CO_2 snow - an environmentally friendly solution for foundries

Liquid magnesium reacts violently to oxygen. A research project showed that CO_2 snow is a viable solution to this problem.

A research project leads to success

Magnesium, the lightest structural metal currently available, is growing in popularity in the automotive industry in particular. When processing magnesium alloys, care must be taken to prevent the liquid metal from oxidising – the surface temperature of the melt is approximately 630°C – as liquid magnesium reacts very violently to oxygen. In the past, manufacturers relied on sulphur hexafluoride (SF_6) or sulphur dioxide (SO_2) to avoid fires in magnesium melting processes and oxidation of the liquid metal. SO2 is highly toxic and requires extensive safety precautions before it can be used in foundries.

SF_6 is not ideal either due to its high global warming potential (GWP). The GWP of an SF_6 molecule is approximately 23,000 times higher than that of a CO_2 molecule. Hence SF_6 has been banned for magnesium melting since 2007. The only exception is foundries requiring less than 500 kg of SF_6 per year.

To resolve this challenge, Linde Gas and its partners launched a research project sponsored by the German government. The research focuses on the use of CO_2 snow to cover molten metal. This process is patent-pending.

If gaseous CO_2 was used to cover the hot molten magnesium, this would produce large quantities of highly toxic carbon monoxide, at the same time depositing elementary carbon on the surface of the molten bath. Carbon may then fall into the melt. This could make the resulting metal parts susceptible to corrosion.

CO_2 snow protects the melt

To combat the disadvantages of gaseous and liquid CO_2 in protecting the melt, Linde and its partners tested solid CO_2.

Once preliminary testing was successfully completed, a nozzle was produced to create solid CO_2 snow from liquid CO_2. This nozzle then spread solid CO_2 over the surface of the molten bath.

The nozzle on the CO_2 snow machine was designed so that the CO_2 expands at the nozzle outlet. The output speed from the nozzle is close to the speed of sound. To protect the molten magnesium against the negative effects of this high velocity, the CO_2 stream is slowed down by attaching a “snow pipe”. In this pipe, the fine cristalline snow at -87.5°C is compacted into particles.

This CO_2 snow is deposited on the molten bath and lowers the surface temperature, slowing down magnesium evaporation. When the CO_2 snow sublimates, (changes directly from solid to gas form), the gas expands, displacing all oxygen from the bath surface and thus achieving the desired effect.