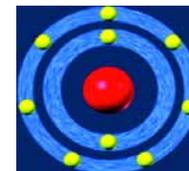




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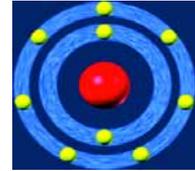
A NOVEL PURIFICATION PROCESS FOR USED SF₆ FROM ELECTRICAL EQUIPMENT

D.C. Lauzon
Solvay Fluorides, LLC
U.S.A.

P. Jannick
Solvay Fluor GmbH
Germany

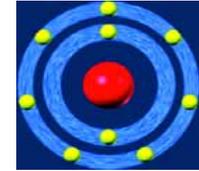


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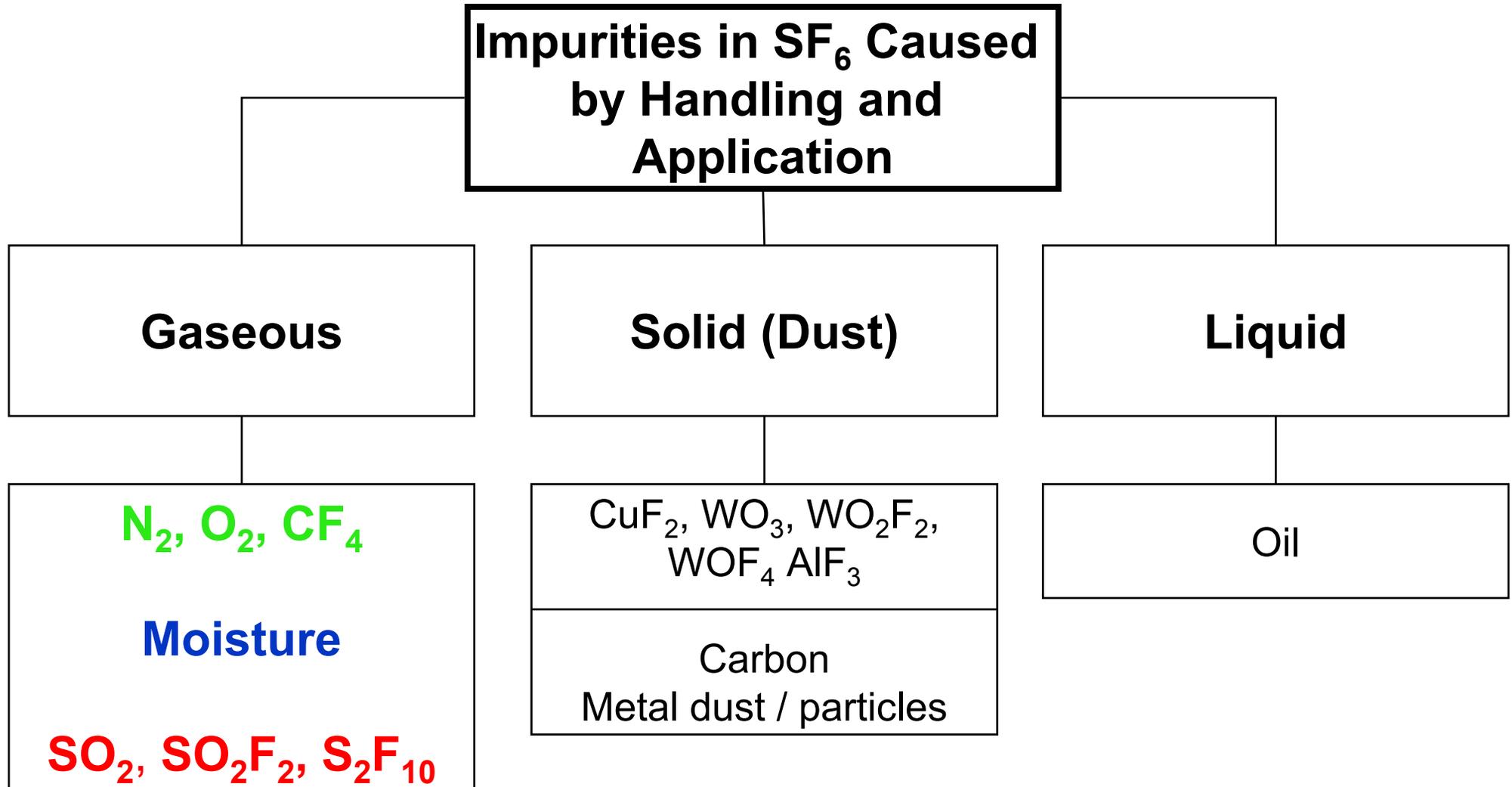


AGENDA

- Introduction
- SF₆ purification processes
- Test facility and pilot plant
- Conclusion

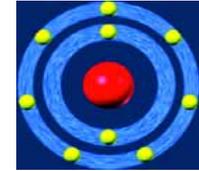


INTRODUCTION





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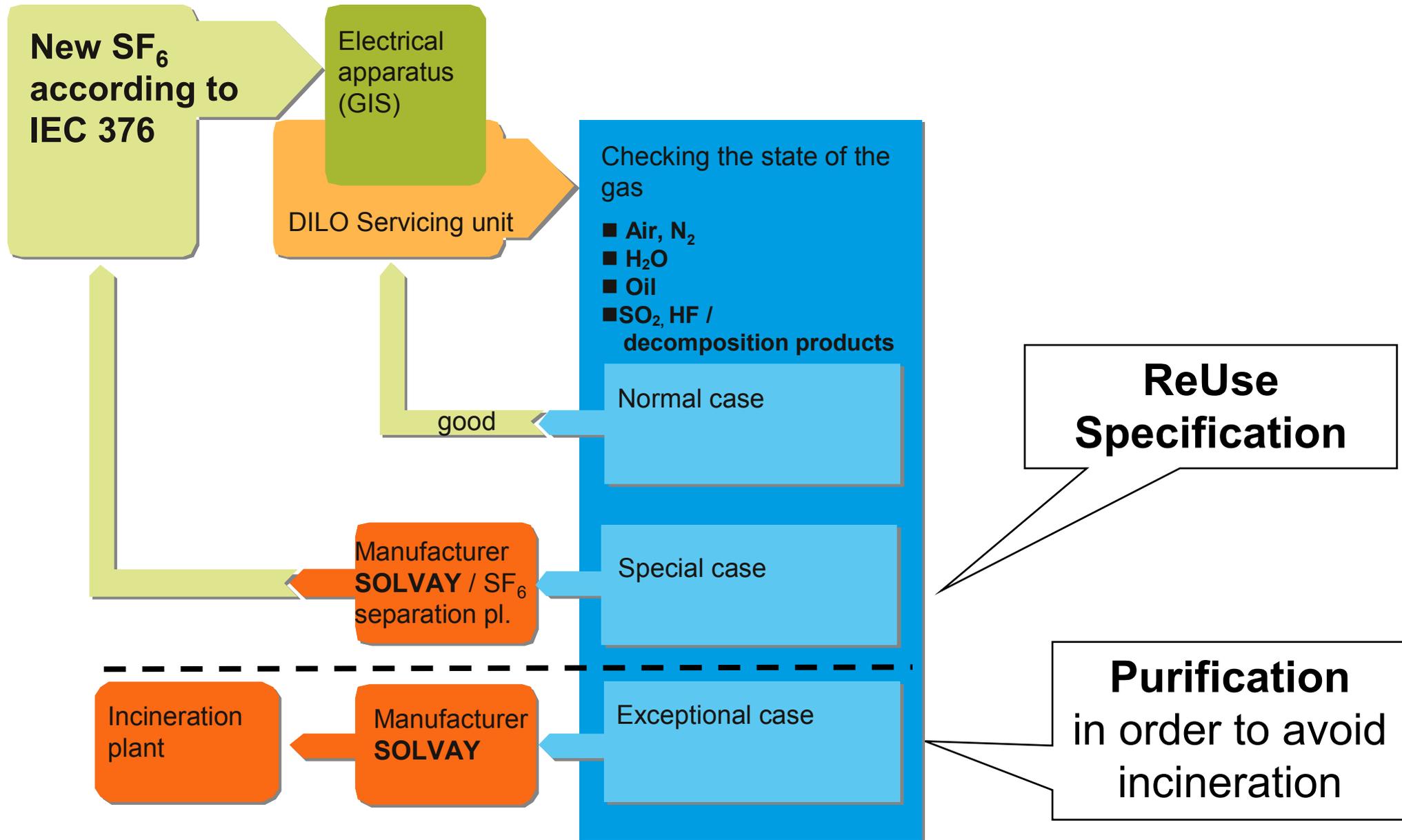
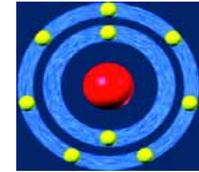
The SF₆ ReUse Program

- Analytical services, packaging, transport and reclaiming of used SF₆
- Re-introduction into the SF₆ production process.
 - separation of inert gases, but no purification!
- Output fulfills IEC 376 standard for virgin SF₆



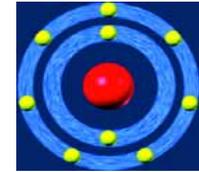
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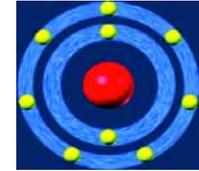


Average Impurities in Used SF₆ from Test Fields in 2001

Impurity (content)	IEC60480	Average value	Maximum value
(SF ₆)	96.99%	97.17%	99.99%
Air (O ₂ , N ₂)	3.0%	1.59%	59.74%
CF ₄		1.15%	2.70%
SO ₂	50ppm	300ppm	1.4%
SO ₂ F ₂		200ppm	1.5%
S ₂ F ₁₀	Not mentioned	174ppm	1.55%



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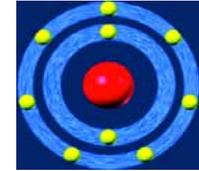
Threshold Limit Values for Possible SF_6 Decomposition Products

Contaminant	SF_6	CF_4	SO_2F_2	SO_2	HF	SOF_2	SOF_4	SF_4	WF_6	S_2F_{10}
TLV (ppmv)	1000	1000	5	2	2	1.6	0.5	0.1	0.1	0.025

Note that S_2F_{10} could dominate the toxicity profile of any given sample



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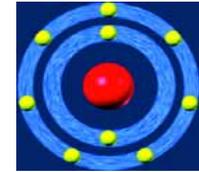


Impurities in Used SF₆, Behavior and Purification Processes

Impurity	Behavior / property	Purification process
Air (O ₂ , N ₂)	Inert	Membrane
CF ₄	Inert	Adsorber
SO ₂	Hydrolysable	Alkaline scrubber
SO ₂ F ₂	Hydrolysable	Alkaline scrubber
S ₂ F ₁₀	Stable / non hydrolysable	Pyrolysis / photolysis

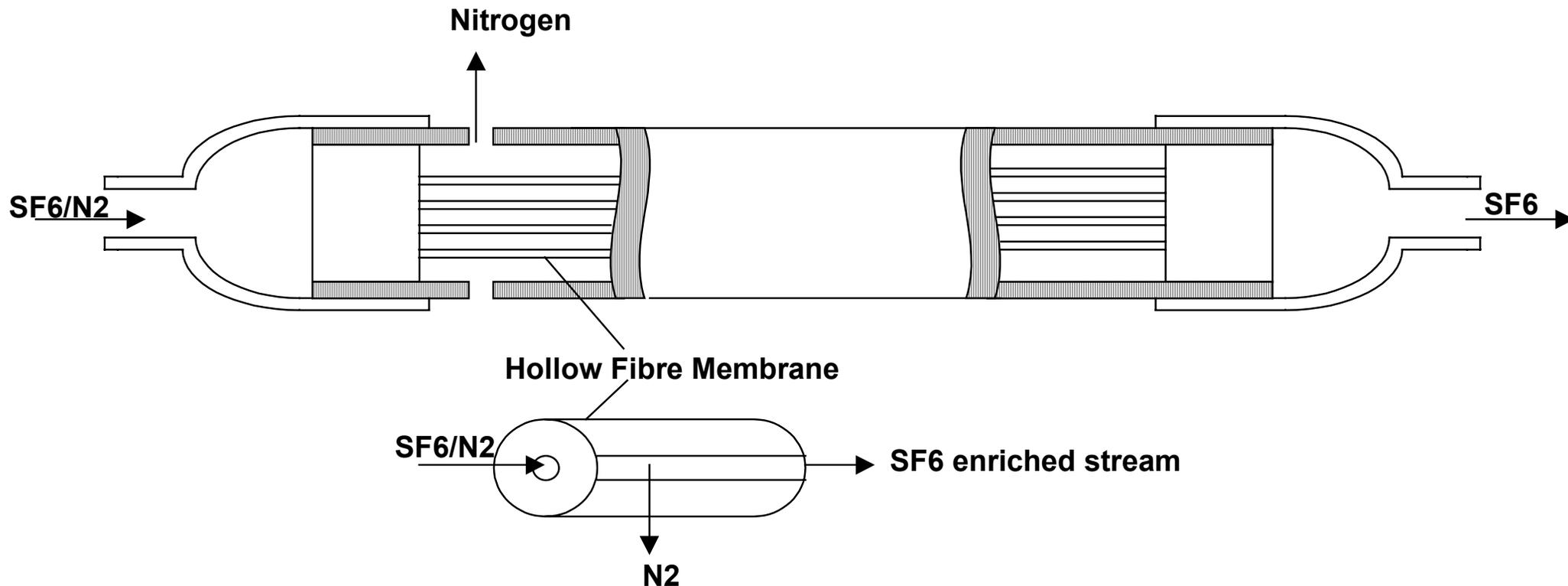


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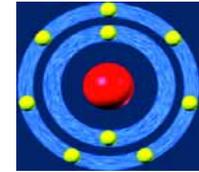
SF₆ PURIFICATION PROCESSES – Membrane

- separation of N₂, O₂ from gaseous SF₆
- application for GIL



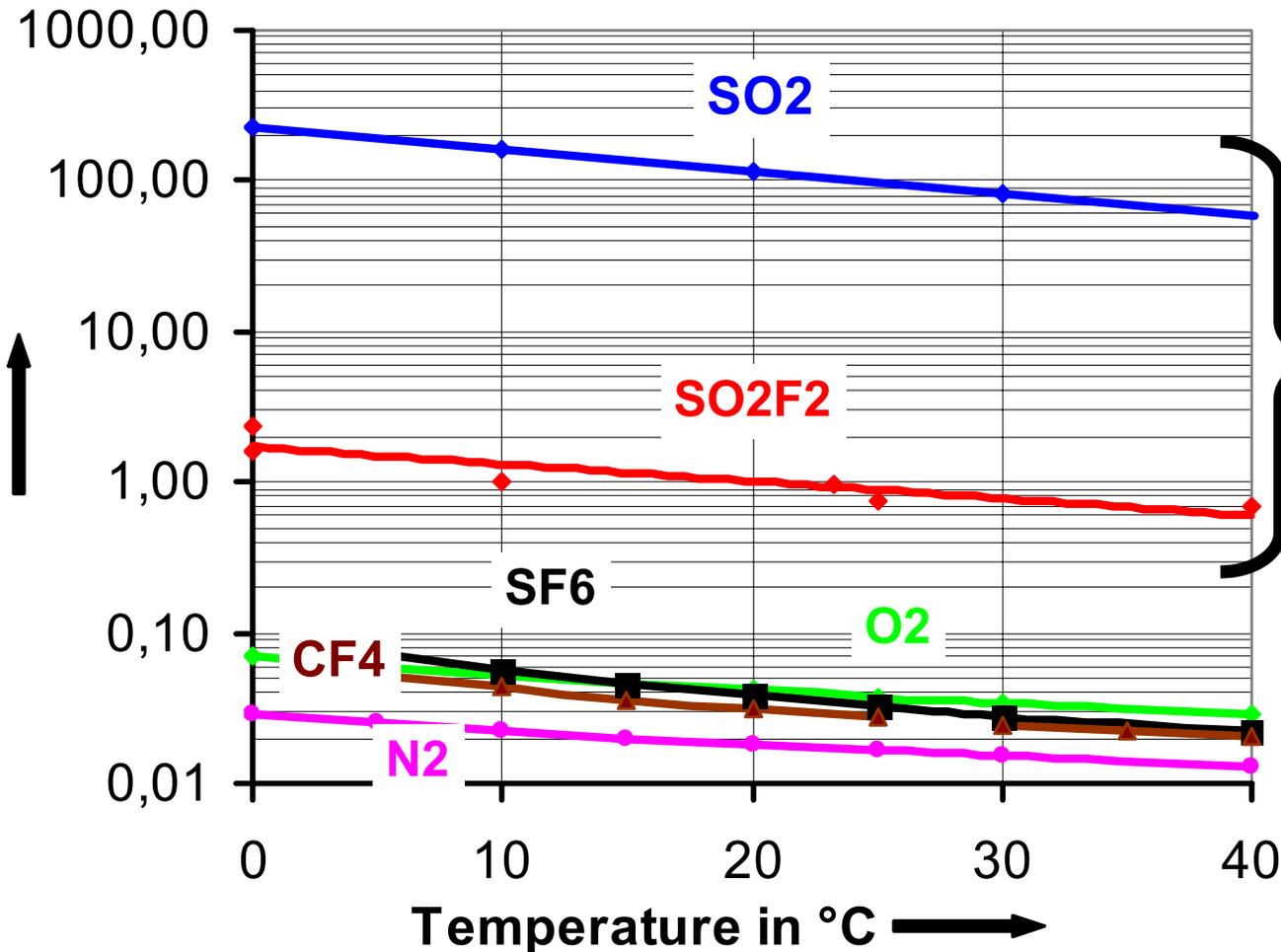


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SF₆ PURIFICATION PROCESSES – Gas Scrubber

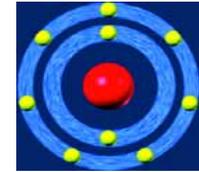
Solubility in g/kg H₂O at 1.013bar



Gas scrubber with
alkaline solutions -
common industry
practice

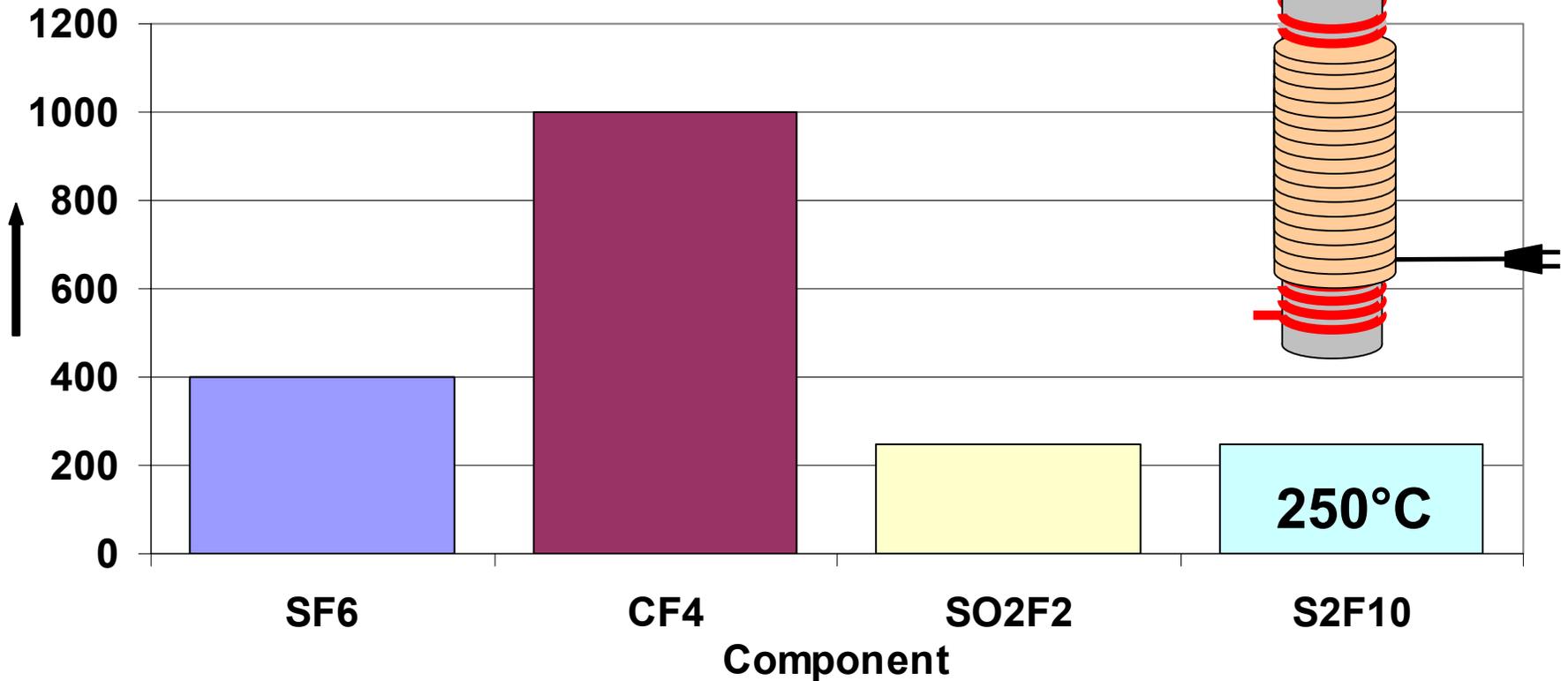


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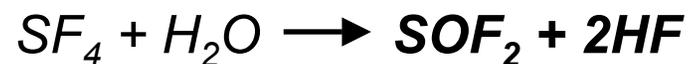


SF₆ PURIFICATION PROCESSES– Pyrolysis

Destruction Temperature in °C

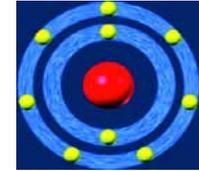


Reaction chain at 250°C:

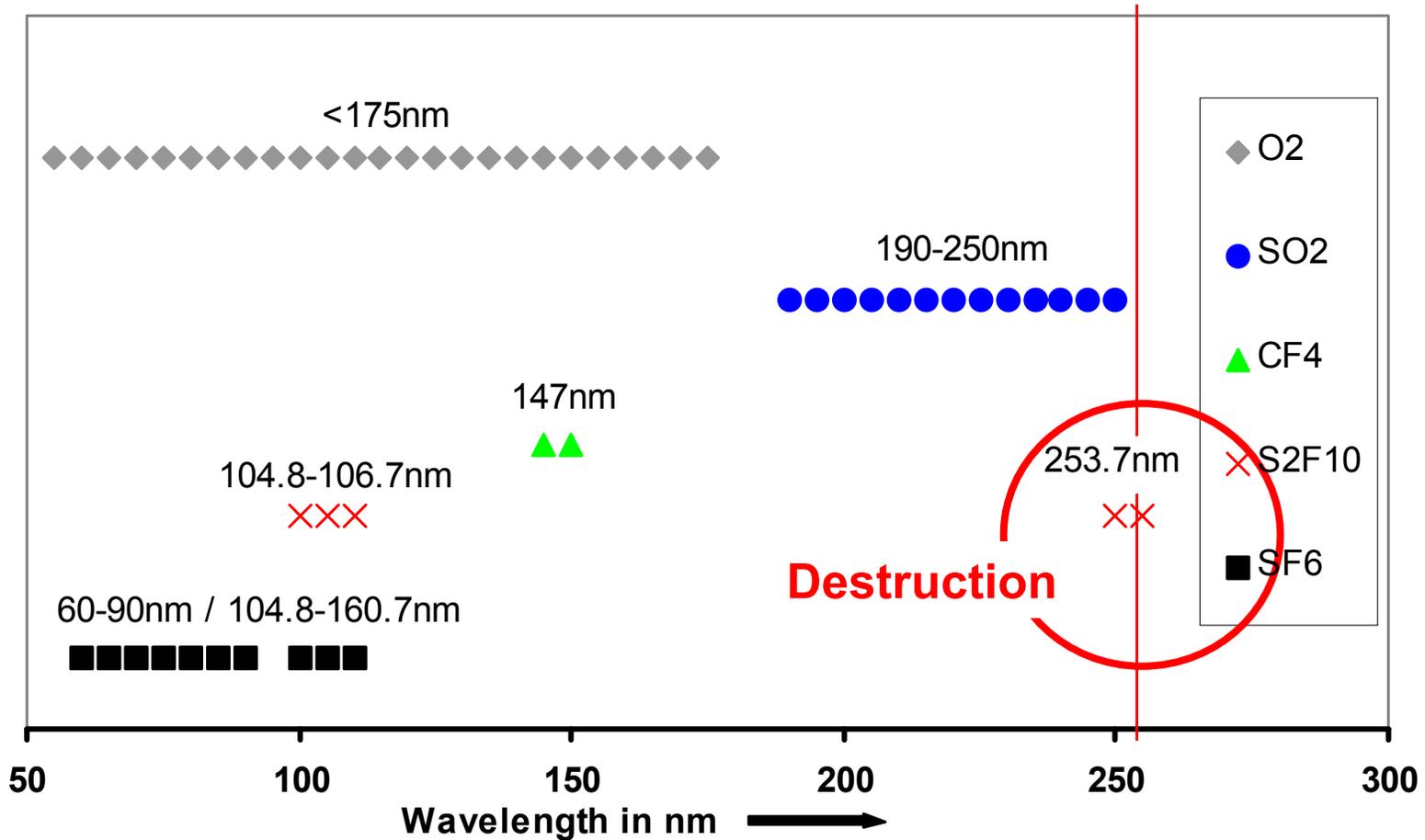




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SF₆ PURIFICATION PROCESSES – Photolysis

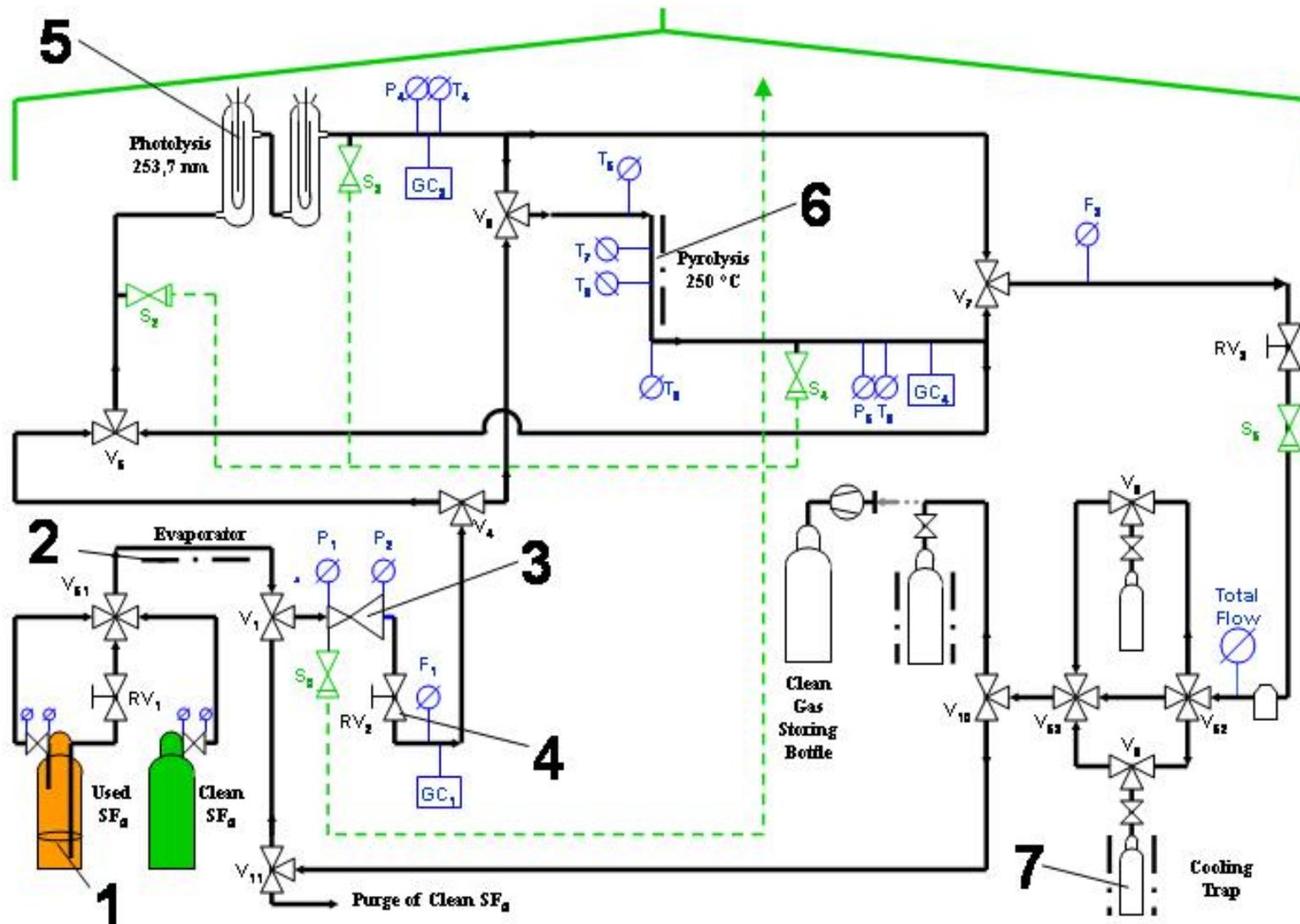
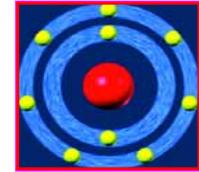


Decomposition Products at 253.7nm: SOF₂, SO₂F₂, SO₂



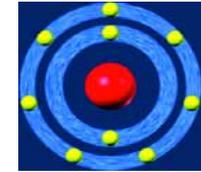
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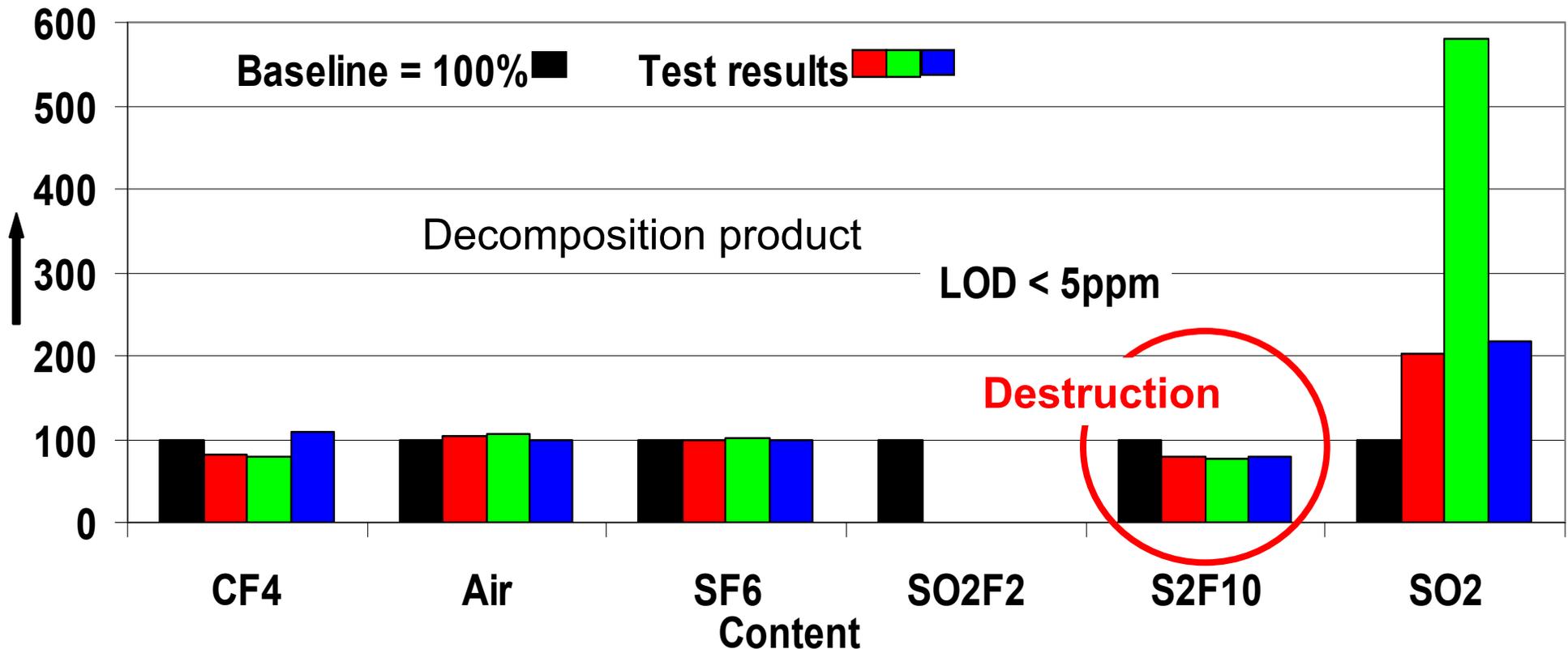


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Pyrolysis Results

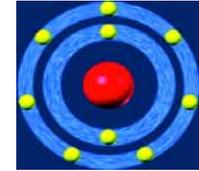
Deviation in % Related to Baseline



Conditions: capacity 750W, Temperature = 250°C, Pressure = 0.8bar
Gas treatment time: 7.6s at a volume flow of 0.5l/min

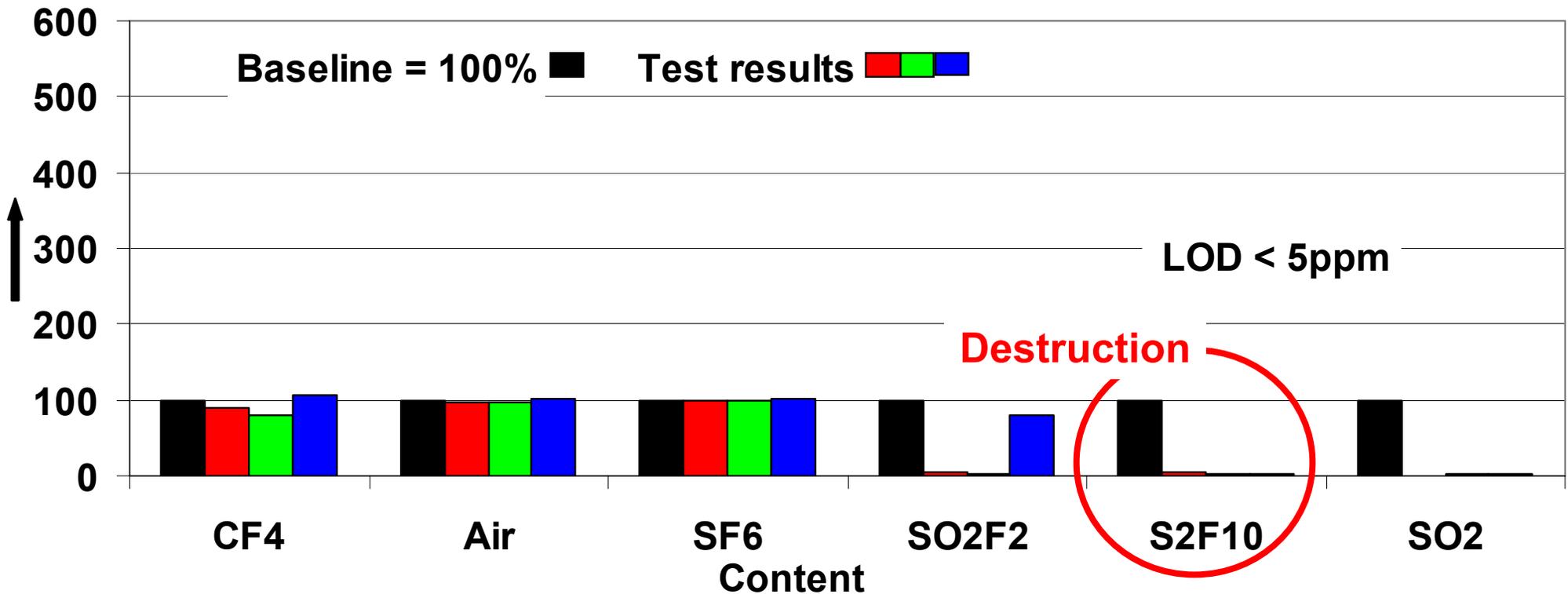


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Photolysis Results

Deviation in % Related to Baseline

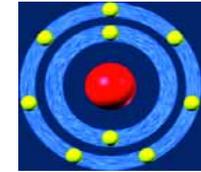


Conditions: wavelength 253.7nm, capacity = 700W, Temperature = 90°C,
Pressure = 0.8 bar

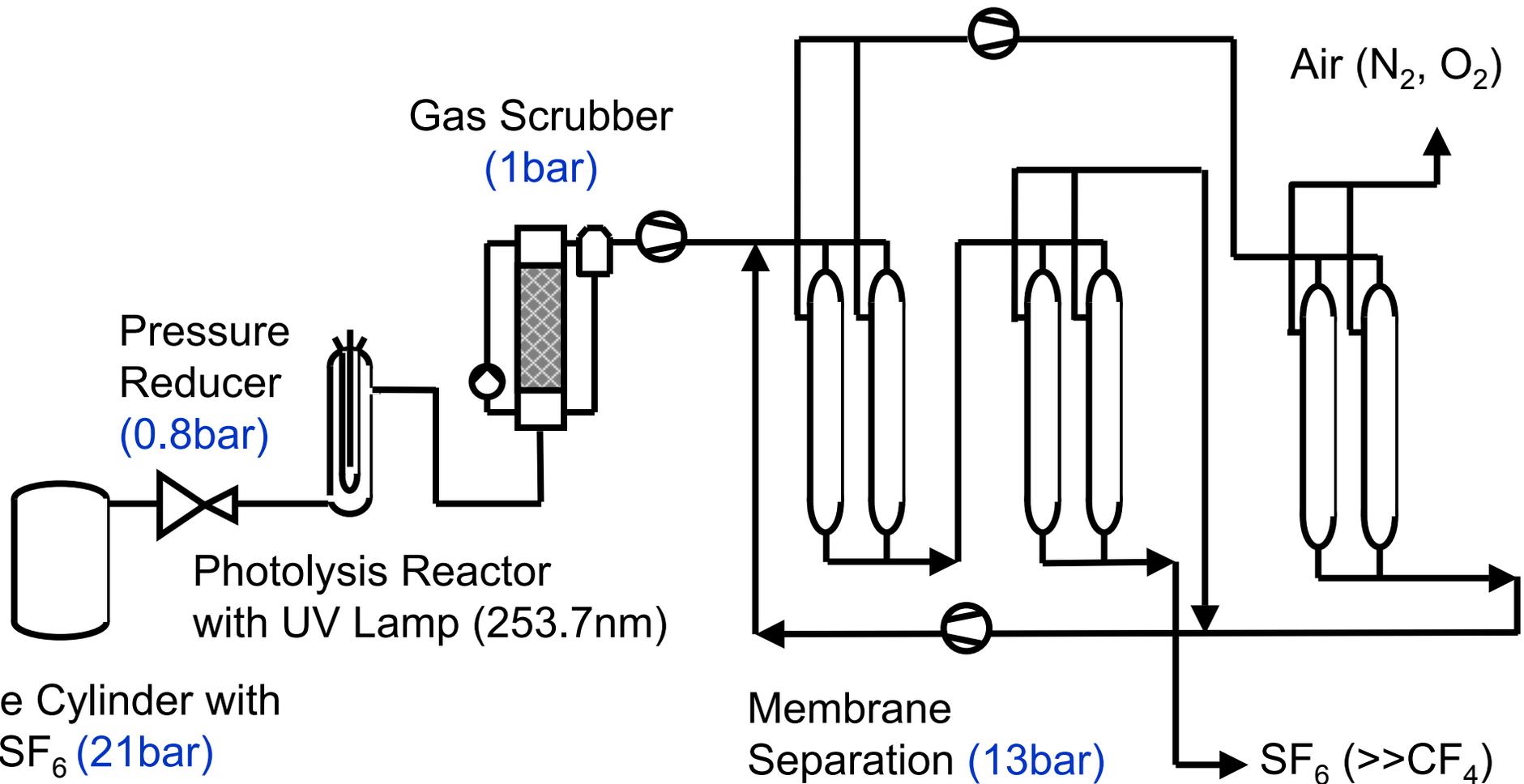
Gas treatment time: 1.26 min at a volume flow of 0.5l/min



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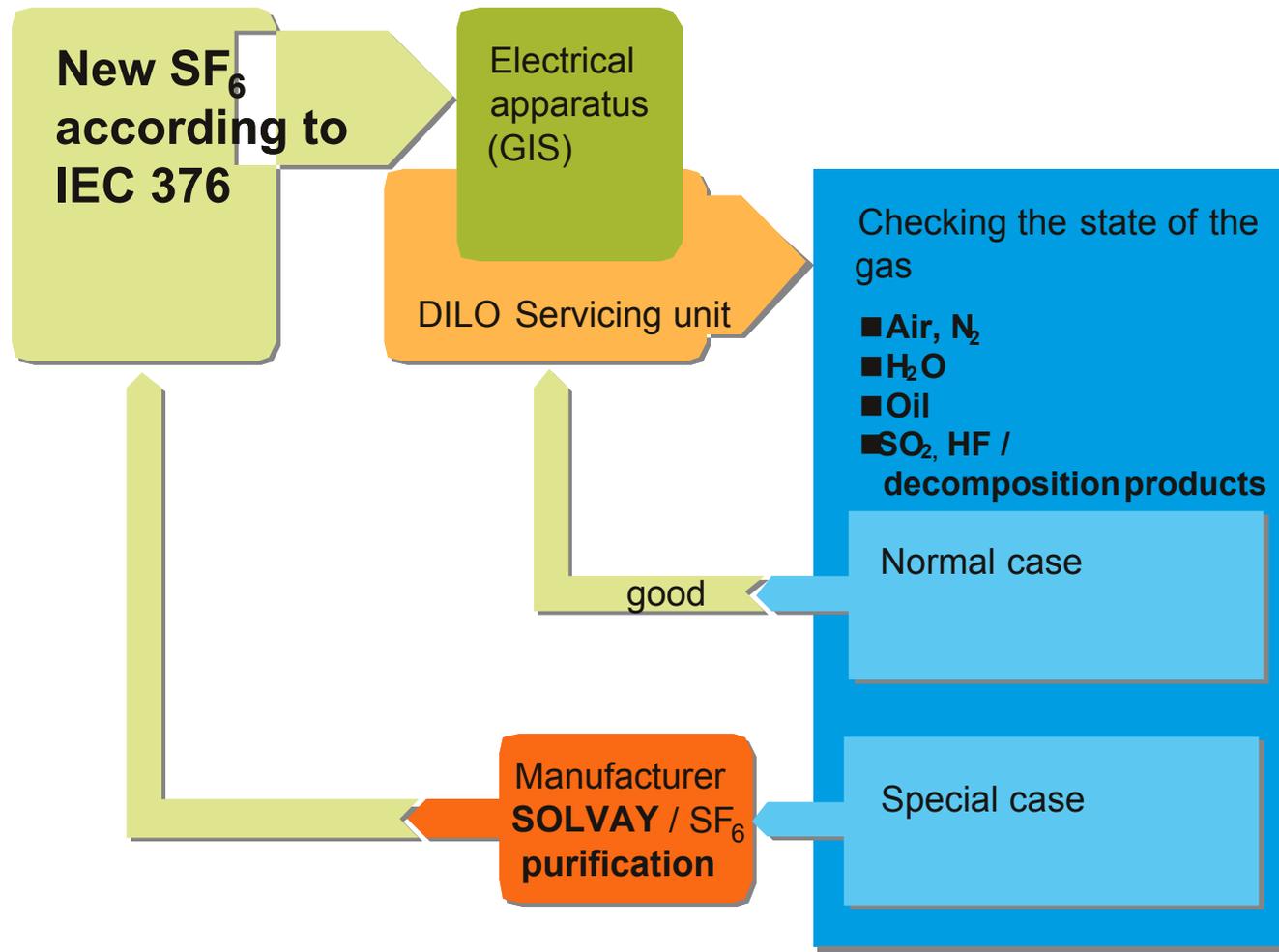
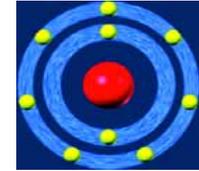
PILOT PLANT for the Pre-Treatment of Used SF₆





Solvay Fluorides LLC

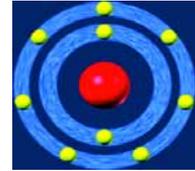
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With purification capabilities, the closed loop handling concept is complete



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CONCLUSION

- Photolysis is probably most appropriate for destruction of S_2F_{10} , further tests
- Pilot plant comprises of:
 - photolysis reactor (S_2F_{10})
 - alkaline scrubber (SO_2 , SO_2F_2) and
 - membrane units (O_2 , N_2)
- Completion of SF_6 ReUse Concept