



**POLYCONTROLS**

Technologies

# Presentation agenda

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## Evolution of technologies of protective cover gas

- ❑ Fixed orifice
- ❑ Volumetric
- ❑ Compensated volumetric
- ❑ Massic

## Capital expenditures and production cost reductions

- ❑ Return on Investment
- ❑ Advanced control systems

## Alternative cover gases



# Fixed orifice mixers

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## The golden age...

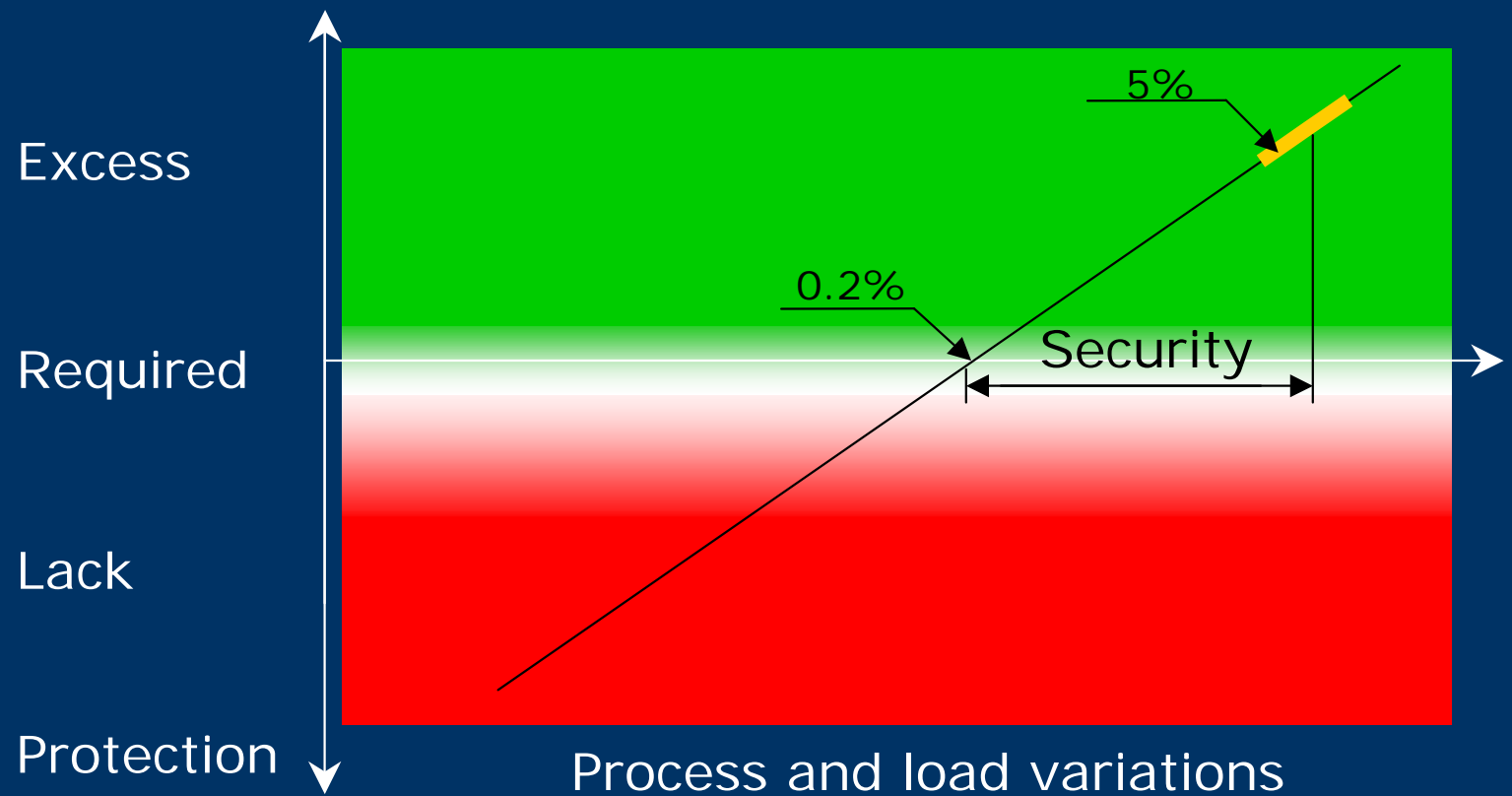
Up to the mid 80's, gas mixers with fixed orifice were largely used for the protection of molten magnesium.

They produce non adjustable mixtures with a very high SF<sub>6</sub> content



# Fixed orifice mixers

## Immunity against process variations of Fixed orifice mixers



# Fixed orifice mixers

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Fixed orifice mixers are strongly influenced by process variations:

- Load variations
- Pressure
- Temperature

Moreover, they are:

- Based on theoretical calculations
- Non-adjustable
- Blind



# Volumetric mixers

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## In the 90's

The need for volumetric gas mixers was created by:

- The rise of SF<sub>6</sub> price
- Troubles associated with the high concentration of fluorine
- Blindness and lack of control
- Necessity to obtain lower mix ratios



# Volumetric mixers

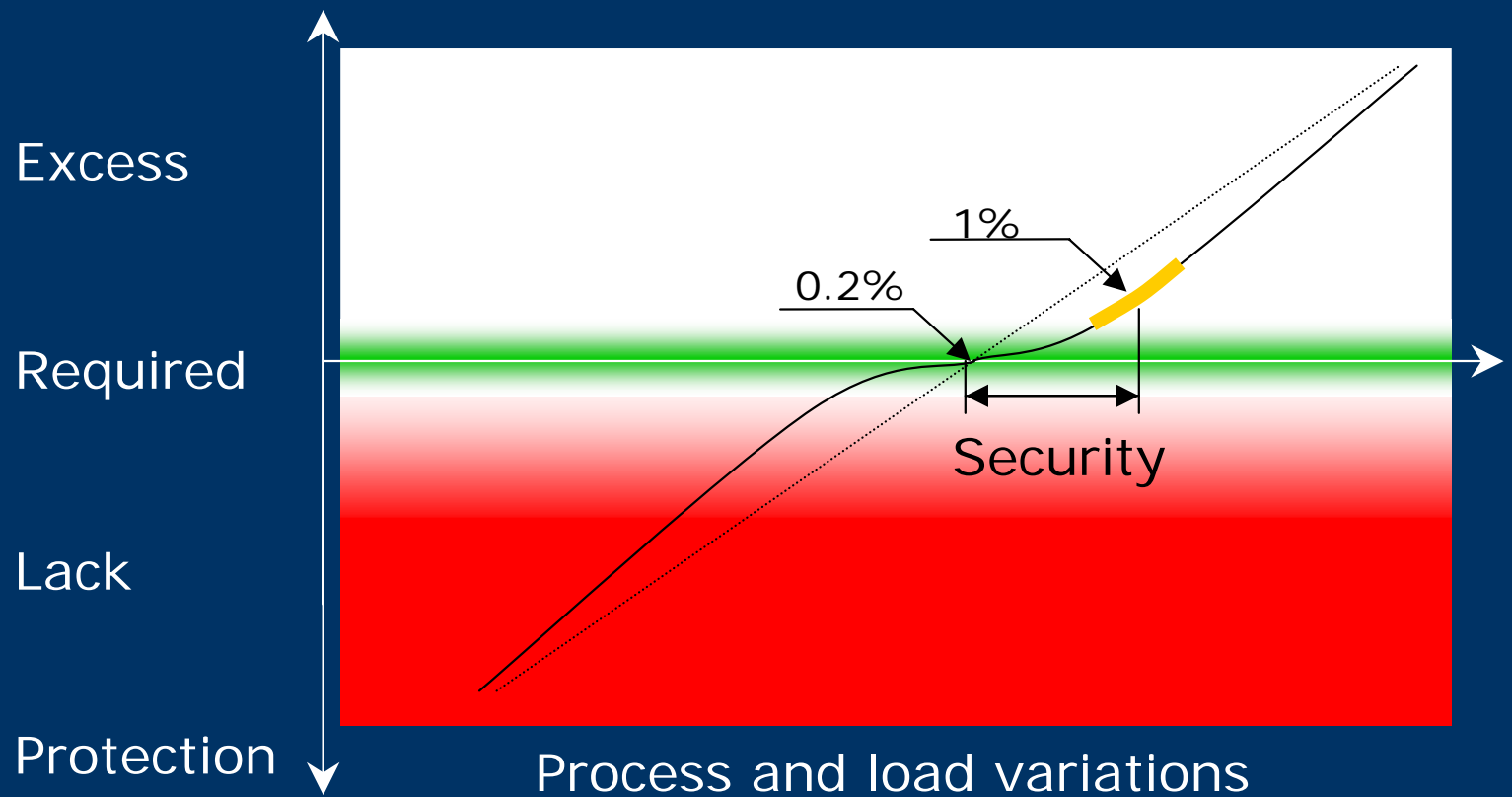
## Improvements

- Replacement of the fixed orifice by an adjustable metering valve
- Addition of reading tubes (rotameter)
- Basic alarms and diagnostics



# Volumetric mixers

## Immunity against process variations of Volumetric mixers





# Volumetric mixers

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Volumetric mixers are less, but still, influenced by process variations related to:

- Pressure
- Temperature
- Load

## Improvement

This generation now allows basic reading and adjustments. In spite of their fair performance, the users have the possibility of reducing mixtures at lower concentration



# Compensated volumetric

An improvement of the previous generation is the Volumetric compensated mixers.

Instead of using typical rotameters, they are designed with:

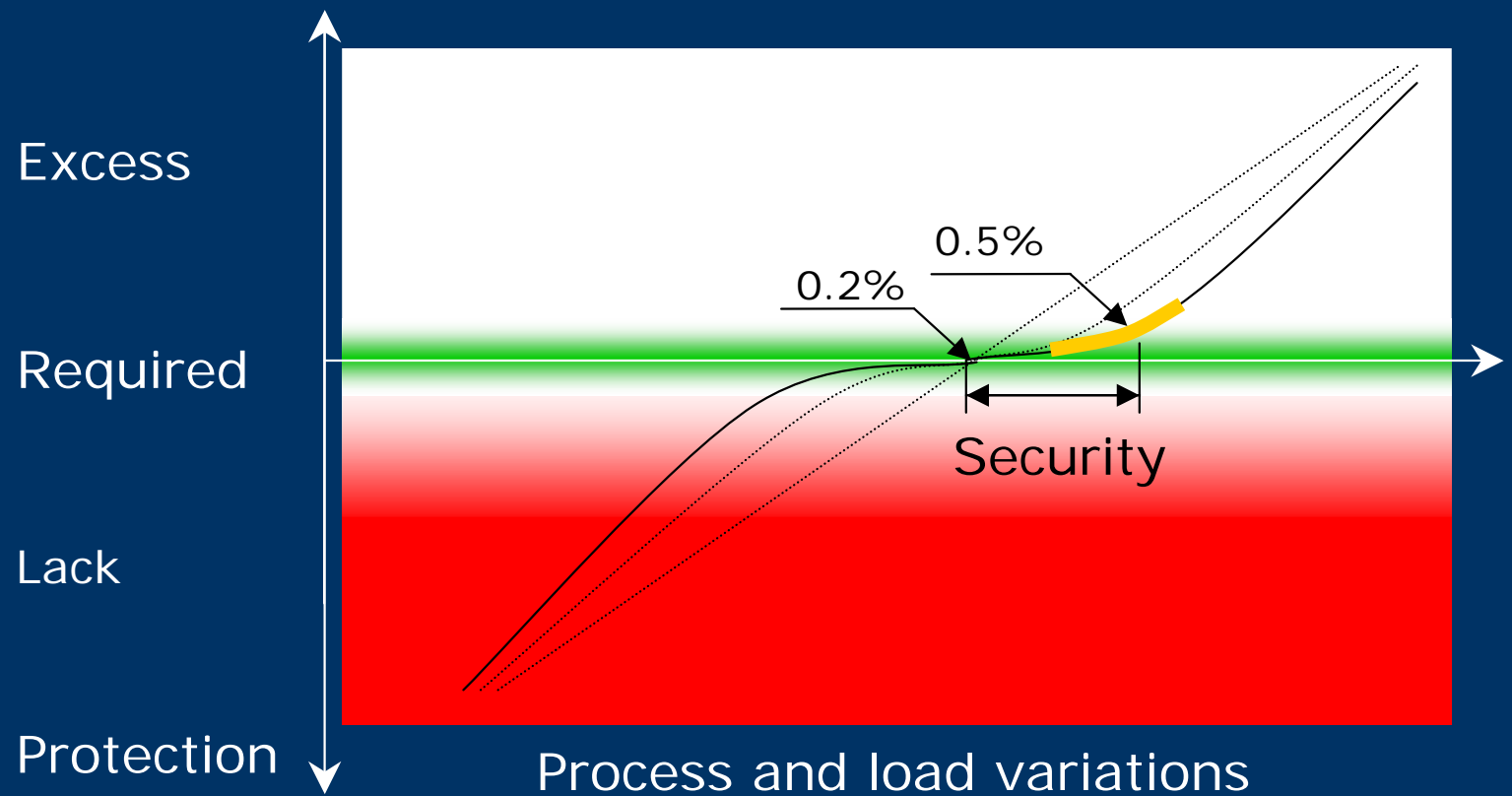
- Compensated reading tube
- More linear metering valves
- More stable flow path.

Their readout are at standard contitions



# Compensated volumetric

## Immunity against process variations of Volumetric compensated mixers



# Massic mixers

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## In the last decade

The requirements for cover gases changed again. This change is motivated by:

- Increase of global environmental concerns
- Urgent need to reduce manufacturing costs
- Arrival of new alternative cover gases which requires gas mixtures with controls as low as 0.01%



# Massic mixers

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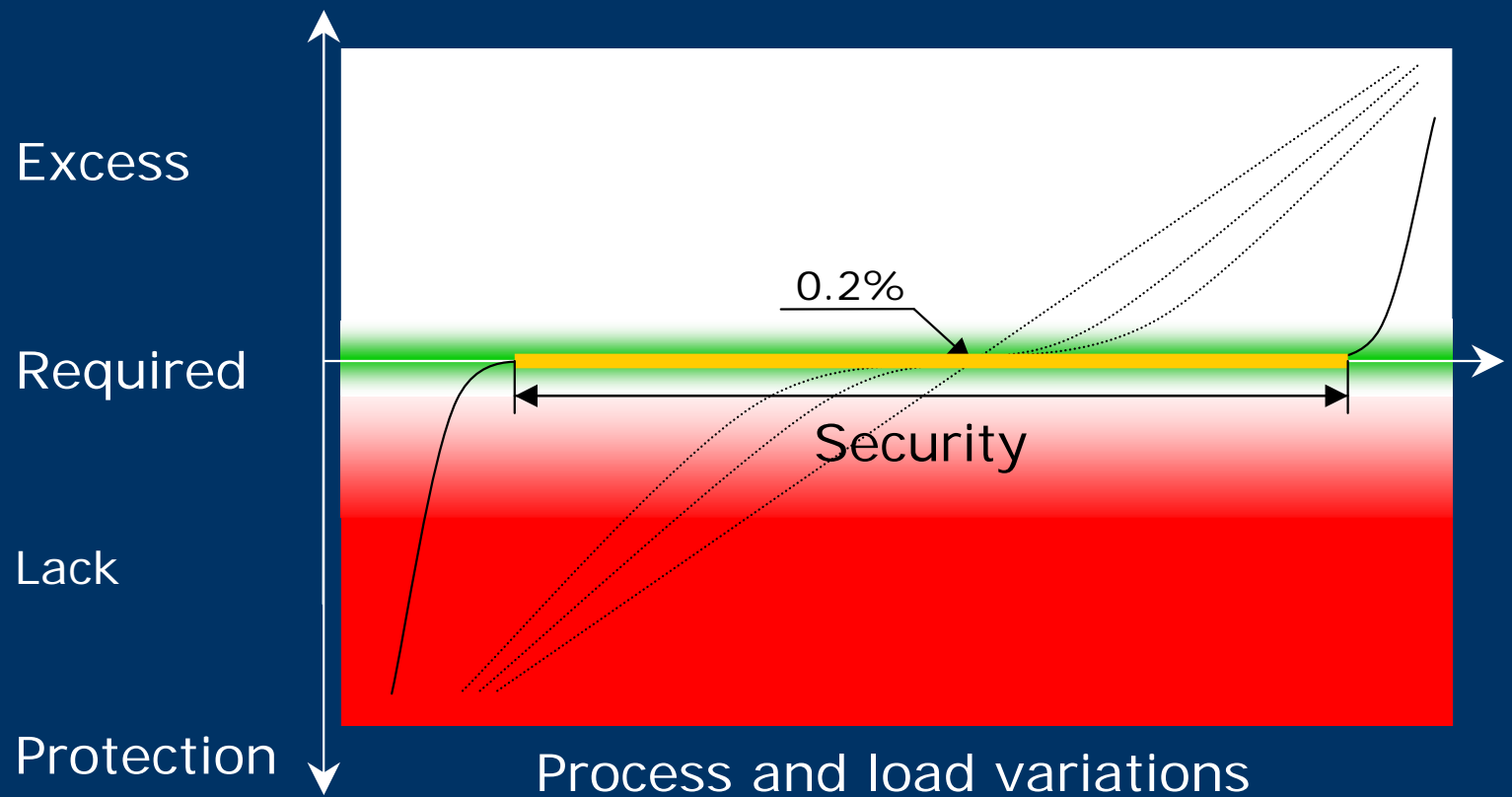
In massic mixers, volumetric devices are replaced by instruments that directly read the mass. Unlike volume, mass is unaffected by changes in pressure, temperature, viscosity, and density

Massic mixers directly measure mass, just as a weigh scale.



# Massic mixers

## Immunity against process variations of massic mixers



# Massic mixers

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Mass measurement is a major advancement for the industry, which is - **or should be** - more interested in metering mass than volume to ensure the **tightest control** and the **right amount of fluorine** in the cover gases.



# Presentation agenda

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## Evolution of technologies of protective cover gas

- ✓ Fixed orifice
- ✓ Volumetric
- ✓ Compensated volumetric
- ✓ Massic

## Capital expenditures and production cost reductions

- Return on Investment
- Advanced control systems

## Alternative cover gases





# Return on investment

Technology	Acquisition cost	Operation cost	ROI
Fixed orifice	1000\$	310,178\$	----
Volumetric	8000\$	61,962\$	12 days
Compensated volumetric	12000\$	30,981\$	141 days
Massic	25000\$	12,397\$	184 days*

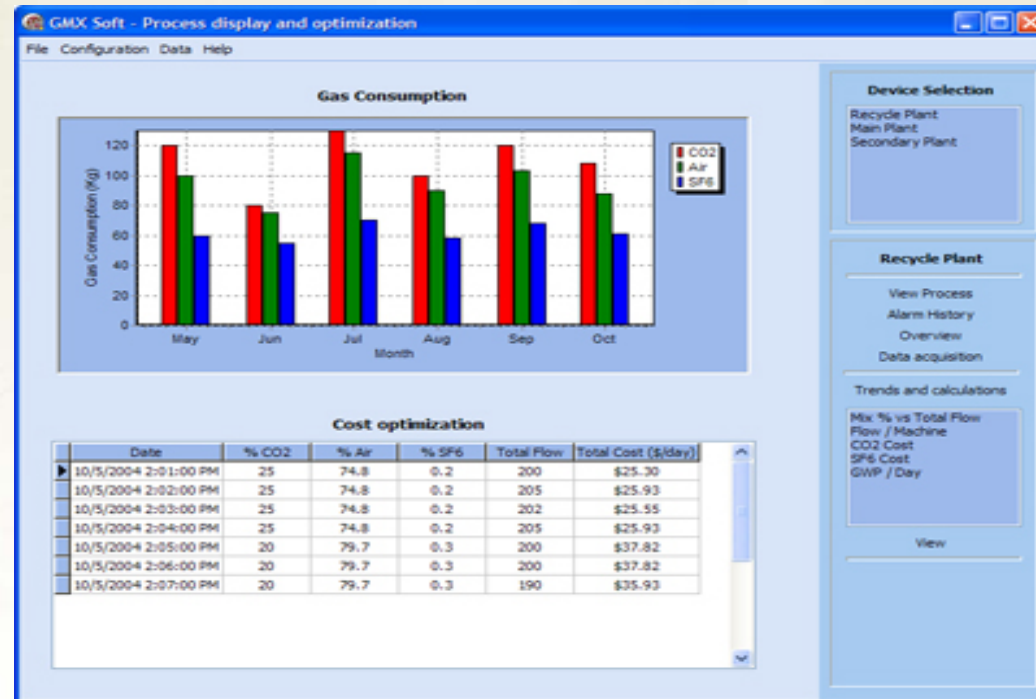
Based on 4 medium machines at 20 slpm of SF<sub>6</sub> mixture (23\$/kg)

(\* ) Based on a conversion from Volumetric to Massic



# Advanced control systems

Optimization software allows you to reduce gas consumption and emissions by finding the right **balance between the mix concentration and the flow rate** used



# Advanced control systems

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Massic mixers incorporate electronic controls, which can allow you to:

- Monitor plant wide gas consumption
- Calculate the cost of operation of each individual furnace
- Choke gas consumption of furnace in standby condition
- Optimize the point of operation (Flow vs Mixture)



# Alternative cover gases

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## Nowadays

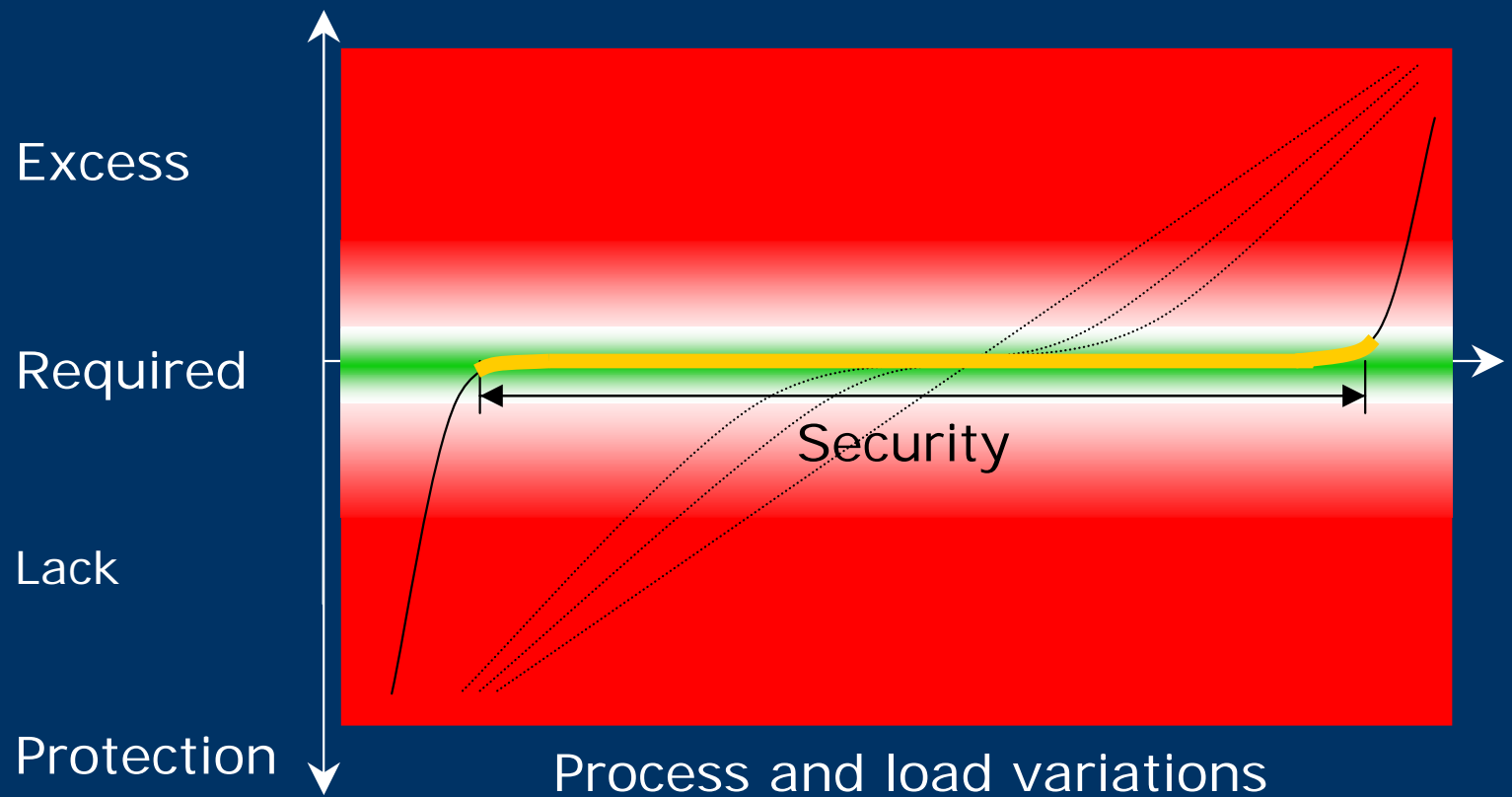
With new alternative cover gases, the magnesium industry no longer runs with excess of protection. When used in excess, they produce:

- Excessive cost of operation
- High GWP emissions
- Corrosive emission
- Dangerous inhalations



# Alternative cover gases

## Alternative cover gases requirements



# Conclusion

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Since the mid 80's, protective cover gas technologies have significantly evolved.

New generation of massic mixers provide the opportunity to:

- Lower mix ratio
- Increase the immunity against process variations
- Lower production costs
- Prevent the lack and the excess of protection



# Conclusion

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Within the magnesium industry, Polycontrols already has systems in operation with:

- SF<sub>6</sub>
- AMCover™
- Novec 612™
- SO<sub>2</sub>
- Other private processes

In addition, all our massic mixers are fully upgradeable to new alternative cover gases



# Questions

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