The use of ceramic filters with foam-like structures is a state-of-the-art technology indispensable in day-to-day operations in the foundry industry. The benefits of using this filter have already been described in literature and validated in practice.

Process improvement by special ceramic filters with foam-like structure and their use in direct pouring applications

By Ulrich Voigt, Peter Vietoris, ASK, Hilden, Germany

There are also a wide range of filter geometries offered by leading manufacturers to meet the respective application requirements and parameters. This applies to both required flow rates of liquid metal and available mould space, or special adaptation to gating and riser systems. Here in particular, significant savings can be achieved through an efficient design. Especially when using filters in direct pouring applications, these effects are immediately visible and can be improved even further by intelligent use of the options available in filter production.

Today, the concept and implementation of resource-saving technologies as well as maximum recycling of materials are firmly anchored in all industries. One of the pioneers in this area is the foundry industry, which has been putting recycling ideas into practice for many centuries. However, the possibilities here are never exhausted and are continuously developing.

In particular if we consider the frequently used direct pouring process, the most economical use of materials and energy is implemented in an exemplary way. Unfortunately, this method cannot be used for every casting and material, but where it can be applied, it brings huge benefits to the founder. The almost complete elimination of the otherwise necessary runner system results in several savings:

- Reduction of circulating and feed material.
- Reduction of energy costs.
- Reduction of the amount of moulding material by using smaller or adapted moulding boxes, thus also saving binders.
- Reduction of labour costs.
- For large cast iron parts, no need for additional tools like ceramic casting systems, etc.

Unfortunately, the method also has disadvantages:

- Dependency on the size and geometry of the casting.
- The function of the gating system (quiet, controlled filling of the melt in the mould cavity) is no longer available.
- Turbulences cause a deterioration in cast quality.

A satisfactory solution was only found with the use of ceramic filters with foam-like structure. The problem of too strong turbulences was solved through the use of these filters, mostly inserted into a sprue that is also used as a riser, see fig.1.

The calming effect of the filter allows for a soft and largely controlled filling with considerable turbulence reduction in the mould cavity (fig.2). It is very important to keep the sprue full at all times during the casting process. There must always be a sufficient bath level in the sprue and thus liquid metal above the filter, otherwise there is the risk of a filter breakage. Also, the ladle outlet or spout should not be too high above the filter to avoid the risk of filter breakage during the pouring process. Today's filters, especially those made of zirconium oxide and carbon-bonded alumina, have very good stability, but these materials are also subject to technical limitations.

Care should also be taken that the filter is not hit laterally by the pouring stream during casting. It is also important to ensure that the filter is deep in the sprue, has sufficient support and therefore cannot tilt. Especially with smaller diameters, the filter may nevertheless become tilted.

For a pouring process to be successful, it is crucial for the filter to float in the riser in the desired way. Practice has shown that a filter which fails to float can hinder the feeding process. What's more, a floating filter can be immediately inspected for cracks or even breakage.

A filter that floats in one piece is always the best guarantee for a successful pouring process. However, this rule is also subject to deviations, as filters may also break as soon as they float, after the end of the casting process.

As a rule, the floating of the filter occurs automatically, based on pure physically properties, due to the differences in the density of the substances involved. The filters are placed in the riser before pouring. Here, many risers have so-called filter receptacles (filter seat), i.e. support surfaces already incorporated during production, which match the conventional, most commonly used filter diameters. The risers may be tubular, oval or have a conical neck. The support surface or its specific geometric design within the risers can vary from manufacturer to manufacturer. It is important to have a safe filter support that ensures sufficient stability and also allows the filter to float freely.

The practical application has shown that some of the filter-riser combinations used cause problems with the floating of filters. The filter can tilt in the filter seat, is pressed into the riser material by the pressure acting on it (this is more often the case with 'soft' riser materials) or is prevented from floating by other circumstances.

To remedy the problem, suppliers offer buoyancy aids in the form of rings specially designed for neck-down risers (support rings, fig.3). These aids are

Fig.1 Sprue-riser with filter (example)

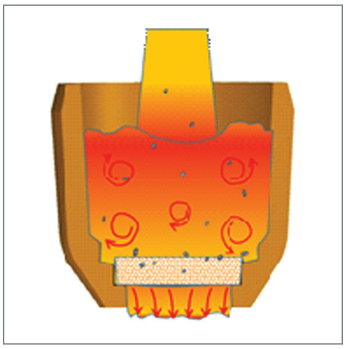

Fig.2 Calming and filtration effects

Fig.3 Buoyancy aids for filters (support rings)

produced by hot or cold box processes and contain alkaline-bonded lightweight materials (glass balloons/spheres).

By using these lightweight materials, the buoyancy aids have a lower density than the molten metal to facilitate floating.

While buoyancy aids solve the problem of non-floating, their use involves other risks. If the pressure of the pouring stream is not kept uniform, the filter may inadvertently float and 'capsize' during the mould filling process. The consequence of this is that contaminants that have been filtered are washed out of the filter again and spread uniformly in the casting. The additional support between filter and riser neck also creates a turbulence zone at the edge of the filter, which can lead to leaks and oxide inclusions. In addition, the metal can also bypass around the side of the filter, see fig.4.

There is also a further setback which is difficult to detect at first glance – the high alkalinity of the binder in the buoyancy aid causes the problems described below in acid-curing binder systems (furan-/phenol-no-bake) in the sand regeneration. In the case of a large-scale use in combination with smaller moulds and low circulating volumes of the old sand system, a pH shift of usually 3.0 to 4.0 occurs. Hardening times are considerably prolonged thereby, requiring a higher acid consumption with the known negative side effects, such as sulfurisation or increase of organic contents in the old sand.

To avoid these negative influences and enable the filters to float properly, the use of UDICELL filters with a conical shape is recommended by ASK Chemicals, especially when using conical sprue-feeders (also referred to as neck-down risers) (fig.5). This special filter type is manufactured by ASK Chemicals in different designs for a wide variety of applications, but can also be specially adapted in close co-operation with the users. Meanwhile numerous variants of this filter type are available. The user can choose from a variety of exterior surfaces, including closed circumferential surfaces as well as a fibre gasket seal or, as a standard, an open structure. Also to be mentioned is edge protection by a chamfer on the filter, which effectively prevents damage and thus crumbling of the edges during installation.

These filters are ideally adapted to the oblique, inner surfaces of the said risers and are characterised by the following advantages:

- Free adaptability of the chamfer to the respective riser.
- Exact adjustment of the filter diameter to the riser (fig.6).

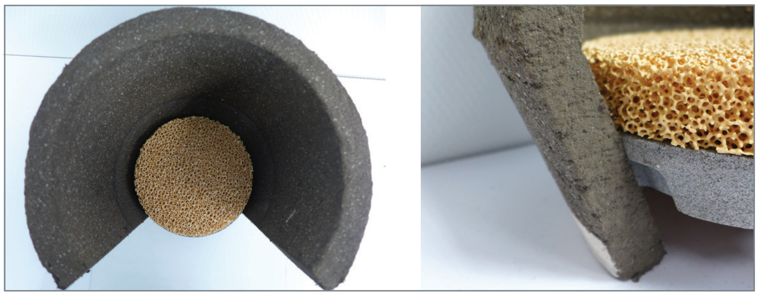

Fig.4 Filter on support ring in the riser with possible bypass formation

Fig.5 Conical filters are also available with all-round edge protection

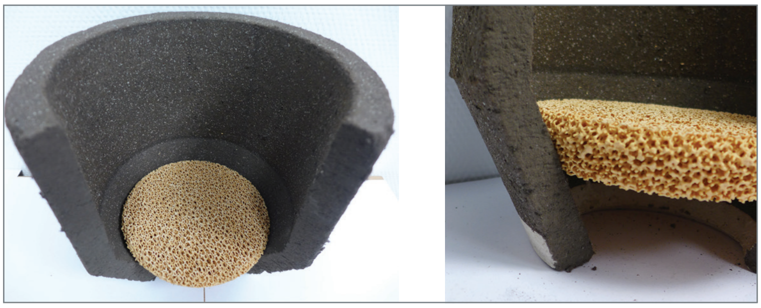

Fig.6 Precisely fitting seat of the conical filters

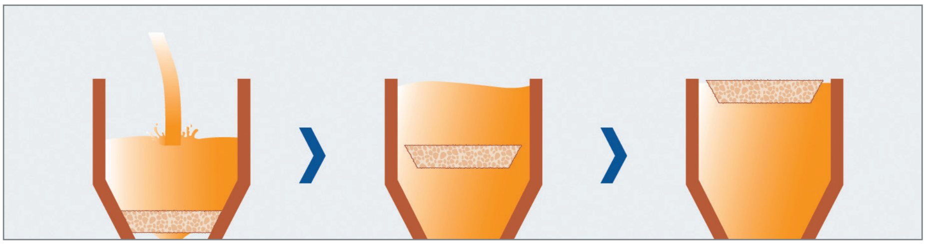

Fig.7 Clean floating after the casting process

- No tilting possible when floating up (fig.7).
- No turbulence-creating zones at the filter edge.
- Maximum usable filter area, no flow loss through the filter support.
- Increased filter capacity with reduced filter breakage risk.
- Reduced pressure on the filter seat, especially with 'soft' riser materials.
- The 'edge' surface of the filter can be sealed or closed (fig.5).
- A float aid is no longer required, process reliability increases and process costs are reduced.

Well known foundries use the conical UDICELL filter with very good success. The filter can be used with different conical risers from different manufacturers. Users are especially impressed by the maximum use of the filter capacity and increased process reliability. UDICELL filters solve the problem of the filter tilting when floating and thus ensure fault-free casting processes. Last but not least, the economic efficiency of the entire system is increased by the elimination of the additional cost-incurring flotation aid.

Additional Literature

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3 Voigt M U, Horvath Lee, '*High performance tubular foam ceramic filters for the foundry industry*', 71st World Foundry Congress, Bilbao, 2014.

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