Feeding Aids

SQ Group
Reminder of some principles regarding feeding of castings in foundries.
Volume variation during solidification

- The metal shrinks when cooling down (with the exception of grey iron: eutectic graphite expansion)
- The total contraction volume is a constant:

\[ V_M + V_p + V_A = \text{constant} \]
Sand molding walls motion

1. Non-rigid molds:
   - **Outward motion:**
     - The volume provided by the riser is bigger
     - The casting weight is bigger
     - The specification sizes are not fulfilled.
Sand molding walls motion

2. Rigid molds
   - *Inward motion*:
     - Sound castings (the mold reacts as a press)
     - Specification sizes are fulfilled.
Solidification behavior of the alloys

• Each alloy has its own solidification behavior:
  – Some ones with the solidification starting from the mold wall in thin layers (low carbon steel).
  – Some others with solidification in thick layers with « doughy zone ».
  – Some others between the two…

• The solidification behavior of an alloy varies according to the alloy composition itself, its cooling speed and its thermal gradient, consequently this thickness concept is very important.
Function of the riser

1. *To offset the volume variation* of the fed casting part during solidification.

2. To feed in liquid metal the casting (*reservoir*)

Therefore, the solidification time of the riser should be longer than the one of the the casting part it is feeding.
Geometric Modulus

The solidification time $T_s$ of a standardized part is function of its volume ($V$) and its cooling area ($S$) according to the equation:

$$\sqrt{T_s} = k \frac{V}{S} = kM \text{ (where } M = \frac{V}{S})$$

$M$ is the geometric Modulus of the standardized part. The unit is in cm (the volumes and the areas being respectively in $\text{cm}^3$ and $\text{cm}^2$).
Risers modulus

To feed properly and correctly the standardized part of a casting, the riser dedicated to this part should act as a reservoir, therefore its solidification time should be longer than the standardized part concerned, hence its (geometric) modulus should be higher than the one of the standardized concerned part:

\[ M_m > M_p \rightarrow M_m = M_p \times k \]

k, is the « safety » factor and its value is usually taken between 1.2 and 1.25
In the event of exothermic sleeves

We can compare the riser yield of a simple casting (usually a cube) and deduce a «correspondence» between a sand riser (of which we know the geometric modulus) and an «exo» sleeve. We will have the relation:

\[ M_{th} = M_g \times MEF \]

\(M_{th}\) (or \(M_{exo}\)) is the thermal modulus (or exo modulus) of the sleeve.

*MEF* = «modulus extension factor»
Exothermic sleeves

Experimental determination of the «MEF»

Comparison between SQ exothermic sleeve and sand riser
• It is on this factor that the « sleeves suppliers » are acting in priority.
• Indeed, the higher this factor is the smaller will be the sleeve, that leads to a great improvement of yield.
• The general values of MEF are :
  – Insulating sleeves : 1.2 à 1.3
  – « standard » exothermic sleeves : 1.5 à 1.55
  – Very exothermic and insulating sleeves : 1.55 à 1.6
  – Special exothermic sleeves of small sizes : 1.65
Sleeves properties

In order to work properly, the sleeves should have the following properties:

- *Increase the solidification time* of their contents, thanks to their exothermic and (or) insulating properties.
- Have **good strength** to withstand handling and transport.
- **High porosity** to exhaust the gas evolution of their own exothermic reaction.
- *Withstands the high temperature* they are producing without any melting nor deformation.
- Do not pollute the metal of their contents by their by products.
- Do not pollute the sand (reclaimable)
- Not toxic for environment and good working conditions.
- For special sleeves (insert sleeves), they should have a very accurate dimensions with small tolerances values.
Exothermic reaction and insulation value.

When the liquid metal gets inside the sleeve, an exothermic reaction (aluminothermics) starts (we can say the sleeve «starts» or «ignites») and the combustion goes on during a certain period of time until the exothermic reaction ceases (we can say the sleeves «stops» burning). It is the knowledge of this complicated reaction that leads the manufacturer to elaborate special recipes using special and specific raw materials.

We can determinates several stages during the burning of the sleeve:

1. The **ignition time**
2. The **combustion (burning) time**
3. The **maximum temperature** reached and the time when it occurs
4. The **insulation behavior**

In fact the reaction is much more complicated and there are many other factors that can be measured, leading to interpretation and then elaboration of specific formulations.
Exothermic reaction and insulation value
From several years ago, SQ is selling sleeves manufactured in his Jinan plant.

Two different types of sleeves are available:

- The sleeves manufactured by sucking water based slurries, then dried, such sleeves are usually known as «fibrous sleeves» because the formulations are based on mineral and organic fibers: **FT 100, 300, 400, 500**.

- The sleeves produced with dried materials and shot like foundry cores: **FM 100**.
The fibrous sleeves are mainly used in steel foundries to produce medium to large castings, usually with diameters $> 120$ mm.

Many shapes are available: cylindrical or oval sleeves, neck down sleeves, open or closed, dome sleeves, insert sleeves, ...
The « shot » sleeves are mainly used for production of small to medium sizes castings in ductile iron or steel.

Their main advantage is their very accurate dimensions with low tolerances, therefore they are mainly used as *insert sleeves*. 
Different shapes
Different shapes
Flexible boards

For large risers, when diameters exceed 600 mm, it is preferable to use such flexible boards that can be bended as request to fit any diameters of risers.

The main advantage of such item is the saving in transport and storage and to minimize the breakage risk during handling, transport and storage.
Some examples of castings produced with « SQ » risers
Some examples of castings produced with « SQ » risers
Some examples of castings produced with « SQ » risers
Some examples of castings produced with « SQ » risers
Some examples of castings produced with « SQ » risers
Propellers: Waetsila at Zhenjiang

Molding: Sodium silicate / CO₂

As cast

SQ products used: Exothermic sleeves

铸件应用行业
Thank you very much for your trust and support to ShengQuan!