Optimizing insert-feeders in insulation, pollution and handling

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Introduction

Insert-feeders have been produced and also used for decades without strong development in their function.

Ingot-casting was running less in steel industry for many years and technical development in new products was turned from ingot casting to continuous casting.

In the last ten years ingot casting became more and more modern again in steel industry. Because of this reason we started the development of new and modern products.

Previous qualities:

Since the last forty years the most often used quality is insulating, based on approximately 90% quartz-sand and has a density of at least 0.9 kg/l. The material has a good solidity. We tested a heat conductivity of 0.36 W/(m*K) and this material can be used as insert-feeder as also as for lining-chains. We call this material our mixture No. 1, other producers of course have different names for their products. The mixtures of all producers are most similar to each other, this is prior art.

Additionally there are some other products. There is a lighter insulating material, based on rice husk ash with a density of 0.6 kg/l. The heat conductivity is better, so we have a better isolation but this material - we call it our mixture No. 23 - is a little hygroscopic, so it is not possible to store it for longer periods of time. This mixture No. 23 is much more expensive than the conventional material but of course it allows a better yield in the ingots.

Figure 1: Insert feeder mixture No. 23

The final alternative is an exothermic insert-feeder. This material is even more hygroscopic, much heavier and the most expensive alternative. Since several years we stopped proposing exothermic insert-feeders because today we have other materials, which allow easier handling and storage.

New developed quality for insert-feeders

Regarding the revival of ingot casting in the last years, it was time for a further development in insert-feeders.

The idea was to find a mixture with a better insulation, which allows a lower hot-top. Due to the fact that usually ingots are made of higher alloyed special steels, a better yield is one of the most important facts.

A lighter material is also easier to handle and so an advantage for the employees who have to work with the insert-feeders. The last idea was to use as little fiber-material as possible.

In the years 2008 and 2009 we used the time of less production, caused by the world economic crisis, to develop this new product. After lots of tests in our laboratory we went to some closely connected steel-plants to make the first tests under realistic conditions. First we have been successful and had extremely positive feedback.

As already mentioned, most of our customers had only low utilization and that meant they had capacity for testing the new material. During this period, we found some points that needed to be improved. Especially in some steel-qualities and ingot-sizes we had infiltrations of steel in the ingot-heads.

With these results, we went back into our lab and continued the development. Now, the use of the final version is in progress since last year's summer.

Our material - that is patent registered since 2010 - contains a high proportion of the natural volcanic stone perlite instead of fiber-material.

Usually perlite has a melting temperature of about 1050°C, which surely is lower than the casting temperature. During our research we found a method to coat the perlite and so, the results are optimal, now.

With this new product, we also introduced new brand names for our products. Our new optimized insulating products are called ISOLUP® and in this case we talk about the quality ISOLUP® 30.

Insulation

To get more information about the insulation of ISOLUP® 30 we started two projects of evaluation.

First, we went on to test the material in steel-plants. Most important figure was to see the appearance of the ingot's top. We expected to get cavity free ingots with very low tops and we reached our target.

Second, we gave a test order to the University Duisburg-Essen and their institute for metallurgy and metal forming.

At the institute they made lots of tests regarding the strength, the heat-resistance and the possibility of using the material for other applications. These tests confirmed the results, we already had made in the steel-plants.

Most important test was to know the heat conductivity. The result is 0.26 W/(m*K), tested at 700°C.

Weight

The second aspect for developing the new ISOLUP® 30 quality was to have a lightweight product that is easier to handle, particularly in big ingot sizes of more than 30 tons.

The density of the conventional mixture No. 1 is higher than 0.9 kg/l. For example an insert-feeder for just a 4.5 t ingot had a weight of 22 kg in total.

Figure 2: 4.5 ton mould with insert-feeder

After switching this insert-feeder to ISOLUP® 30 the weight was only 9.5 kg. The density of this material is only less than 0.5 kg/l.

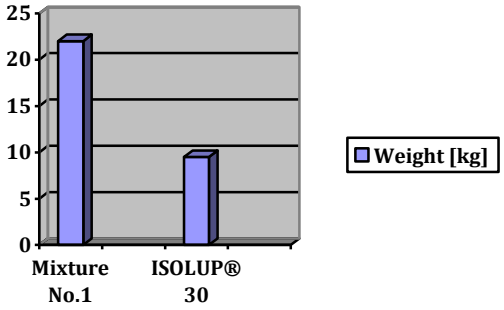

Figure 3: Difference in weight insert feeder for 4.5 t ingot

Yield

In a second step, after turning from conventional insulating material to ISOLUP® 30, there are some projects at our customers to reduce the volume of the top. This means a bigger part of the usable ingot.

To show you an example, we took a 6-t-ingot, which was formally insulated with a lining-chain in a height of 270 mm in conventional mixture No. 1. The customer switched to a one-piece insert-feeder in a similar quality and same size. At last we made a one-piece insert-feeder in ISOLUP® 30. This had just a height of 200 mm, what means 25 % less lost top.

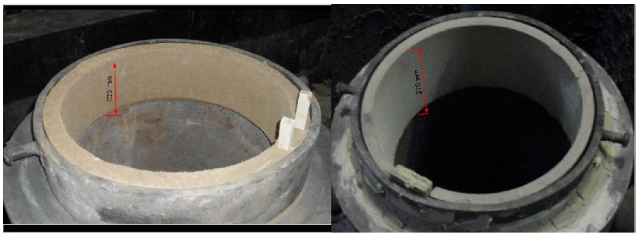

Figure 4: Comparing the height

We will show you the results later, because of course there is another very important material for a small top and a good ingot. This is the covering material.

So there is a second invention we have to talk about:

Covering-powder

There are two possibilities to cover the top of an ingot in the mould. The one is using an exothermic powder, which usually is again covered by an insulating powder. The second possibility is using a cover plate, which is a board shaped suitable for the

mould. Cover plates are supplied in exothermic or insulating qualities.

Conventional quality

Usually covering an ingot is divided in two steps. First an exothermic powder is put on the ingot, directly after finishing the casting-process. This creates often a big flame, lots of dust and very hot temperatures inside the ingot and also around.

Figure 5: Smoke from conventional covering powder

In the second step an insulating powder – very often rice husk ash – is put onto that flame to insulate the exothermic heated steel for keeping it liquid.

Figure 6: Covering with rice husk ash

The quickly and extremely hot exothermic reaction heats the ingot very much, what creates a risk of segregations.

The second conventional product is the exothermic cover plate. These boards also create an exothermic reaction, when they are put on the mould before casting or onto the ingot after casting. Due to the more densely packed material the exothermic reaction is slower. That means the energy is put slower into the ingot. The reaction is not as hot as with the powders and the boards include insulating components, which are able to hold the necessary temperature in the ingots' tops.

We have been supplying cover plates to our customers for more than ten years now and more and more our customers asked, if there is a possibility to cover big ingots with a diameter of e.g. more than one meter. This size in a board is unwieldy and there is a big risk of breaking while handling it.

New quality of covering-powder

This was the reason for us to start the development of a covering-powder that should behave like a cover plate. The target was a covering-powder with a slower reaction than usual, the insulating part to be included but applicable for every type of ingot, also big ones.

We started to test the exothermic mixture of our cover plates (which is called LUPUTOP® 20) without binder but as a powder. In our laboratory we found, that this easiest way of development was impossible. The exothermic reaction was missing and so we needed more compounds that supply energy in the powder. We found the optimal mixture which again was tested in the closely connected steel-plants.

This new material is called LUPUTOP® P1 and it is the result of all the goals we had to achieve.

Characteristics

As already mentioned, the conventional covering-powder heats up very quickly and to very high temperatures. This includes a risk of segregation. The insulating component has to be put onto the material in a second process step.

Oppositional to this, the LUPUTOP P1 powder has a slower heat up to temperatures that are not so superheated with less risk of segregation.

Figure 7: LUPUTOP P1 without smoke

This material has the insulating components integrated and so saves the second process step.

Safety/Pollution

The combination of exothermic and insulating parts offers advantages in the characteristic of pollution and in the safety.

There s no danger from a high flame before putting the rice husk ash onto the ingot.

The pollution, the dust during the exothermic superheat reaction isn't released. This means less health hazards for the employees and less dust in the filter-systems to be depolluted.

Consumption rate

Finally we have to talk about the quantities that are used. With conventional covering-powder the consumption is between one and two kg powder per ton steel in the ingot. The rice husk ash is additionally used with 0,5 kg up to 1 kg per ton steel.

The new LUPUTOP® P1 with its density of 0.6 kg/l has a big volume and so it is needed with only 1 kg/t up to 1.5 kg/t.

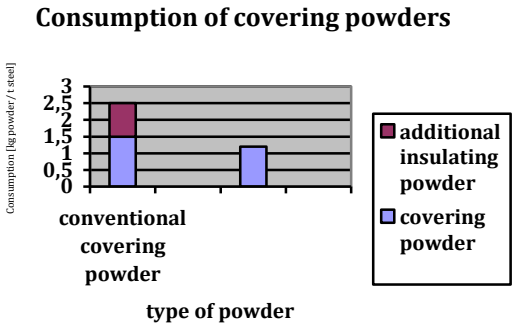

Figure 8: Comparing needed quantities of covering powders

Regarding the cost for this material, there are three issues: First the needed material in total is less, second there is less work to do and at last without the smoke, there is less dust to dispose.

Conclusion

The combination of highly insulating lightweight insert-feeders and an easy to use exothermic covering-powder is a big chance to improve the yield, to reduce costs and to protect the workforce and the environment. With technical progress ingot casting remains a modern production method for high alloyed steel qualities.