Design and Fabrication of Exothermic Sleeve using Ceramic Fibre

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***Abstract*—Direct pouring system is an existing method in Casting. In that method, for pouring the liquid metal inside the cavity the exothermic sleeve are replace both as sprue, runner and also riser in the other end where the metal overflows. These exothermic sleeve were made of paper wool and it can be used only once. Therefore, we replaces the paper wool with the ceramic fiber to reduce the replacement at every time of pouring.**

Keywords—casting, direct pouring, riser sleeves, feeder design , gating system.

I. Introduction

In the current global competitive environment there is a need for the casting units and foundries to develop the components in short lead time. Defect free castings with minimum production cost have become the need of foundry. The gating and riser system design plays an important role in the quality.

Direct pour system is one of the method in casting. Direct Pour System is a combination of Ceramic Foam Filter and Insulating Sleeve. Ceramic Foam is the type of filter used in the direct pour system to filter the unwanted things in the molten metal. Insulating sleeve is a component used in the direct pour system for pouring the molten metal into the molten cavity. By using these exothermic sleeves there are several benefits such as gating system is eliminated, surface finish and machinability is improved, etc. In this project we have changed the conventional exothermic sleeve material with the ceramic fibre.

II. DIRECT POUR SYTEM

Direct Pour System is a combination of Ceramic Foam Filter (shown in fig.2) & Insulating Sleeve (shown in fig.1).It is used for Cast Iron, Aluminium, Copper Base alloys & Steel.

Direct Pour Mechanism takes place in two stages. They are

1. Filtration
2. Feeding.

Fig 1: Exothermic Sleeve

Fig 2: Different size of filter

1. *Filtration*

The Filtration effect is due to the mechanical entrapment of inclusions. The change in flow & pressure through the filter causes the contaminants (Inclusions) to stick to the filter labyrinth (Web of pore).VUKOPOR Filter has maximum open pore structure (minimum internal blockages).This enhances the filtration efficiency & flo5w rate. It also reduces entrapment of air bubbles into the metal downstream. It changes Turbulent flow to a Laminar flow. It also reduces the oxide formation within the filter.

2. *Feeding*

Once Filtration takes place Ceramic Foam Filter floats at top & Feeding action starts. Feeding effect is due to the highly Insulating nature of the Sleeve. It improves the temperature gradients within the castings & promotes the Directional Solidification.

Salient Features of Direct Pour System:-

- Gating System is completely eliminated.
- Rejection due to slag inclusion especially at machining stage is minimized.
- Soundness of Casting is improved.
- Fettling work & other rework is minimized.
- Surface finish of casting is improved.
- Machinability is improved.

Types of Direct pour system

There are three types of direct pour system they are explained below:

1. Conventional direct pour system
2. Insert type direct pour system
3. Neck down type direct pour system

1. Conventional Direct Pour System

It can be used as Ram up or insert applications. It is suitable for jolt squeeze molding machine, hand molding and for high pressure & disamatic molding machine. The below as (3) shows the conventional type direct pour system.

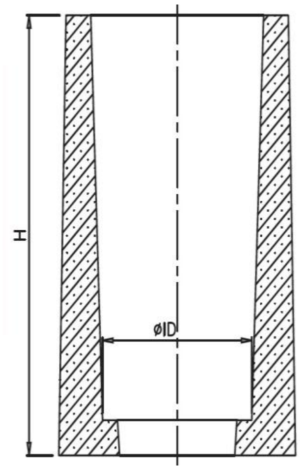


Fig 3: Conventional type direct pour system

2. Insert type Direct pour system

In this type of direct pour system, ceramic foam filter is placed in the seat provided at the top of the sleeve. It can be used in insert applications in the pre-formed mould cavity in the upturned molding system. The sleeve is located below the down-sprue. It is available in 50,70,90 diameter. The below as (4) shows the insert type direct pour system.

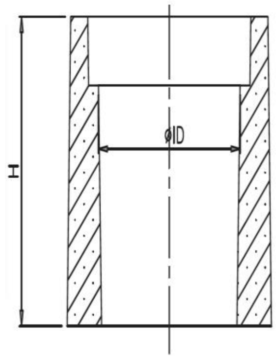


Fig 4: Insert type direct pour system

3. Neck down type Direct pour system

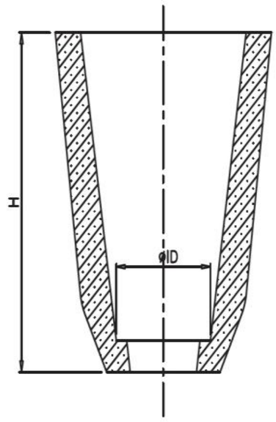
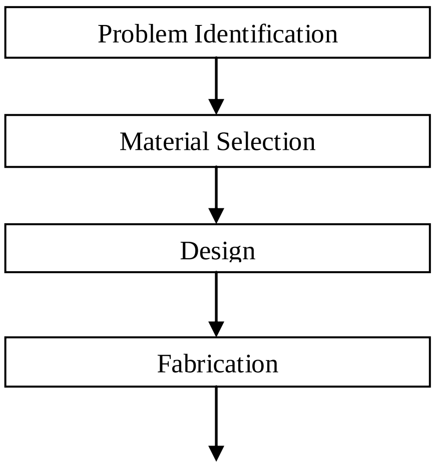


Fig 5: Neck down type direct pour system

It is mainly used for top feeder application where feed metal requirement is higher. It is directly placed on the casting surface with or without breaker core. The below as (5) shows the neck down type direct pour system. In these type of direct pour system our project is related to the conventional type direct pour system.

III. METHODOLOGY



Analysis

IV. MATERIALS SELECTION AND PROPERTIES

The materials used for the fabrication of the exothermic sleeve made of ceramic fibre are given below

- Ceramic fibre
- Bentonite
- Exothermic powder
- Epoxy acrylic resin
- Core fix

Ceramic Fibre:

Fig 6: Ceramic Fiber

The high-temperature insulation wool (HTIW), known as ceramic fiber wool until the 1990s, is one of several types of synthetic mineral wool, generally defined as those resistant to temperatures above 1000°C. The first variety, aluminium silicate fiber, developed in the 1950s, was referred to as refractory ceramic fiber.

Ceramic materials are hard, have low densities (compared to metals), high compressive strength and very good thermal resistance and strength at higher temperature. Due to their notable high temperature performance, these are useful as reinforcement in metal and ceramic matrix composites, where the structures are required to operate at high temperature and under oxidizing/ corrosive environments, examples: in- heat exchangers, first containment walls for fusion reactors, gas turbines, as well as for high temperature gas filtration.

The low strength of these materials is significantly increased when the ceramics are in the form of fine filaments composed of sub-micron grains. The requirements for high-performance reinforcements would therefore be fulfilled if such bulk ceramics were transformed into fibres.

Bentonite powder:

Bentonite is a type of absorbent clay that is usually refined from volcanic ash. Its high absorbency makes it a useful substance in industrial applications, in products like kitty litter and even in natural medicine. While you may be able to purchase bentonite as wet clay or as a gel-like substance, its most common, affordable and versatile form is powder. Bentonite powder is available without a prescription wherever natural supplements are sold, though a consultation with a physician is recommended before beginning any bentonite regimen, especially for people with iron intolerance, high blood pressure and life-sustaining prescriptions.

Fig 7: Bentonite powder

Bentonite has been widely used as a foundry-sand bond in iron and steel foundries. Sodium bentonite is most commonly used for large castings that use dry molds, while calcium bentonite is more commonly used for smaller castings that use "green" or wet molds. Bentonite is also used as a binding agent in the manufacture of iron ore (taconite) pellets as used in the steelmaking industry. Bentonite, in small percentages, is used as an ingredient in commercially designed clay bodies and ceramic glazes. Bentonite clay is also used in pyrotechnics to make end plugs and rocket engine nozzles. The ionic surface of bentonite has a useful property in making a sticky coating on sand grains. When a small proportion of finely ground bentonite clay is added to hard sand and wetted, the clay binds the sand particles into a moldable aggregate known as green sand used for making molds in sand casting. Some river deltas naturally deposit just such a blend of clay silt and sand, creating a natural source of excellent molding sand that was critical to ancient metalworking technology. Modern chemical processes to modify the ionic surface of bentonite greatly intensify this stickiness, resulting in remarkably dough-like yet strong casting sand mixes that stand up to molten metal temperatures.

The same effluvial deposition of bentonite clay onto beaches accounts for the variety of plasticity of sand from place to place for building sand castles. Beach sand consisting of only silica and shell grains does not mold well compared to grains coated with bentonite clay. This is why some beaches are much better for building sand castles than others.

The self-stickiness of bentonite allows high-pressure ramming or pressing of the clay in molds to produce hard, refractory shapes, such as model rocket nozzles.

Exothermic powder:

Exothermic powder is a powder used in casting and several other application.The blow picture gives the

Fig 8: Exothermic powder

Epoxy acrylic resin:

Epoxy resin works similarly, doesn't smell as bad, but it is the hardener that makes it set. It is a sensitizer, meaning that you can get a nasty allergic reaction after repeated exposure. Some hardeners are not as bad as others in this respect. Epoxy won't set water-clear like acrylic, and doesn't resist sunlight (UV) degradation as well, but works better with high-tech cloths, like Kevlar and graphite.

Almost any dry pigment (with a few exceptions test first on a small scale) can be used to color these resins, as well as various inert fillers which also add color; there are also special polyester dyes available. It can be made opaque or transparent acrylic is used for casting "plexiglas" sheets, among other clear things. Be very careful when using any of these materials: these are generally considered industrial rather than art supplies, and you are expected to know how to protect yourself from their harmful effects. If you don't have the proper facilities for dealing with them, consider using safer alternative systems.

Core fix:

Fig 9: Core fix (Para-Toluene Sulphonic acid)

p -Toluenesulfonic acid (PTSA or p TsOH) or tosylic acid (TsOH) is an organic compound with the formula.

$CH_3C_6H_4SO_3H$

Properties:

- It is a white solid
- It is soluble in water, alcohols, and other polar organic solvents.

The $CH_3C_6H_4SO_2$– group is known as the tosyl group and is often abbreviated as Ts or Tos. Most often, TsOH refers to the mono hydrate , $TsOH.H_2O$.

As with other sulfonic acids, TsOH is a strong organic acid . It is about one million times stronger than benzoic acid . It is one of the few strong acids that is solid and, hence, conveniently weighed. Also, unlike some strong mineral acids (especially nitric acid, sulfuric acid, and perchloric acid), TsOH is non-oxidizing.

V. MAKING OF EXOTHERMIC SLEEVE

The making of exothermic sleeve are very simple process. They are explained in following steps:

1) Initially place the two hallow shaped pipes by keeping the small diameter pipe inside the larger diameter pipe and place over the plain surface.
2) Here we use the normal plastic pipe for the making of that sleeve. The top view (10) and the side view (11) of the setup is shown below.

Fig 10: Top of view of the setup

3) Mix the ceramic fibre with the exothermic powder, core fix (para-toluene sulphonic acid), bentonite powder and mix them as a composition.
4) From the surface level to the top the composition is filled layer by layer.
5) And inbetween the layer the epoxy acrylic resin is added to each and every layer.

6) The ramping is carried out after the addition of every layer.

Fig 11: Front view of the setup

7) The filling of the layer should be carried out upto the height of the pipe and it is allows to cool for hardening.

8) Finally, the two pipes are removed when the exothermic sleeve are fully hardened.

This process is made manually by just ramping. If they made by some machines the production rate should be very high.

Fig 12: Finished exothermic sleeve

VI. ANALYSIS

After the making of the exothermic sleeve it is made to analysis by several tests. The exothermic sleeve is need to bear high temperature, hence they are tested by pouring some molten metal.

We have tested for cast iron metal the values are tabulated below:

TABLE I. Dimension of the exothermic sleeve the test

S.No.	***Diameter of the sleeve (mm)***		***Height Sleeve (mm)***	***Thickness Measured (mm)***	**Temperature of the metal poured**
	OD (mm)	***ID (mm)***			
1	100	50	150	25	1200

The exothermic sleeve is placed in the path of the molten metal. The molten metal is subjected to flow at very high temperature. The dimension of the exothermic sleeve are given in the table 1.

Fig 13: Exothermic sleeve during testing

VII. RESULTS

As a result the following results are obtained which are mentioned as below

- In the exothermic sleeve the flowing distance of the molten metal is very less hence the molten metal can be heated to little less temperature comparing to conventional method.
- The exothermic sleeves made of ceramic fibre are used for minimum five times due to the character of the molten metal and the high temperature.
- The yield of the casting process is improved.
- The fettling work are reduced.

- Hence,the exothermic sleeve can be used for several different materials with less cost and less material consumption

VIII. ACKNOWLEDGMENT

This research was partially supported by Mr.Sivakumar, Sri Sakthi Foundry,Coimbatore. He provided industry for testing purposes and supported us to complete the project successfully

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