# INSURAL ATL ladle lining at NEMAK CZ

## Introduction

Energy costs and environmental considerations continue to put financial pressures on the foundry industry. Concerns with global warming is resulting in governments taxing both companies and individuals into becoming more fuel efficient. To remain competitive foundries will have to look closely at all working practices to see where cost savings can be made and more efficient forms of metal melting and holding will have to be considered along with good recycling practices.

The foundry industry, where energy consumption is a major factor, must consider improving insulation along with sophisticated temperature control and monitoring in order to reduce costs.

One particular area of the foundry which is often overlooked is that of transfer ladles, where costs are often not considered to the extent that they ought to be. Although these ladles are of fairly simple design they can play a key part in controlling quality as well as cost of production.

When looking for the ideal transfer ladle lining material a number of factors have to be considered. Many foundries use traditional refractory concrete linings which are poor insulators and difficult to dry completely. These linings can be a source of hydrogen pick up as they can take many days or casts to fully stabilise.

Other foundries use crucibles to line ladles but these are inherently conductive and therefore lose heat rapidly.

When looking for the ideal lining material a number of factors need to be considered mainly good insulation properties, metal cleanlinesses and speed of replacement.

INSURAL ATL, a highly insulating, simple lining system, has been designed for optimum performance in all these key areas. INSURAL ATL liners are pre–cast to shape, highly insulating, fully fired and delivered ready for rapid installation. The INSURAL ATL liner is fitted into a conventional steel shell and surrounded by a highly insulating backing material for secure fitting called INSURAL 10. The complete system is quickly installed and instantly ready for use with no further firing necessary.

## Insulation

To obtain optimum energy utilisation for melting more foundries are now using central melting, where large melting furnaces provide molten metal at the correct temperature on a fast and economic basis. For foundries that use this system it is becoming more popular to carry out metal treatment in the transfer ladle so that casting can begin quickly after transfer. Cleaning, degassing, grain refinement and modification can be completed quickly, particularly in a system such as the automated FOSECO MTS 1500 process, but even here a total time of 10 minutes may be required. For such a holding period insulation and temperature loss is an issue and so a highly insulating lining is essential.

For example, if a conventional lining with an expected temperature loss of 8°C per minute is used then a super heat of 80°C may be necessary leading to increased oxide formation and higher dissolved hydrogen levels. Whereas an INSURAL ATL lining system will only have a temperature loss of around 3°C per minute and so for the same treatment time will only require 30°C of superheat. This reduces the holding temperature of the melting furnace, leading to cost savings.

Figures 1 and 2 show the relative insulation of traditional linings against INSURAL ATL liners, an Infra red camera is used to compare the energy emitted from both systems and the reduction in heat loss is clearly evident.

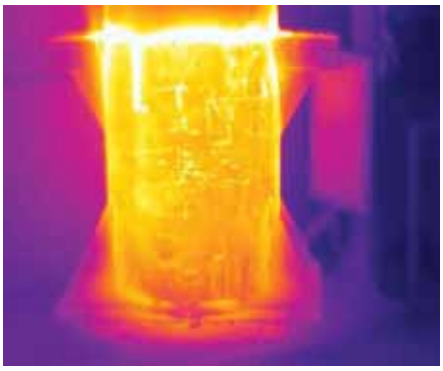

**Figure 1** Refractory concrete ladle seen through an Infra red camera showing the level of energy emitted

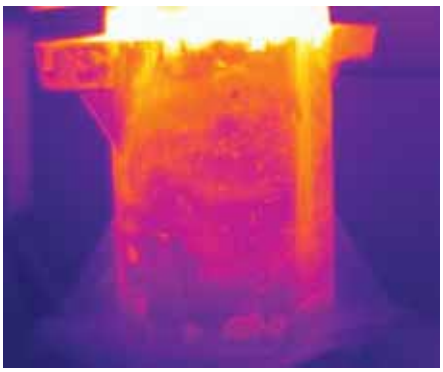

**Figure 2** The same ladle after being lined with an INSURAL ATL lining

## Metal cleanliness

To maintain casting quality the avoidance of oxide skins and non metallic inclusions is very important. Oxide films and inclusions will reduce mechanical properties, act as nucleating sites for porosity and unwanted intermetallic compounds, as well as increasing the chances of lack of pressure tightness. A ladle lining which avoids the formation of an oxide skin or, which makes any skin very easy to remove, will ensure there is no cross contamination between metal transfers and there will not be a build up of oxide which can grow before breaking away to give hard inclusions in the melt. Using a lining material which is non wetting will therefore be advantageous. INSURAL ATL is such a system where the skull of remaining metal can be easily removed once cooled, leaving a clean dry lining for subsequent transfers, compared to a conventional lining as seen in figure 3 where a thick skull can be seen.

**Figure 3** A conventional concrete ladle after 4000 fillings, showing a heavy build up of oxide

The regular use of a refractory coating such as CERAMOL* 258G (supplied as liquid, ready to use) or TERRACOTE* 7667 (supplied as a powder) can further improve the ladle lining cleanliness of the INSURAL ATL liner, as shown in figure 4.

**Figure 4** An INSURAL ATL ladle, which has been coated regularly, after 4000 fillings.
The metal skull in the base is still easily removed by a gloved hand

## Thermal shock

Many ceramic and refractory materials suffer from thermal shock and thus have to be carefully preheated before use for a considerable period of time, this being a costly process. INSURAL does not have this problem and metal can be safely poured into the ladle even when it is below 150°C with no adverse effects.

## Preheating

Many refractory concretes have high thermal capacities and will chill the molten metal on filling if not preheated close to the metal temperature. It is not unusual to see these refractory concrete ladles being continuously preheated with strong gas burners when not in use. INSURAL does not suffer from this problem and minimal preheating is required. To prevent hydrogen pick up, INSURAL should only be preheated after standing for many hours, such as weekends, but in normal working conditions little or no preheating is required. The avoidance of preheating offers the foundry a significant reduction in energy usage.

## Wear resistance

INSURAL ATL transfer ladles are available in sizes up to 2 tonnes, however, with larger ladles significant impact is experienced on filling. This impact will often be focused on the same position every time and so the ladle bottom can erode. Larger INSURAL ATL ladles are supplied with INSURAL 180 wear plates to avoid this erosion. These are of a material strong enough to avoid erosion and are fitted into the appropriate position in the base of the liner.

## Flexibility of shape and size

INSURAL ATL liners are installed in a steel shell surrounded by INSURAL 10 backing powder. This means that an INSURAL liner can be applied in almost any ladle size or shape (figure 5). Although there is a comprehensive range of INSURAL ATL liner shapes, sometimes the capacity of the transfer ladle has to be slightly reduced. However, the low density of INSURAL compared to most refractory materials means more aluminium can be transported without compromising the capacity of the crane or forklift.

**Figure 5** Various ladle shapes and sizes

## Case Study

Nemak CZ produce 5,000 tonnes of gravity die cast cylinder heads per year by the gravity die process.

Melting is carried out in gas fired tower furnaces and is transferred by forklift using a 1000 kg capacity ladle, see figure 6. The ladle is moved to a treatment station for 10 minutes rotary degassing before being transferred to the casting line.

**Figure 6** INSURAL ATL1000 IB-Ladle with a capacity of 900kg

When the foundry was first commissioned a conventional refractory concrete lining was used and a gas fired preheater maintained a temperature of 800°C on the refractory surface. This was necessary to avoid excessive temperature loss.

This ladle has now been replaced by an INSURAL ATL 1000 ladle lining giving a safe transfer weight of 900 kg molten metal. The ladle lining was installed in 4 hours, painted with CERAMOL 258G and put into service following careful heating. In order to use a tapping temperature of 750°C and a delivered temperature of 710 °C the ladle liner is mildly heated and a temperature of 380°C is maintained on the INSURAL surface. The gas consumption over the full period of the project was measured and a reduction in gas usage of 90% was found. The gas usage was reduced from 3.117 cu m per hour to 0.29 cu m per hour.

Further advantages of using the INSURAL ATL 1000 ladle liners are: minimum cleaning and maintenance compared to the old refractory concrete lining system, less aluminium skull remaining after each pouring operation, and a reduction in hydrogen pick up due to lower melt tapping temperature. The first INSURAL ATL 1000 liner installed at NEMAK CZ gave a life of 12 months with 20 transfers per day.

## Conclusions

The advantages of the INSURAL ATL lining system for aluminium transport ladles are:

- ❑ High insulation
- ❑ Good refractory cleanliness, avoiding the carry over of oxides and other inclusions
- ❑ Minimum or no preheating required, offering energy savings
- ❑ Enables lower tapping temperatures to be used, again saving energy
- ❑ Excellent resistance to thermal shock
- ❑ Wide range of sizes and capacities available
- ❑ Can be fitted to most existing steel ladles
- ❑ Supplied ready for use
- ❑ No drying required
- ❑ Fast relining.