Cooperative Study of Magnesium Melt Protection Technologies: Emissions Characterization and Occupational Exposure

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Magnesium Die-Casting

A Study in the Use of AM-Cover™, MTG-Shield™, SO_2, and SF_6

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Lunt Manufacturing Co., Inc.

- Privately owned company started in 1973 by Helmut Brandt.
- Lunt is one of the few die casting companies exclusively devoted to magnesium alloy die casting and has one of the most diversified application portfolios.
- Lunt produces over 200 different magnesium parts for Automotive, Power Tool, Recreation and Computer/Electronics industries.
- Lunt has 19 cold-chamber die cast machines ranging in size from 400t to 4000t and has significant secondary operation capabilities.
- We were the first to introduce a centralized SF_6 system into production for die cast melt production in 1977. It was a readily available gas, highly effective & non-toxic.

Lunt's Environmental Leadership

- Environmental commitment
  - ISO 14000 Certified
  - Elimination of SF_6 by end of 2007.
- Participant in the EPA's SF_6 Emission Reduction Partnership since 1999
- Recognized by White House and EPA for support of Climate VISION in 2003
- Volunteered to host the melt protection measurement study in June 2006

Cooperative Study Details

- Strong support from industry suppliers
- Careful coordination of numerous parties

Where: Lunt facility in Hampshire, IL

When: August, 2006

Who: Lunt Manufacturing Co., Inc.
US Environmental Protection Agency
Advanced Magnesium Technologies
Matheson Tri-Gas/Taiyo Nippon Sanso Corporation
Polycontrols Technologies
3M
ICF International
URS Corporation

Study Details - Parameters

Study Parameters:

- Automated 400t Cold-chamber die casting cell
- Cover gases evaluated:

  AM-Cover™ (HFC-134a) w/ N_2 carrier

  MTG-Shield™ (Novec™ 612) w/ CO_2 carrier

  SO_2 w/ dry air carrier

  SF_6 w/ dry air carrier
- Extractive FTIR sampling of crucible head-space and worker areas

Study Objectives

Four Objectives:

1. Estimate cover gas destruction in the crucible head-space
2. Monitor the production of byproducts
3. Estimate relative GHG emission reduction potential of alternative technologies compared to SF_6
4. Identify potential occupational exposure concerns

Global Warming Potential

The climate impact of a given substance (e.g., cover gas) may be determined by understanding the mass of actual emissions and the GWP of the gases

Input gases react and transform in the crucible to varying degrees

100 year GWP – relative to CO_2:

Chemical	GWP Value
CO_2	1
SF_6	23,900
AM-Cover™ (HFC-134a)	1,300
MTG-Shield ™ (Novec™ 612)	~1 (estimated)
SO_2	0

Climate Impacts / Potential Benefits

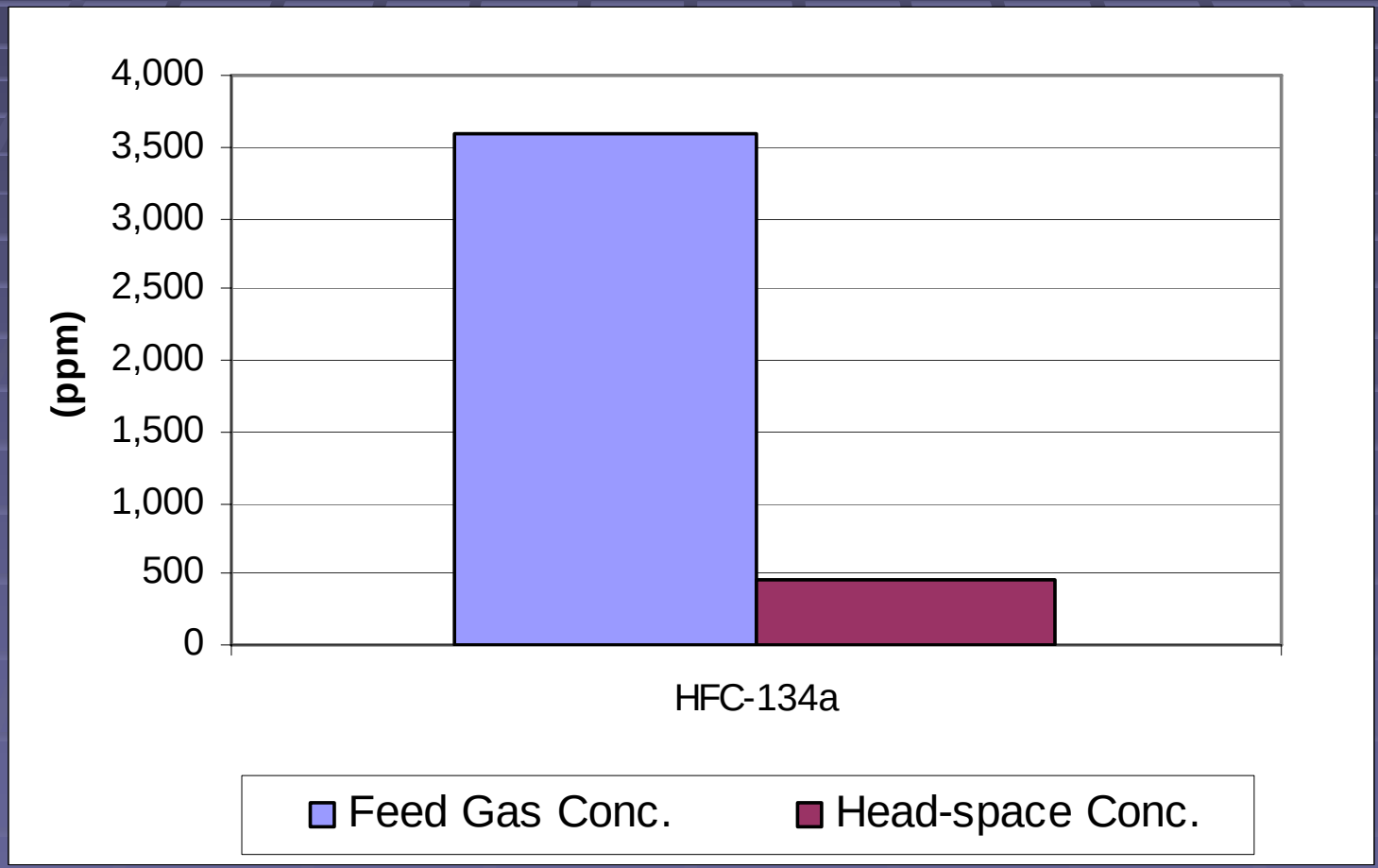
Average Amount of Destruction*:

SF_6	32%
AM-Cover™ (HFC-134a)	79%
MTG-Shield™ (Novec™ 612)	77%
SO_2	33%

*Within the crucible head-space and across multiple cover gas concentrations; values are corrected for dilution

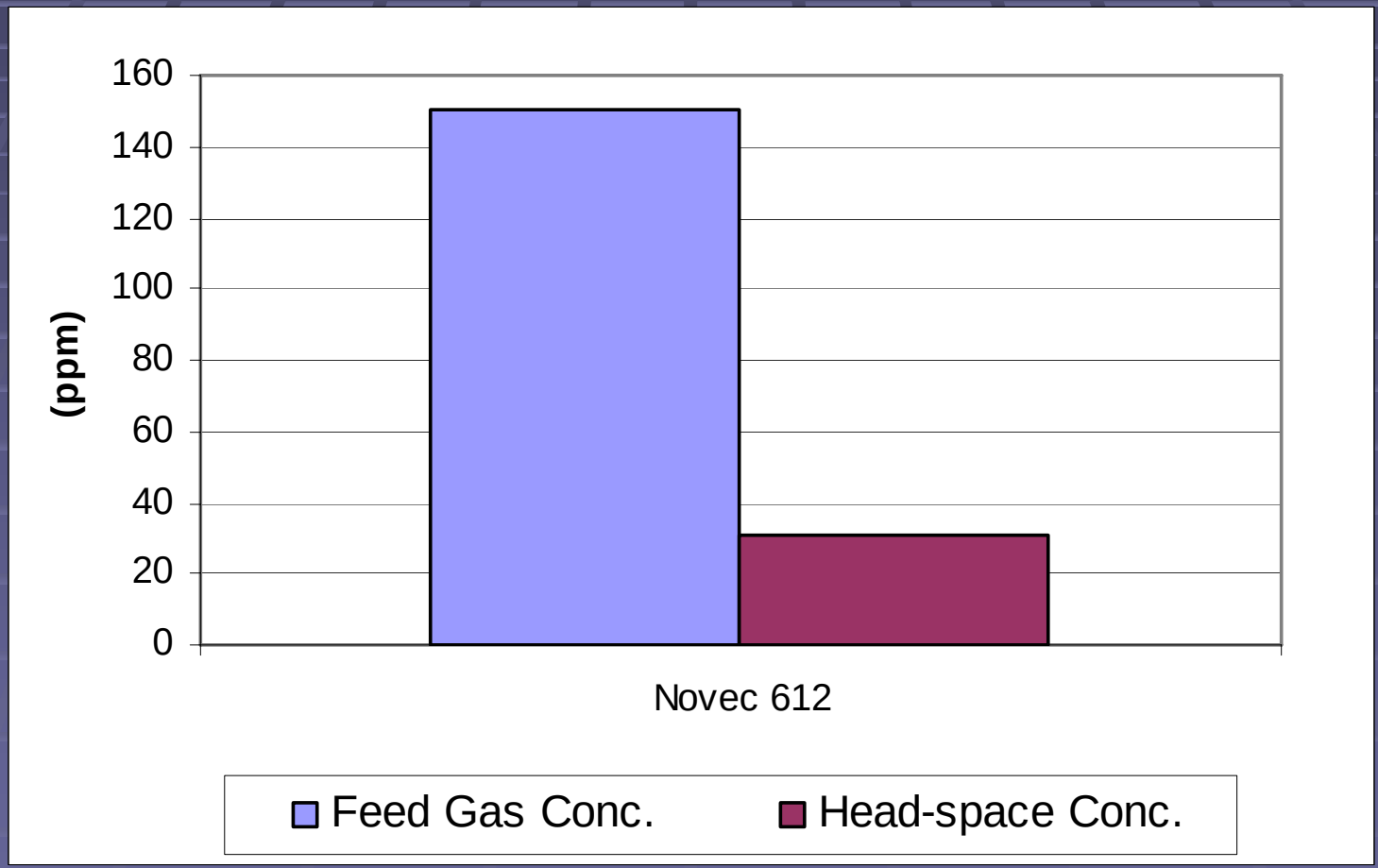
HFC-134a Concentrations

79%



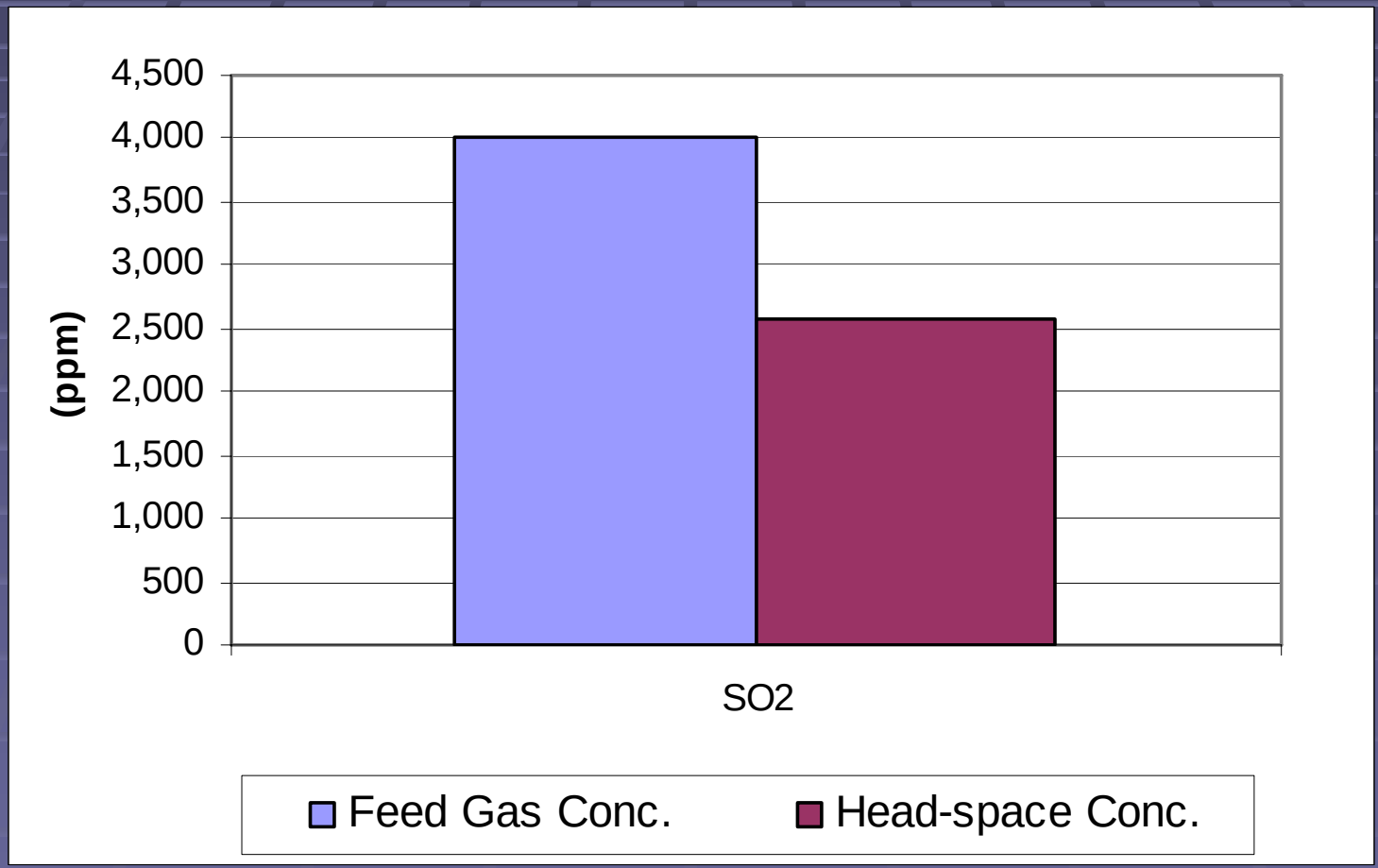
Novec™ 612 Concentrations

77%



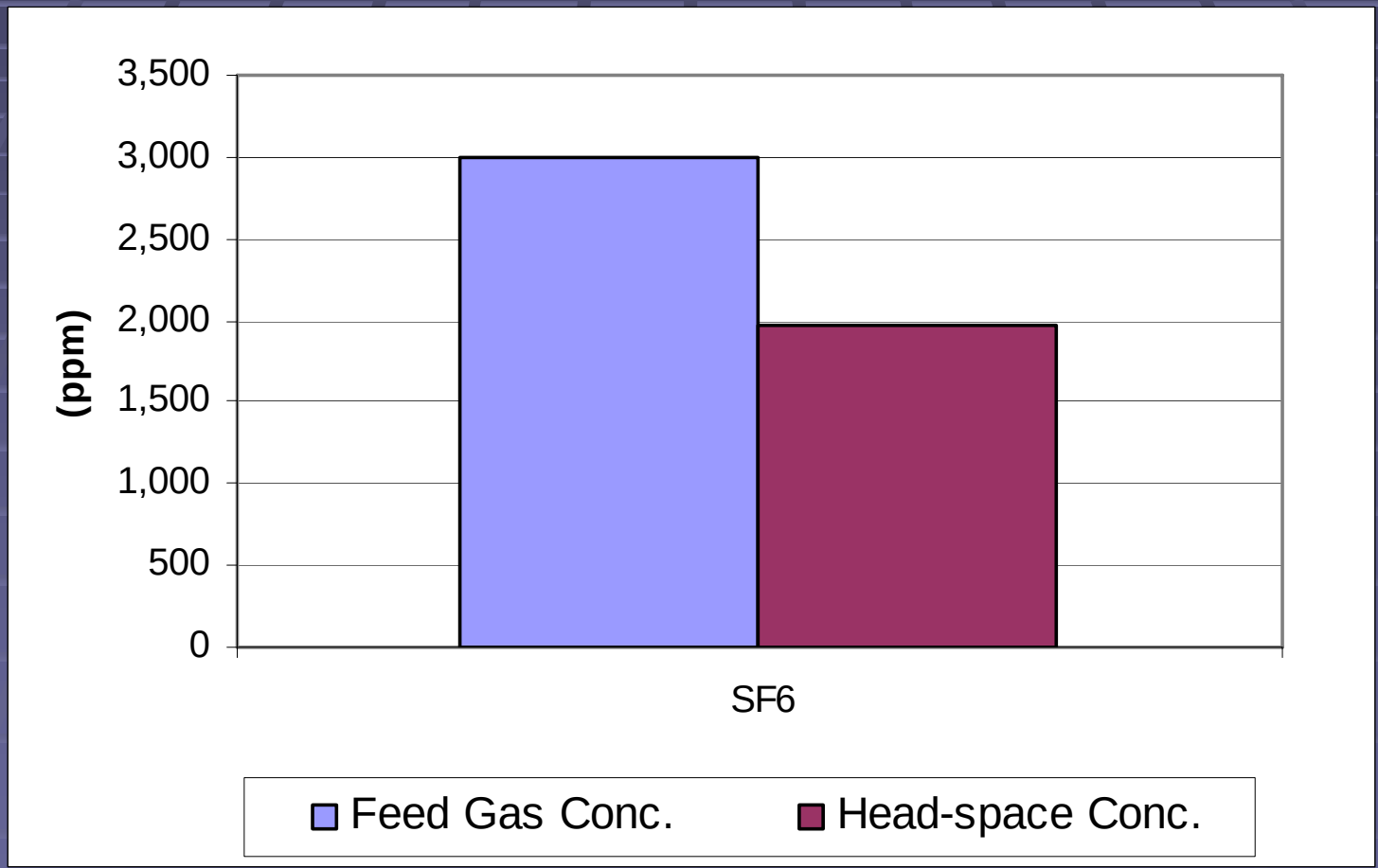
SO_2 Concentrations

33%



SF_6 Concentrations

32%



Preliminary Results Summary
Relative Climate Benefit

Melt Protection:

AM-Cover™, MTG-Shield™, and SO_2 displayed melt protection characteristics similar to SF_6

Global Warming Potential Comparison:

Cover Gas	SF_6	AM-Cover™	MTG-Shield™	SO_2
GWP[1]	100	3	2	0

[1]GWP normalized to an SF_6 value of 100

Preliminary Results – Reaction Byproducts

Byproducts (head-space):

Melt Protection	Detected Byproducts
AM-Cover™	CO, HF, COF_2, CH_2O
MTG-Shield™	CO, HF, COF_2, CH_2O, C_2F_6, C_3F_8, CHF_3
SO_2	None detected*
SF_6	HF, SO_2

*H_2SO_4 and SO_3 were below detectable limits.

Preliminary Results – Exposure Hazards

Occupational Exposure Monitoring:

- HFC-134a and Novec™ 612 byproducts such as HF, H_2CO (formaldehyde), and COF_2 (carbonyl fluoride) were not detectable during continuous monitoring of ambient air at the operator platform and around the furnace.
- SO_2 concentrations at the crucible were well below the permissible exposure limit (PEL)*

* A single measurement did approach the SO_2 PEL of 2 ppm when the ingot door was open for a prolonged period due to an ingot loading malfunction

Final Report to be Released by Early 2007

Moving Forward

Lunt Manufacturing is presently conducting long-term trials of the alternative melt protection technologies in order to evaluate robustness of the systems and economic viability.

Expect to begin installation of alternative melt protection by 3rd Qtr 2007 and achieve Partnership goal of eliminating emissions by end of 2007!