

What is AM-cover®?

AM-cover® is a low cost, safe, and environmentally friendly cover gas system for the protection of molten magnesium from oxidation. Use of AM-cover reduces the greenhouse gas emissions arising from cover gas use by more than 95% compared to normal current practice with SF₆ gas mixtures. The AM-cover technology has been comprehensively trialled in die casting plants and in a range of other magnesium molten metal handling and casting situations.

The need for cover gas

Molten magnesium readily burns in air unless protected by a layer of salt flux, cover gas or other protection system. Thus, for reasons of safety as well as minimisation of costly metal losses, an effective melt protection system is required. Cover gas mixtures using SF₆ have proved to be very effective in protecting molten magnesium and offer several advantages over systems that use salt fluxes, sulphur powder or sulphur dioxide. Replacement of salt fluxes and sulphur dioxide with SF₆ has resulted in improved operator health and safety and increased equipment life from reduced corrosion. Although expensive, SF₆ is effective at low concentrations.

AM-cover offers similar benefits to SF₆ but with the added advantages of substantially reduced greenhouse gas emissions and significant cost reduction. AMT's research partner, CAST, has shown that fluorine from SF₆ changes the characteristics of the thin oxide film that forms on the surface of molten magnesium in the presence of even small concentrations of oxygen. The active fluorine makes the film wettable by molten magnesium and the film is self-repairing if broken by disruption of the melt surface. Thus, in the presence of SF₆, molten magnesium is protected by a thin, highly elastic and self-repairing film that acts as a barrier to further oxidation.

Why change from SF₆?

SF₆ has become recognised as a very potent greenhouse gas. It has a Global Warming Potential (GWP) of 22,200 over a 100-year time horizon [1] and for this reason has come under intense scrutiny by environmental agencies. In response to this, the International Magnesium Association (IMA) assembled an SF₆ Alternatives Sub-Committee to actively research SF₆ alternatives. The Kyoto Protocol also calls for a reduction in SF₆ use. Some countries have banned the use of SF₆ for applications such as the protection of molten magnesium and many others are expected to follow suit.

HFC-134a; the green hub of AM-cover®

HFC-134a is the active chemical constituent of AM-cover. Following extensive screening of possible alternatives to SF₆, this compound (chemical name 1,1,1,2 tetrafluoroethane) was selected as an equally effective and environmentally much improved choice. The key benefits of HFC-134a are:

- readily available worldwide from many suppliers as it is widely used as a refrigerant gas
- approximately one half the cost of SF₆ (depending upon the tonnage used and local supply conditions)
- reduced Global Warming Potential (1300-1600 compared to 22,200-23,900 for SF₆)
- reduced atmospheric lifetime (13.6 years compared to 3200 years for SF₆)
- zero Ozone Depletion Potential and is not classified as a Volatile Organocarbon (VOC)
- non-corrosive and non-toxic at room temperature
- non-flammable
- more effective than SF₆ for the protection of molten magnesium in many applications

The AM-cover®: System for Protecting Molten Magnesium

AM-cover®

Change over to AM-cover® ...

Research with AM-cover has demonstrated that the mechanism of protection is analogous to that of SF₆, with effective melt protection requiring only dilute amounts of HFC-134a mixed with the selected carrier gas. In addition, the procedure of mixing and delivering AM-cover is similar to that commonly used for SF₆ making the transition to the new cover gas system relatively simple.

...for all your melt protection requirements

The flexibility of AM-cover has been demonstrated through its application to numerous forms of magnesium casting, including:

- cold chamber and hot chamber high pressure die casting
- ingot casting
- low pressure casting
- squeeze casting
- sand casting
- investment casting

Die casting trials have indicated that AM-cover has no deleterious effect on the castability of the metal or the mechanical properties of the final casting. Furthermore, magnesium melts protected with AM-cover exhibit a unique "memory effect", whereby the molten metal can remain protected from oxidation for a short time when the cover gas is removed. This decreases the tendency for the metal in a furnace to burn when the lid is opened and also reduces the burning of dross when it is removed from the furnace.

What about health and safety?

Just as for SF₆ cover gas, AM-cover utilises a fluorinated gas and therefore needs to be used correctly to avoid harmful emissions of primarily, HF. Because HFC-134a is non-toxic at room temperature, most of the health and safety issues are concerned with decomposition products of the gas at molten metal temperatures. An exhaustive testing program, reviewed by occupational health and safety experts, has identified the correct carrier gases and operating parameters for safe use of AM-cover. In order to ensure safe practice and avoid breaching patented technology it is absolutely essential that intended users of the system obtain a licence for its usage from AMT, together with the technology package of instructions and specifications.

The right choice for magnesium and the environment

In comparison to SF₆ gas mixtures, AM-cover reduces greenhouse gases by more than 95%, it costs less, and in many aspects provides better protection. When used correctly it is also more cost effective than SF₆. AM-cover has been patented in order to ensure responsible and correct use of the technology. Licences and comprehensive information can be obtained from AMT who will also provide advice on appropriate operating parameters for particular production situations.

References

1. NJ Ricketts and SP Cashion, Hydrofluorocarbons as a replacement for sulphur hexafluoride in magnesium processing, Presented at US EPA Meeting on SF₆ and the Environment, San Diego, 2 Nov. 2000.
2. NJ Ricketts and SP Cashion, Hydrofluorocarbons as Cover Gases for Magnesium Melt Protection, Magnesium Technology 2001, Ed. J. Hyrn, The Metallurgical Society, Warrendale, 2001, 31-36.
3. PD Rogers, P Lyon, JF King, SC Cashion and NJ Ricketts, Magnesium melt protection at Magnesium Elektron using HFC-134a, Magnesium Technology 2003, Ed. H. Kaplan, The Metallurgical Society, Warrendale PA, 2003, 11-14.

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Further information on **AM-cover®** can be obtained from Advanced Magnesium Technologies.

