Low density insulated ladle linings at Sinclair Works

Introduction

The Sinclair Works of St. Gobain Pipelines produces drainage castings in both grey and ductile iron. There are three foundries on site, one producing larger fittings using an airset system, one making rainwater products in metal moulds and the third using a Disamatic machine to make smaller fittings. Metal is melted in coreless induction furnaces in the rainwater and Disamatic shops, whilst the airset foundry receives its metal by transfer ladle from the rainwater foundry. Typical Products are shown in Figure 1.

Figure 1: Typical products of Sinclair Works

Staff and operators are well aware of the importance of controlling the temperature and cleanliness of the iron poured into moulds and ladle linings play a vital part in maintaining this control.

KALTEK* ISO is a lightweight, highly insulating and easy-to-use lining material. It was first introduced into the airset and rainwater foundries, and advantages identified there have led to its being used also in the Disamatic foundry. The material is now employed for all pouring ladles throughout the works. These ladles range in capacity from 250 kg to 450 kg of iron.

The advantages will apply to many other iron foundries and the prime purpose of this Case Study is to explain what the system is, how it is used and the benefits that can be expected from it.

Lining a ladle with KALTEK ISO

The lining process consists essentially of pouring KALTEK ISO, a dry powder, around a former suitably located within the ladle shell, igniting the powder, allowing the resulting flame to spread throughout the mixture, and removing the former a few minutes later from the hardened body of refractory.

Clearly, the operations involved vary slightly depending upon the size, variety and performance required of the ladle, but a typical sequence is:

- ❑ Clean the ladle shell of all lining material
- ❑ Pour about 75 mm of KALTEK* ISO powder onto the base
- ❑ Coat the internal former with release agent
- ❑ Set the former in place (it is fitted with lugs which engage with sockets on the shell)
- ❑ Feed the powder from its 25 kg bags directly into the gap between former and shell (figure 2)

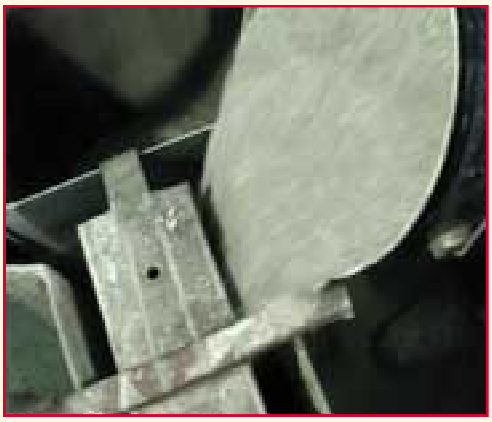

Figure 2: KALTEK ISO powder being applied

- ❑ Fill the gap to the desired level
- ❑ Apply a gas torch to the inside of the former for 1 to 2 minutes to initiate the exothermic reaction (figure 3)

Figure 3: The KALTEK ISO reaction being initiated with a gas burner

❑ Remove the gas torch and allow the reaction to go to completion (15-20minutes) (figure 4)

❑ Remove the former (figure 5)

❑ Top off the lining and make up the spout with rammable material

Figure 4: The KALTEK ISO reacting

Figure 5: The finished KALTEK ISO lining

The ladle in use

Before being put into use, the ladle is usually pre-heated for an hour. The ladle then undergoes no further heating during the shift unless there has been an unusually prolonged stoppage. Lining life varies with the duty, but, for example, on the Disamatic line at Sinclair works, which works a 3-shift day, it averages 5 shifts (This compares with 3 shifts on ladles lined with castable material). It is noteworthy that the useful life when working on ductile iron is about two-thirds that achieved on grey iron, because of build-up on the lining. Nevertheless, the life achieved is greater than that of linings made of castable refractory.

The benefits

Use of the system has many benefits, including:

❑ Reduction in overall costs

❑ Rapid replacement of linings

❑ Consistent ladle capacity

❑ Excellent heat retention

❑ Reduction in energy consumption

Reduced labour

Lining a ladle with the KALTEK* ISO lining is far simpler and quicker than using conventional casting/ramming techniques. For example, a 330 kg ladle used on the Disamatic line at Sinclair works requires some 85 minutes total labour time to remove a used KALTEK* ISO lining and replace it completely. This compares with a labour time of 175 minutes using a rammed refractory.

In each case, approximately half the labour time is needed to remove the old lining, a task which involves the use of a pneumatic chisel. The reduction in time for which the chisel has to be used is of considerable benefit in reducing the risk of Vibration White Finger.

Rapid replacement of ladles

In many foundries, ladles lined with "conventional" materials are frequently kept in use despite the lining being in a poor state and almost certainly resulting in "dirty metal", simply because of the length of time required to replace the lining or effect major repairs. The speed with which a ladle can be lined with KALTEK* ISO and brought back into use contributes to increased productivity and improved quality.

Reduced overall costs

Although the KALTEK* ISO lining material price per kilogram is higher than that of a rammable refractory, the fact that ladles can be kept in use for far longer without replacement or major repairs means that lining costs are lower, as seen from the table below. This is based on the ladles in use in the Disamatic foundry.

	Comparative costs of lining individual ladles at Sinclair Works			
	250 kg capacity		330 kg capacity	
	KALTEK* ISO	Rammed	KALTEK* ISO	Rammed
	–	–	–	–
Material	€ 163.05	€ 82.65	€ 181.50	€ 99.15
Labour	€ 12.37	€ 36.00	€ 25.20	€ 52.65
Heating	€ 0.45	€ 2.70	€ 0.45	€ 2.70
Total	€ 175.87	€ 121.35	€ 207.15	€ 154.50

Ladle lining costs over 3 shifts		
	KALTEK* ISO	Rammed
	–	–
250 kg ladle	€ 105.52	€ 121.35
330 kg ladle	€ 124.29	€ 154.50

Note: KALTEK* ISO lined ladles average 5 shifts before replacement
Conventionally lined ladles average three shifts before replacement or major refurbishment.

Consistent ladle capacity

The fact that ladles stay clean for a longer time when lined with the new material is an additional benefit. The foundry produces SG iron by a process in which a measured amount of a proprietary treatment alloy, based on the nominal capacity of the ladle, is added to the metal stream as it passes through a refractory-lined vessel. Metal is tapped from the electric furnace until the ladle is filled. Variations in ladle capacity can result in the fixed quantity of alloy treating different amounts of metal. Since ladle capacity does not vary to the same extent as with previously-used refractories, greater metallurgical consistency is achieved in the SG iron.

Heat retention

The rate of loss of heat from a pouring ladle depends upon a number of factors, hence it would not be possible without a prolonged and detailed study to make precise comparisons of the difference between the rate of temperature loss from a KALTEK* ISO lined ladle and that from a ladle lined with an alternative material.

Observations to date, however, indicate that the temperature loss rate of the ladle lined with KALTEK* ISO is about one-third that of the alternative, typically 5°C per minute compared to 15°C.

A model of the comparative metal temperature losses of a KALTEK* lined and cement lined ladle is shown in Figure 6. The prediction was made using a "Ladle Transient Temperature Calculation Program" based on the following assumptions:

- ❑ 350 kg capacity ladle
- ❑ 40mm lining thickness
- ❑ The ladle is in use, the lining is therefore at high temperature
- ❑ The ladle is not covered
- ❑ 350kg of grey iron is tapped into the ladle at 1400°C

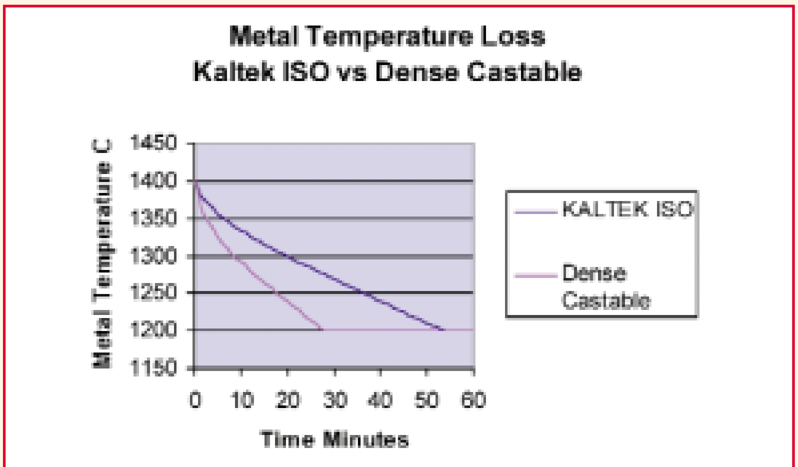

Figure 6: A model of heat loss from molten iron contained in a KALTEK ISO lined ladle compared with a refractory cement lined ladle

Metal quality

Good ladle practice is an important feature of practical metal control. The KALTEK* ISO lining system now in use contributes to the reduction in levels of foundry scrap, thanks to cleaner linings, better control of ferro-alloy addition levels and reduced temperature losses during pouring.

Reduced energy

With the need for foundries to meet their obligations under the Climate Change Levy Agreement, any reduction in the use of energy is welcome. Whilst a gas torch is used to ignite the refractory powder, to dry any topping refractory and to pre-heat the KALTEK* ISO lined ladle for up to one hour before initial use, the amount of gas used in more conventional systems, where the ladle is likely to be under a pre-heater for 5 to 6 hours , is far greater.

It is also worth noting that improved ladle practice helps to improve overall yield of good castings, thereby reducing the amount of metal which has to be melted to produce a given output of good castings and resulting in a lower electricity consumption.

The Manager's view

" I am a firm believer in the use of KALTEK ISO lined ladles. It enables us to bring ladles into service more quickly, reduces temperature loss rates, reduces energy consumption and contributes to the reductions in foundry scrap levels we have achieved in recent months. It also has several less obvious advantages. For example, the consistent ladle capacity has simplified the control of metal treatment, whilst the easier removal of linings at the end of their life helps significantly to reduce the hand-arm vibration problem which can arise in carrying out this task".*

Steve O'Brien
Plant Manager.

Opportunities for other foundries

The excellent results obtained at Sinclair Works have already been confirmed at a number of other plants throughout Europe and should encourage many iron foundries to examine their present ladle lining practice and experiment with this simple and effective system. The benefits they obtain will inevitably vary. Some will gain from reductions in the number of defective castings produced – e.g. misruns and inclusions are likely to be fewer – others will find the saving in labour very valuable and a few may even discover that the lower weight of refractory will enable them to use larger ladles on existing runways.

The energy savings possible are another important feature, since lower heat losses and better yield lead to energy savings in melting. Many foundries use considerable (but unmetered!) quantities of gas to cure and preheat ladle linings and should consider the new material as an opportunity to reduce this cost.

The knocking out of conventional linings can be a dirty and strenuous activity and has serious Health and Safety implications. The ease of removal of the KALTEK* ISO linings is therefore an important benefit.

In carrying out trials, it should be remembered that the very property which makes removal of the lining so easy also makes it more prone to mechanical damage than a rammed or cast lining of denser refractory. It is for this reason that the tops and lips of the ladles, which need frequent cleaning of build-up, are occasionally made of a denser refractory.

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