

Development of **3TM NovecTM 612** Magnesium Protection Fluid as a Substitute for SF₆ over Molten Magnesium

Dean S. Milbrath

3M Performance Materials Division

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Protection of Molten Mg

Molten salt fluxes protected melts, but contamination results in increased corrosion and low metal recovery

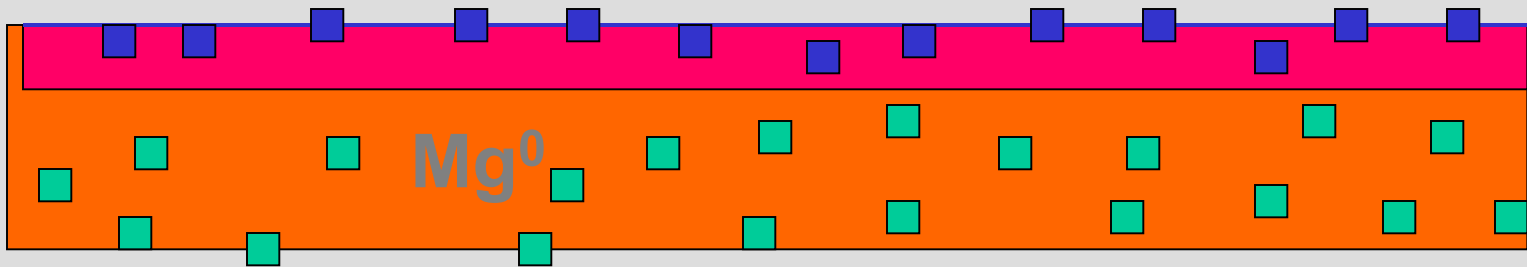
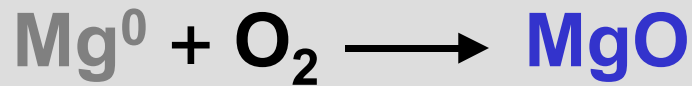
Sulfur and SO_2 have been used for protection of molten Mg without added corrosion

-1934, Reimers patented use of fluorine containing materials such as HF , BF_3 , SiF_4 , SbF_5 , IF_5 , PF_5 , SO_2F_2 , NF_3 , or SF_6

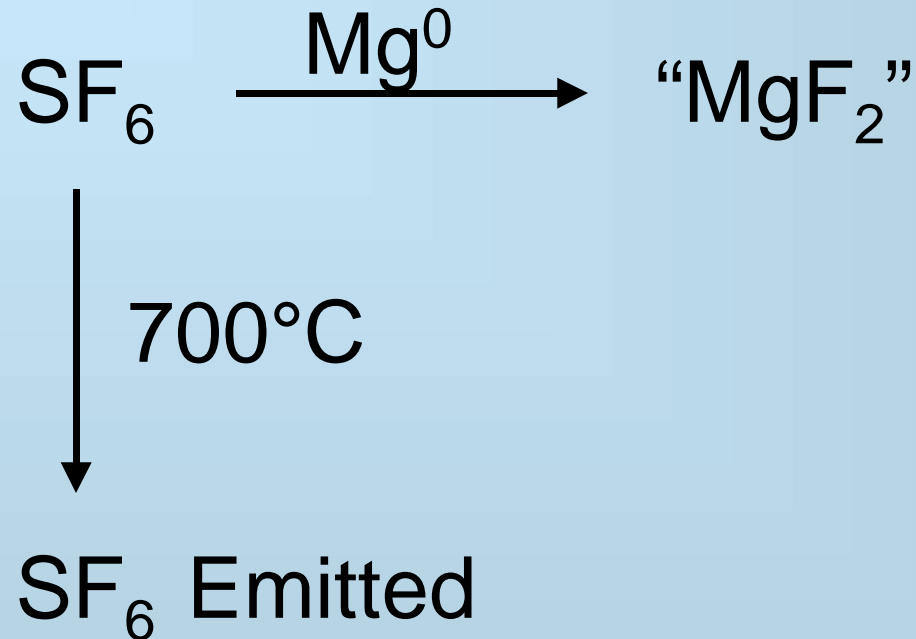
-1970-79 Fruehling started and Couling continued work to show SF_6 was effective

-1998-2001 Cashion and SINTEF/Hydro workers described the surface films on Mg produced under SF_6 cover gases

SF₆ Protection of Molten Mg



SF₆ Reactions over Mg?



Global Warming Potentials

<u>Compound</u>	<u>Lifetime (yrs)</u>	<u>GWP (100 Yr ITH)</u>
CO ₂	100-150	1
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C₃F₇C(O)C₂F₅	0.014	~1	FKs

Fluorinated Ketone Physical and Environmental, Safety and Health Properties

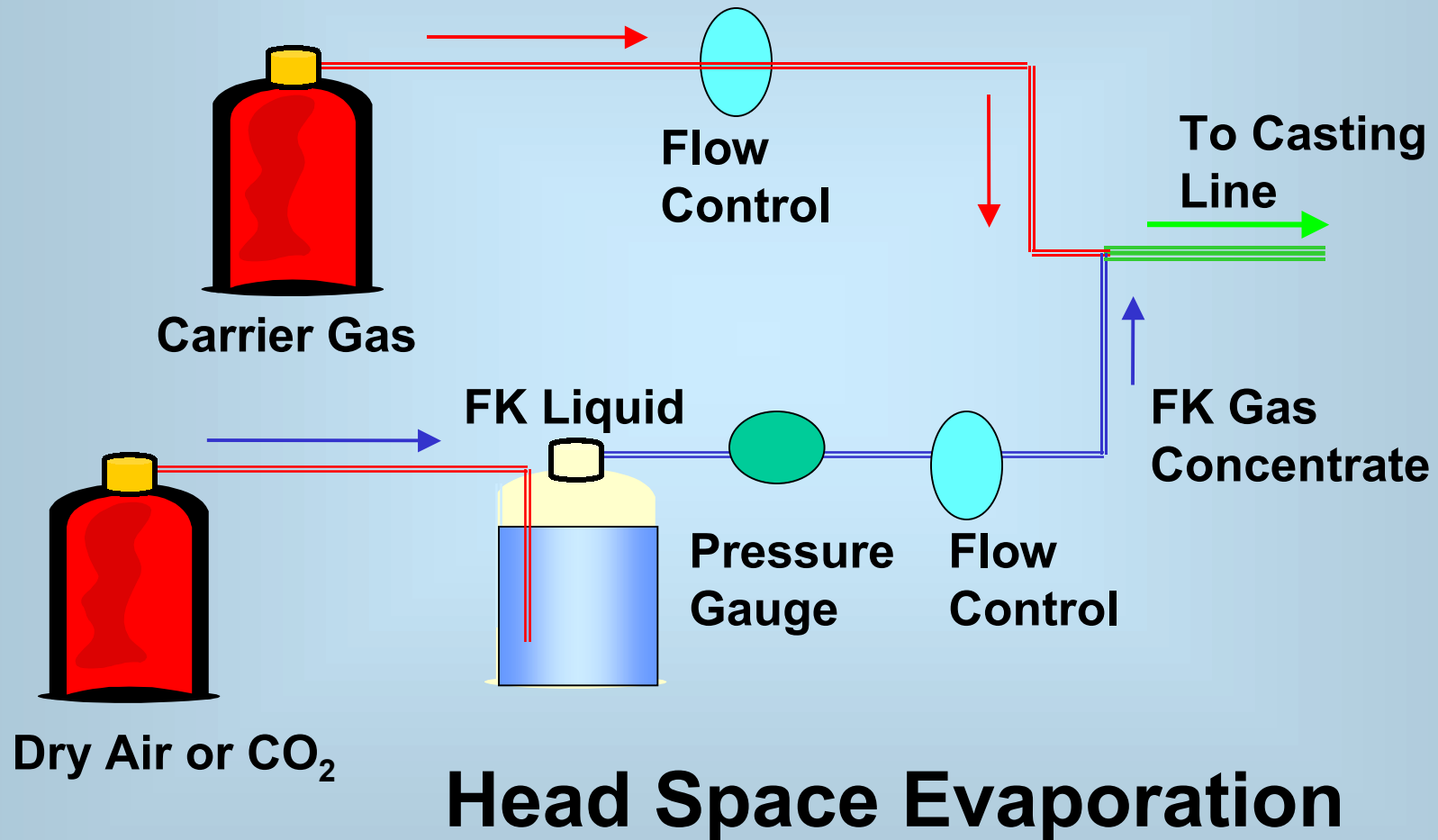
Physical Properties	
Boiling Point °C	49
Freezing Point °C	-108
Viscosity, liquid @ 20°C, cSt	0.042
Vapor Pressure @ 20°C, kPa	32.6
Liquid Density @ 20°C, g/mL	1.61
Gas Density @ 80°C - 1 Atm, g/mL	0.011

EHS Properties	
Atmospheric lifetime, days	<10
Global Warming Poteintial	~1
Flash Point	None
PEL, ppmV	150
Acute LC50, ppmV	>100,000

Environmental

- Novec™ 612 : GWP = 1, Non-ozone depleting, short atmospheric lifetime (1 week)
- Degraded in sunlight to CO₂, HF and TFA
- Fully registered in Europe, US, Canada, Australia with no restrictions
- Registration in Japan early 2003

Liquid to Gas System to Generate Cover Gas System



Novec™ 612

Applications Experience

Tested over pure Mg, AM-50, RZ-5, AJ-52, AZ-91
With dry air, CO₂, N₂, Ar or mixtures as the carrier
gas

At melt temperatures from 650 to 790 °C

In 3 to 500 kg furnaces with melt areas of 0.008
to 0.5 m²

For open casting (ingots and sand casting) and
die casting

Pilot Scale Furnace



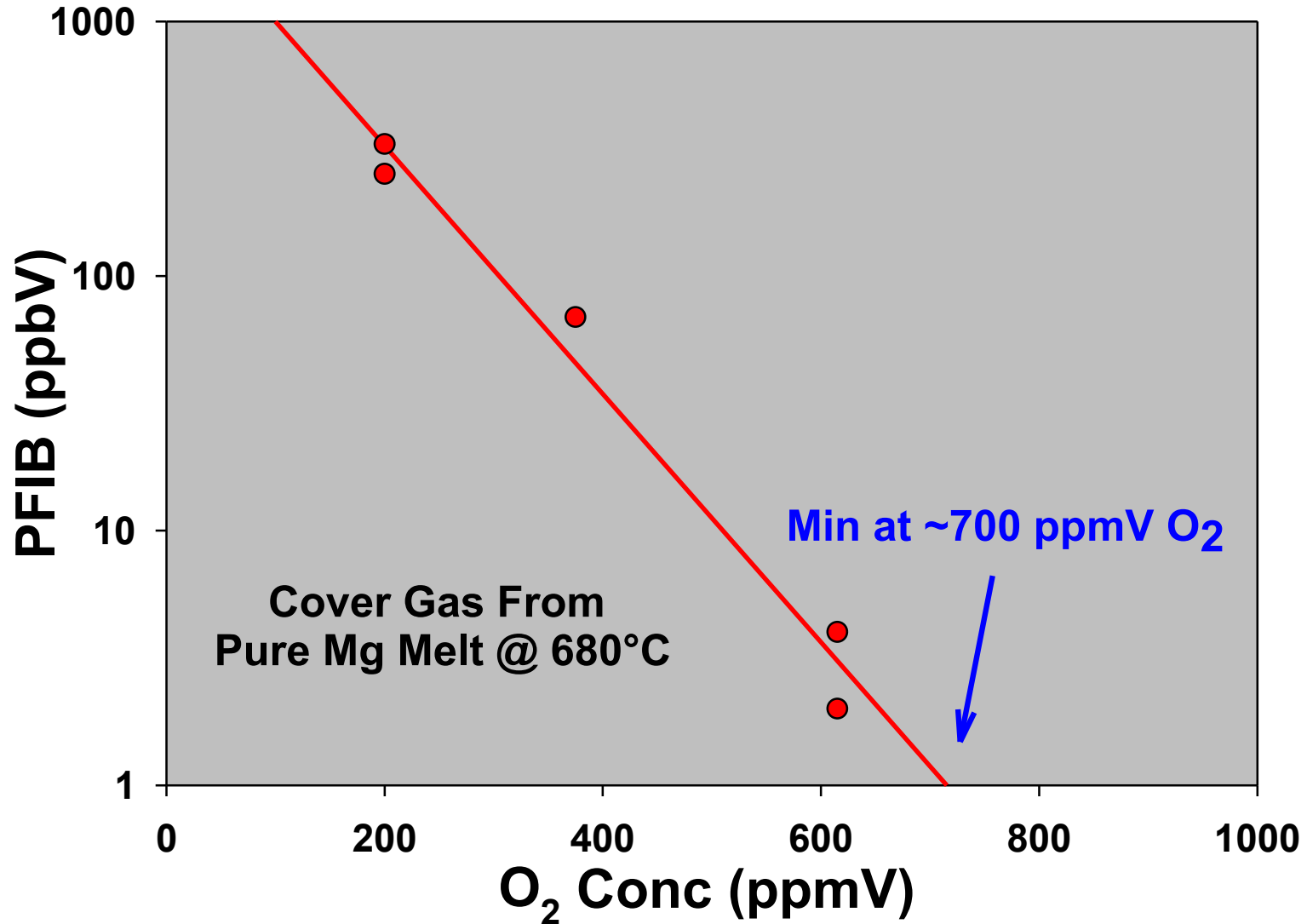
Capacity
80-150 kgs

Composition In Furnace

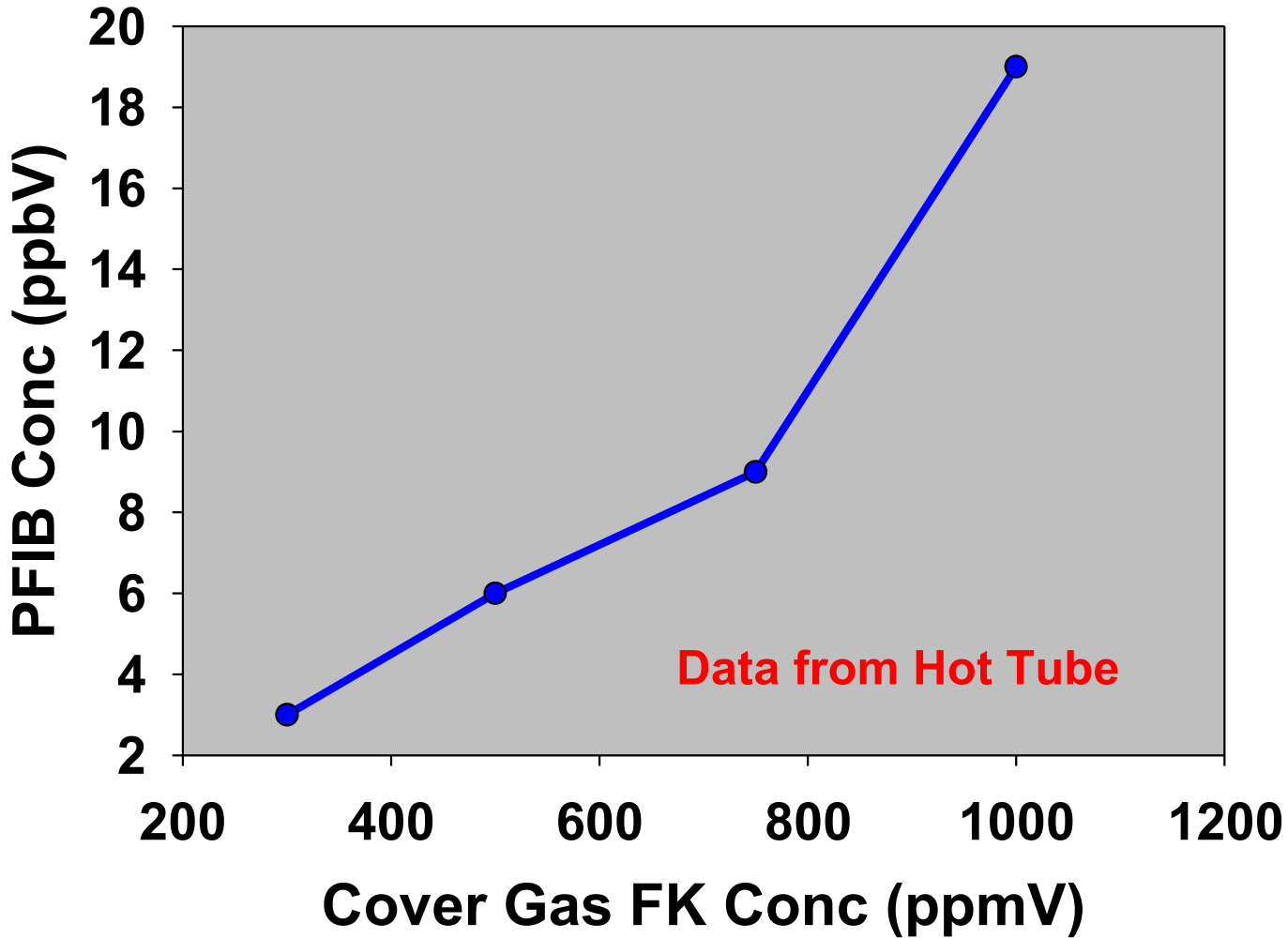
Alloy	Conditions			Furnace Protection	Gas Analysis		
	Melt Temp (°C)	FK Conc (ppmV)	Flow Rate (CFH)		FK found ppmV	PFIB Found ppbV	PFC Found ppmV
AM-50	680	1000	20	Good	894	204	-
AJ-52	720	1000	10	Good	164	26	322
Pure Mg	680	1000	20	Good	23	23	380
Pure Mg skimmed	680	1000	20	Good	1	Not Det	Not Det

CO₂ as carrier gas

Effect of O₂ Content of Cover Gas



Effect of FK Conc on PFIB Formation



Control of F-Olefin Production

- Oxygen in the cover gas mixture (1-5% air) for furnaces
- Use low concentration of FK (higher flow rates)
- Increase flow rate not concentration
- Don't overprotect

Furnace Gas Composition over AM-50

AM-50 @ 680°C with 500 ppmV in CO2-5%air

Gas	Novec 612	PFC	F-Olefin	COF2	HF
Flow rate	Conc	Conc	Conc	Conc	Conc
2.5	22 ± 5	25 ± 7	ND	ND	84 ± 19
L/min	ppmV	ppmV			ppmV

From SINTEF Pilot Trials 9/2002

- Melt is over protected at these conditions
- HF generation is under study

Beta-site tests are underway

Testing at user sites to produce useful information on use conditions and performance.

Sites chosen to broaden application types and uses to confirm efficacy and refine designs of application equipment.

Continued Cooperation with IMA Program

Commercial Introduction

3TM NovecTM 612

Magnesium Protection Fluid

Phased Market Introduction 2003

North America, Europe, Japan

Full production in 1st Quarter 2003

Pilot supplies are available now

Technical Support for Conversions

Acknowledgement

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