BestSolv™ ZULU MAG

Non-Flammable Engineered Solvent

Technical Data Sheet

Features and Benefits

- Non-Flammable
- Zero Surface Residue
- Low Surface Tension
- Low Viscosity
- No Flash Point
- High Boiling

Enviromental Properties

- GWP of 1
- ODP 0

Industries Served

- Automotive
- Aerospace / Military
- Electronics
- Sports Equipment / Toys
- Power Tools

Introduction

BestSolv™ Zulu MAG Magnesium Protection Fluid is a exact molecule replacement (dodecafluoro-2-methyl-3-pentanone or ($CF_3CF_2C(O)CF(CF_3)_2$) for 3M™ Novec™ 612 which was developed to replace ozone depleting substances (ODSs) and materials with high levels of global warming potential (GWPs). The BestSolv™ Zulu Mag fluid is an excellent alternative to sulfur hexafluoride (SF_6), commonly used as a "cover gas" to prevent molten magnesium from igniting during casting processes. SF_6, with a global warming potential 22,800 times greater than carbon dioxide (CO_2), is the most powerful greenhouse gas known. Efforts to significantly reduce its emissions have been made under the Kyoto Protocol and European regulations.

BestSolv™ Zulu MAG fluid is a safe, sustainable shield cover gas for magnesium casting operations. It provides excellent protection for molten magnesium at operating costs comparable to SF_6, while enabling greater than 99% reduction in greenhouse gas emissions.

BestSolv™ Zulu MAG is a transparent, odorless fluid that remains in liquid form at ambient temperature. Its liquid state allows for easy transportation in standard liquid containers of varying capacities. Due to its low viscosity, BestSolv™ Zulu MAG can be easily transferred using pumping equipment. Moreover, its high vapor pressure and low heat of vaporization enable it to rapidly evaporate into a gas stream, making it suitable for use as a cover gas.

Physical and Chemical Properties

CAS #	*756-13-8*
Appearance	Clear & Bright
Flash Point	None
Boiling Point	49 °C / 120.2 °F
Critical Temperature	169 °C / -336.2 °F
Critical Pressure	1.88mPA
Freezing / pour point	-108°C

Specific Gravity	1.60g/mL@25°C
Specific heat	1103 j/kg*K@25°C
Viscosity	0.64cPs@25°C
Vapor pressure	305mmHg @25°C
Latent Heat of Vaporization	88-kJ/kg @ BP
Dielectric Constant	1.8@1kHz
Dielectric Strength	48kV

Data compiled from published information. Not for specification purposes.

BestTechnology

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BestSolv™ ZULU MAG

Applications

When BestSolv™ Zulu MAG fluid is evaporated into a suitable carrier gas, it serves as a highly effective cover gas agent for safeguarding molten magnesium. BestSolv™ Zulu MAG fluid proves to be particularly beneficial in a range of processes, including various melting furnaces and casting operations, such as:

- Hot or cold chamber melting furnaces for high-pressure die casting
- Pure magnesium or other alloy preparation
- Remelt recycling of casting scrap
- Open casting of ingots, direct chill casting, sand casting, or investment casting

Performance

The BestSolv™ Zulu MAG fluid has demonstrated the ability to safeguard pure magnesium and its alloys at temperatures ranging from 650°C to 800°C (1170°F to 1450°F) both in furnaces and during casting processes. It creates a thin, flexible surface protective film similar to SF_6 which effectively prevents casting surface oxidation. Compared to SF_6, the BestSolv™ Zulu MAG fluid exhibits greater reactivity at high/melt temperatures resulting in more efficient utilization. This increased efficiency allows for use at lower concentrations, virtually eliminating greenhouse gas emissions associated with using a cover gas agent. The majority of the BestSolv™ Zulu MAG fluid is consumed during the process, maximizing its effectiveness, and reducing operating costs.

Cover Gas Use for Casting

The performance of BestSolv™ Zulu MAG fluid is directly related to its greater reactivity. Greater reactivity also means that it is best to upgrade components of the cover gas delivery system as needed rather than to use BestSolv™ Zulu MAG fluid as a simple drop-in replacement agent. Specifically, it will be beneficial to optimize cover gas formulation, agent concentration and flow rates, cover gas distribution over the molten metal and flow rate adjustments control during process operations.

- ***Formulating Cover Gas:*** BestSolv™ Zulu MAG fluid is introduced into a carrier gas stream using a gas bubbler or a precision pumping system. Carrier gases like dry carbon dioxide (CO_2) or dry nitrogen (N_2) with 5–10 volume % dry air (frost point <-40°C) are recommended.

With CO_2/dry air carrier gas, white magnesium oxide residue in the casting area is dramatically reduced while also minimizing BestSolv™ Zulu MAG fluid consumption. The inclusion of oxygen from dry air in the cover gas formulations also assists in controlling the generation of unacceptable levels of carbon monoxide (CO), the production of high GWP perfluorocarbons (PFCs), and/or other potentially hazardous process byproducts.

Comparatively, the concentration of BestSolv™ Zulu MAG in cover gas formulations is significantly lower than that of any other shield gases it replaces. The usual concentration ranges for magnesium casting and furnace operations using BestSolv™ Zulu MAG fluid and alternative cover gas agents are shown on the table in the next page. Due to the increased reactivity of BestSolv™ Zulu MAG molecules and fluorine content twice that of SF_6 and three times that of HFC-134a, it is able to form a protective film at extremely low concentrations.

BestSolv™ ZULU MAG

Cover Gas Use for Casting

• ***Gas Mixing:*** **Because of the low levels of BestSolv™ Zulu MAG being utilized in the casting process, it is advised that the gas mixer in use has the ability to maintain concentrations close to the set points and is not influenced by fluctuations in carrier gas line pressure or sudden shifts in volumetric requirements for cover gas flow. These factors could lead to significant fluctuations in concentration if an older rotameter or fixed orifice based equipment is used.**

• ***Gas Distribution:*** **The low reactivity of SF_6 allows it to diffuse through the headspace of a furnace, produce an even distribution, and slowly react with the hot metal. The greater reactivity of BestSolv™ Zulu MAG fluid allows only diffusion over short distances before reacting with magnesium and requires physical distribution of the cover gas over the melt surface. Multiple gas ports and sometimes more extensive gas distribution system changes are required to produce a "shower" of cover gas while being compatible with melting furnace lids and casting processes.**

• ***Gas Flow Rate:*** **Increased gas flow rates result in a uniform distribution when accompanied by a proportional reduction in the concentration of BestSolv™ Zulu MAG fluid which also leads to a decrease in emissions. The high flow/low concentration method offers superior protection compared to the low flow/high concentration typically utilized in SF_6 systems, as it greatly enhances gas distribution uniformity. It is essential to maintain a consistent delivery of the BestSolv™ Zulu MAG agent for effectiveness of this approach. The calculations provided below show the correlation between concentration, flow rate, and the amount of BestSolv™ Zulu MAG agent being delivered.**

Flow Rate	Concentration	BestSolv™ Zulu MAG Fluid Delivered
10 Liters/minute	500 parts BestSolv™ Zulu MAG Fluid/liter	5000 parts BestSolv™ Zulu MAG Fluid/minute
20 Liters/minute	250 parts BestSolv™ Zulu MAG Fluid/liter	5000 parts BestSolv™ Zulu MAG Fluid/minute
50 Liters/minute	100 parts BestSolv™ Zulu MAG Fluid/liter	5000 parts BestSolv™ Zulu MAG Fluid/minute

• ***Replacement of Lost Cover Gas:*** **The hot cover gases present in the headspace of a furnace typically have half the ambient air density. Upon opening the furnace hatch to perform tasks such as adding an ingot, removing dross, or taking samples, the gases in the headspace escape rapidly which backfills with the surrounding air, which tends to be more humid and reactive to magnesium resulting in a degradation cover gas protection. When using SF_6, the concentration is raised during all stages of processing for fast recovery of backfilled ambient air which results in considerable operating costs and emissions. Realistically, only half the amount of cover gas agent is required to maintain control over an idle furnace compared to during casting processing with only more cover gas necessary to recovery backfilled ambient air.**

Therefore, increasing the flow rate of BestSolv™ Zulu MAG Fluid when a hatch is opened and for a period of time after the hatch is closed can effectively address this ambient air backfill issue while also reducing the usage of cover gas agents. Existing automatic ingot addition systems can be utilized to activate the additional flow. In order to ensure effective and robust protection of the melt, achieve satisfactory process operational cost, and minimize emissions, optimized utilization of BestSolv™ Zulu MAG cover gas in specific systems and equipment by following the recommendations provided above. Inadequate distribution, concentration, low flow/high concentration, of cover gas can lead to decreased protection, increased operating costs, and the generation of harmful emissions like high levels of hydrofluoric acid (both corrosive and toxic), fluoro-olefins (toxic), and perfluorocarbons (additional greenhouse gases).

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BestSolv™ ZULU MAG

Storage and Handling

BestSolv™ Zulu Mag is thermally stable and will not oxidize or degrade during storage under normal conditions. It is recommended to store the product inside a clean, dry area and out of direct sunlight or other heat sources. Do not freeze or store below 32°F (0°C) nor above 90°F (32°C) to prevent leakage or potential rupture of container due to contraction/expansion and pressure changes. Drum pumps are recommended to dispense the solvent from its container. Refer to the Safety Data Sheet for more information or contact Best Technology for further assistance. As a fluoroketone, BestSolv™ Zulu MAG is reactive with water/moisture; therefore, it is critical to keep the container closed tightly and not exposed to humid conditions before use.

Based on Pensky-Martens Closed Cup (ASTM D93) or Tag Closed Cup (ASTM D56) methods, BestSolv™ Zulu MAG exhibits no flash point and is not classified as flammable by OSHA. BestSolv™ Zulu MAG is not classified as flammable or hazardous for transport by DOT.

Environmental Properties

- SNAP EPA accepted substitute for ozone depleting substances
- Not subject to SARA Title III (EPCRA) reporting regulation
- Non hazardous air pollutant (HAP) / Not regulated under NESHAP
- ODP is 0. When used to replace SF_6 in casting application, greenhouse gas emissions can be reduced by more than 99% and by more than 68% when used to replace HFC-134a.

Health and Safety

Reference the SDS for details on:

- Individual chemical components
- Disposal
- Transportation
- Regulatory requirements
- Other information

Materials Compatibility

BestSolv™ Zulu MAG Magnesium Protection Fluid has been found to be suitable for use with common materials used in furnaces and die casting equipment, such as carbon steel and stainless steel. The fluid does not affect the materials typically used in gas mixing and cover gas transport equipment, such as carbon steel, stainless steel, aluminium, brass, and copper. Polymeric seals and gaskets in valves and gas mixing meters are typically compatible with BestSolv™ Zulu MAG. Use of BestSolv™ Zulu MAG with fluoroelastomer o-rings, gaskets, or seals is not recommended. It is recommended to conduct initial compatibility testing on non-production parts. Material compatibility testing should always be conducted using specific contaminants, under process-specific cleaning conditions and is the responsibility of the user.

Product Use / Warranty

All information contained in this document is based on data believed to be reliable but the accuracy or completeness thereof is not guaranteed and are made without representation or warranty. Many factors can affect the use, performance, time and environmental conditions in a particular application. User is responsible for evaluation to determine whether it is fit for a particular purpose and application and products discussed are sold without warranty, expressed or implied, in law or fact.

We shall not be liable for any injury, loss or damage direct or consequential regardless of the legal theory asserted, including warranty, contract, negligence or strict liability arising out of use or the inability to use the product. If the product is defective within the warranty period, your exclusive remedy and seller's sole obligation will be, at seller's option, to replace the product or refund the purchase price.

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