use of fabric in desiring and runner segmentation. This 600-employee ductile iron shop used Ametek's Flexsil silica mesh fabric as an aid for desiring and runner segmentation:
• **Example 1**—A large hub, weighing 1350 lb, contained two risers that measured 8 in. in diameter and 14 in. in height. The risers weighed about 200 lb each and were connected with a 3-in. contact on the bottom of the riser and a 1-in. contact on the side of the riser near its top. These risers were extremely difficult to remove until the fabric was added to both contacts and a wedge used to drive between the riser and the hub sidewall;

• **Example 2**—Another casting with risers that had been difficult to remove was a large axel housing that weighed 1250 lb. This casting had four traditional risers that measured 6 in. in diameter and 10 in. in height and were fed through 3.25-in. round contacts. For cutoff, this large casting had to be manipulated into position so that the risers could be removed. Since the fabric filter has been added to the contacts, these risers are now knocked off with a hammer (Fig. 5);

• **Example 3**—Another application that utilized the fabric involved the segmenting of complex runner systems into shorter sections. Gating systems were becoming tangled in the return system, which then had to be cleared out manually. This slowed production and often required hazardous labor. The fabric was used to break up large, extra long runners in shakeout so that they could more easily be back-charged into the furnace. Runner sizes typically run from 1.5-3-in. high and average 1.5-1.75-in. wide at the base. By inserting a section of 2 x 2-mm

---

**Ease Steel Riser Knockoff with Breaker Cores**

The use of breaker cores on steel castings can greatly relieve bottlenecks by either allowing feeders to be broken off or greatly reducing the area to be cut off. Despite the obvious benefits associated with the use of breaker cores, many foundries tend to limit their usage because of variable results.

**Sand**—The extreme operating conditions that breaker cores are subjected to dictate that the sand for breaker cores must be resistant to penetration and sintering. Therefore, it is recommended that a high-purity, fine grain silica sand be used—typically US-110 AFS—with breaker cores. Special refractory sands such as zircon or chrome are recommended for breaker cores on feeders greater than 8-in. diameter.

**Binders**—The breaker core’s binder system must be capable of producing a strong, rigid, non-friable core that is able to withstand the rigorous casting conditions and burn out completely after use. Organic binders are generally favored for these reasons and most heat or gas hardened processes are suitable. Binder addition rates are generally higher than for normal cores because of the high strength requirement of the thin core and the need for slow burn out of the binder.

Sodium silicate is not a suitable binder for breaker cores as the bond is plastic at elevated temperatures, causing deformation of the core. Also, sodium silicate tends to lower the refractoriness of silica, causing sintering problems. Additives such as bentonite and iron oxide should be avoided as they will reduce the refractoriness of silica sand.

**Dimensions**—Breaker cores must be dimensioned so that they solidify after the casting. To achieve this, it is important that the thickness and orifice size is calculated based on the solidification time (or modulus) of the casting. Using the diameter of the feeder head, breaker cores have a typical thickness of 10-12% of the feeder diameter and orifices 40-50% of the feeder diameter. However, this approach sometimes will result in cores that are too thick and orifice diameters too small for the casting section to which they are attached and cause premature freezing of the neck.

**Aperture Shape**—The shape of the neck can affect the efficiency of feeding and the ease of removal. Generally, round necks are used and give good results in terms of soundness and ease of removal. The use of shapes having sharp reentrant corners, such as stars or crosses, can aid the breakability of the feeder and are often used on alloy steels for this reason. Square shaped necks should be avoided as they do not feed as efficiently as round necks of equal area.

**Application Limitations**—Problems associated with breaker cores are generally caused by failure to heat the core sufficiently either because the core is too thick or the metal temperature too low. The breaker core must absorb sufficient heat from the metal to reach a temperature greater than the liquid before the alloy reaches that temperature. The heat required for this must come from the superheat of the steel and not its latent heat. It is important to ensure there is sufficient superheat to achieve this requirement and the breaker core is of the correct thickness.

Shrinkage is often encountered under breaker cores when they are positioned on casting sections that are less than the feeder diameter. This problem also is caused by inadequate heating of the core. If breaker cores are to be used on thin section castings, then the casting section should be padded to ensure adequate heating on both sides of the core.

Segregation of carbon and other alloys is sometimes encountered at the contact of breaker cores at a greater level than is normally experienced with full contact feeders. This problem can usually be avoided by increasing the orifice diameter to three times the casting modulus. Carbon segregation is often accentuated by the use of carbon containing anti-piping compounds and the use of such materials should be avoided in alloys where this could be a problem.

—Jeff Meredith, Casting Solutions Pty., Ltd., Australia

This sidebar was adapted from an article that appeared in the January-February 1996 issue of Metal-Casting and Surface Finishing.
mesh fabric into a slot in the runner on the pattern, so that three-fourths of the height of the runner was covered, the runner broke up in shakeout and the fabric did not impede metal flow (Fig. 6).

**Problems and Solutions**

Several problems were encountered when placing the fabric filter across riser necks, especially on the larger cross-sections. In some cases, the fabric reduced the open area enough so that riser feed metal to the casting was not adequate, and a shrink cavity was produced on the casting side of the fabric. In some cases, the shrink cavity had entered the casting.

One solution to this problem was to only cover a portion of the cross-sectional area of the contact. As long as the fabric covered a minimum of 20-30% of the area, adequate flow of metal was easily obtained. Another solution was to place a hole in the center of the fabric to aid feeding from the riser.

Another problem occurred when the fabric deflected toward, or into, the casting because of the force of the metal flow. This problem was usually the result of placing too small a hole in the center of the fabric or not holding the perimeter of the fabric securely enough. In this case, when the riser was knocked off, the fracture was started in the direction of the casting and could have resulted in riser contact break-in. A larger center hole and the use of a breaker core to hold the perimeter of the fabric solved this problem. The core held the fabric tightly and did not allow the fabric to deflect as much.

---

This article was adapted from a paper (98-552) presented at the Ductile Iron Society’s 1998 Keith D. Mills World Symposium on Ductile Iron and is available from the AFS Library at 800/537-4237.