A challenging experimental setup for testing the impact of sustainable gases on gas distribution materials

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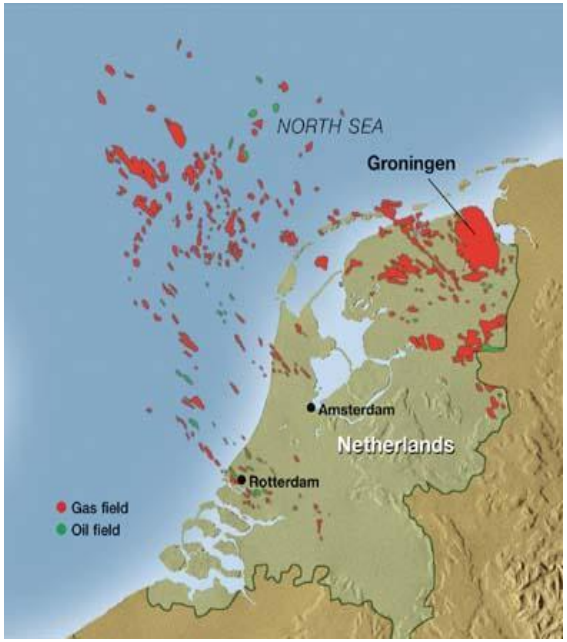
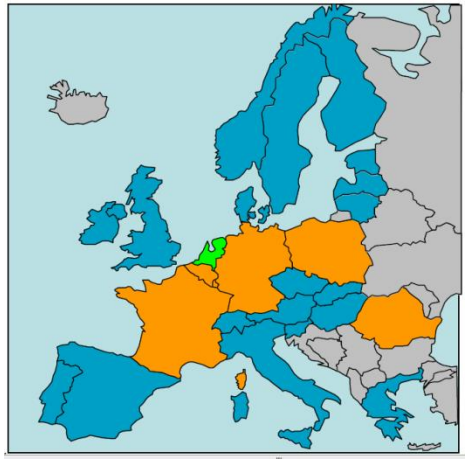
September 2014, International Gas Research Conference, Copenhagen

Changing of the gas qualities!

In the past & now



Now & nearby future



Future

G - gas

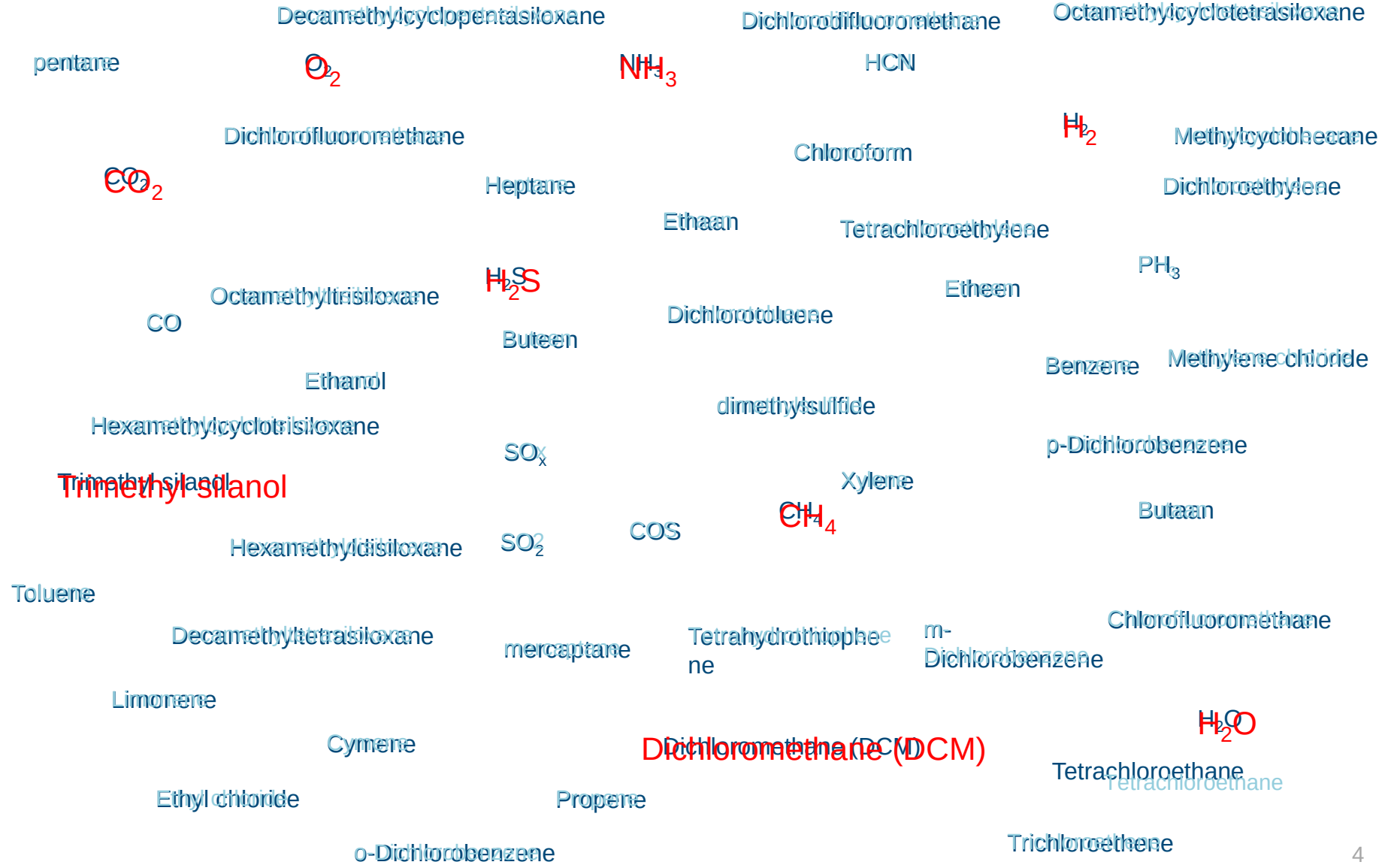
‘Narrow band’ gas

‘Wide band’ gas

Step-by-step approach

- Literature survey
  - Sustainable gases (concentration levels)
  - Gas distribution materials (importance)
  - Impact on materials
- Experimental set-up
  - Polymeric materials (focus on ESC)
  - Metallic materials (focus on corrosion)
- Lab & Field experiments
  - Finalized in 2015

Composition of sustainable gases



G-Gas, narrow and wide band gas

Chemical compound/mix	G-gas Average	Narrow band gas limiting values	Wide band gas Max. found concentration	Unit
Inorganically bound sulphur (H_2S)	0.4	5	4 300 (160)	ppm
Chlorine containing compounds	< 0.1	50	735	mg/m^3
Fluorine containing compounds	< 0.1	25	256	mg/m^3
Ammonia (NH_3)	< 0.1	4	100	ppm
Hydrogen chloride (HCl)	< 1.0	1	Traces	ppm
Carbon dioxide (CO_2) in dry gas	0.9	10.3	59	vol%
BTX	500	10 000	900	ppm
Oxygen (O_2) in dry gas	< 0.01	0.5	3	vol%
Hydrogen (H_2)	< 0.01	12	62	vol%
Methane (CH_4)	81.29	No limit	99.8	mol%
Nitrogen (N_2)	14.32	No limit	50.9	mol%
C_2+	3.0	-	35	mol%
Organo-silicons	< 0.1	5	20	mg/m^3

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Nitrogen (N_2)	14.32	No limit	50.9	mol%
C_2+	3.0	-	35	mol%
Organo-silicons	< 0.1	5	20	mg/m^3

Materials in gas distribution grid

Steel St 37

NBR

Stainless Steel 304

Hemp

Polyamide
(PA)

SBR

Neoprene
rubber

Polyvinylchloride
(PVC-HI)

Steel
(St 235JR)

Copper (Cu-DHP)

Steel ASTM A106 gr. B

Polyvinylchloride
(PVC-U)

Polyethylene
(PE80)

Nickel

Polyethylene
PE100

EPDM

Cast-iron

Stellite

Asbestos

Brass

Titanium

Polyethylene
(PE50/PE63)

Polytetraflurorethylene
(PTFE)

Bronze

Aluminium

Polyethylene terephtalate
(PET)

Cobalt

Polyoxymethylene
(POM)

Zinc

Neoprene
rubber

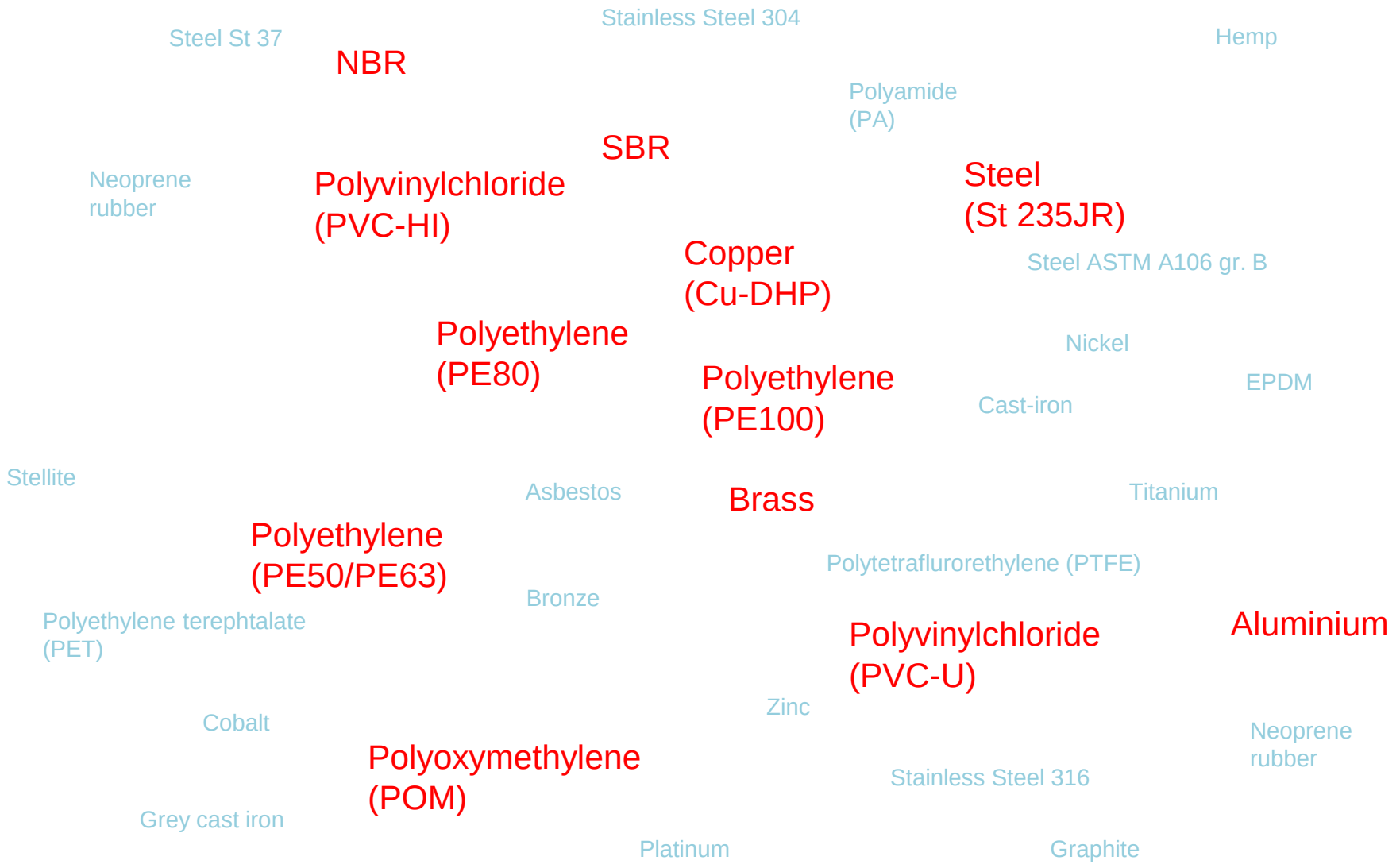
Stainless Steel 316

Grey cast iron

Platinum

Graphite

Materials in gas distribution grid



Impact on materials

	S	H_2S	Mer-captans	Odo-rant	NH_3	Cl comp.	F comp.	HCl	HCN	CO	CO_2	BTX	Aroma-tics	O_2	H_2
PVC															
PE															
NBR															
Steel															
Copper															
Aluminium															

Impact on materials – Narrow band gas

	S	H_2S	Mer-captans	Odo-rant	NH_3	Cl comp.	F comp.	HCl	HCN	CO	CO_2	BTX	Aroma-tics	O_2	H_2
PVC															
PE															
NBR															
Steel															
Copper															
Aluminium															

No problem

Impact on materials – Narrow band gas

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Aluminium															

No problem

Probably a problem

Impact on materials – Narrow band gas

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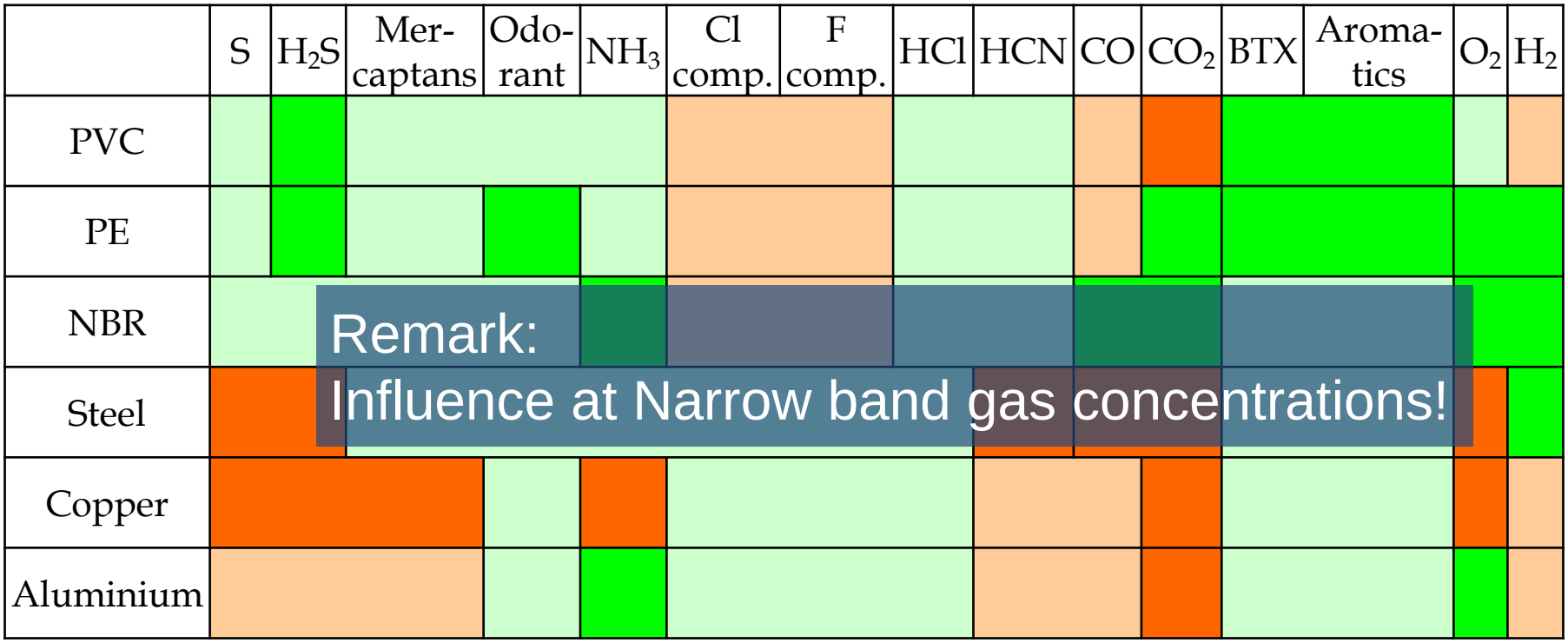
Steel															
Copper															
Aluminium															

No problem

No problem expected

Probably a problem

Impact on materials – Narrow band gas



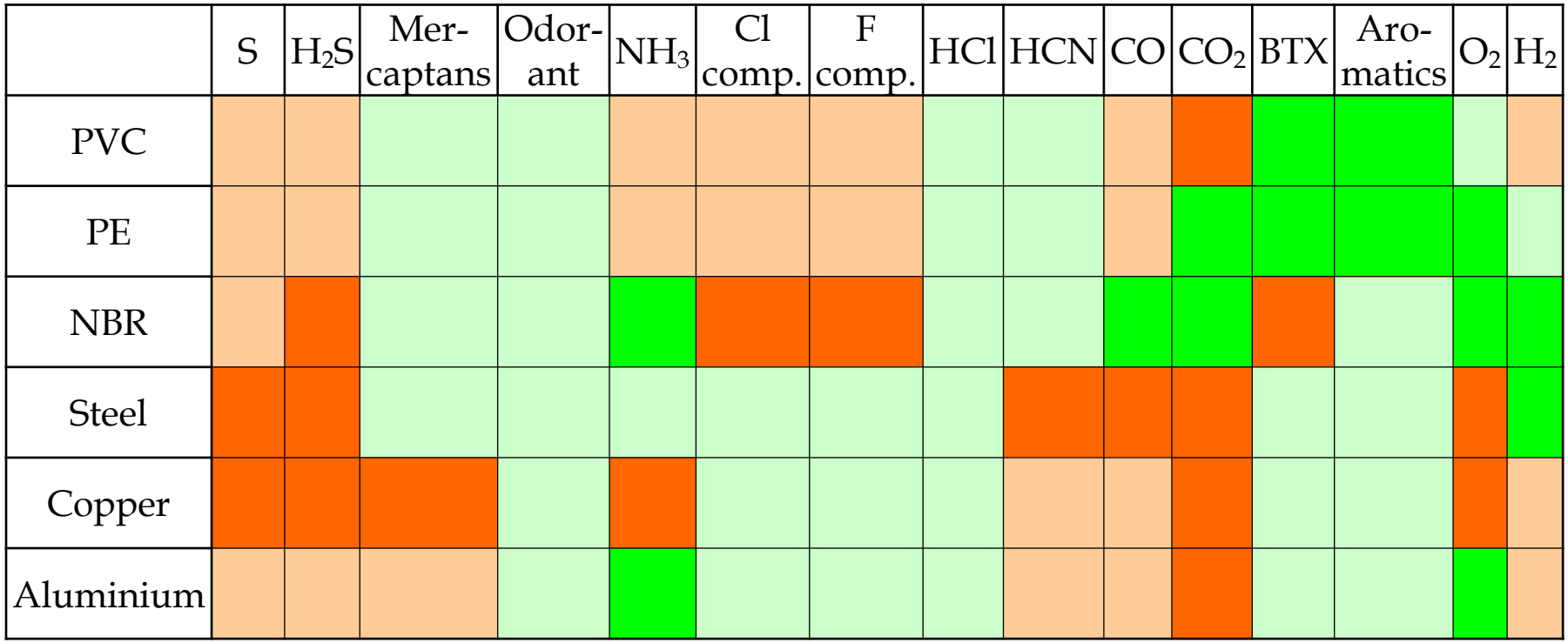
No problem

No problem expected

Unknown, possible a problem

Probably a problem

Impact on materials – Wide band gas



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Experimental set-up

- Polymeric materials
  - To determine if there is any effect at all at a certain chemical component concentration
  - Focus on Environmental Stress Cracking (ESC)
- Metallic materials
  - To determine at which chemical concentration levels problems arise
  - Focus on Corrosion

Polymeric materials – Gaseous environments

#	Gaseous environments	Polymeric materials
1	100 vol% N_2	PE, PVC, Rubber, POM
2	5 ppm H_2S	PE,
3	160 ppm H_2S	PE,
4	80 ppm H_2S	
5	75 mg/m^3 DCM	PE,
6	62 vol% H2	POM
7	550 mg/m^3 DCM	Rubber
8	100 ppm NH_3	PE, PVC, Rubber, POM
9	59 vol% CO_2	PVC, Rubber, POM
10	3 ppm HCl	POM
11	1000 mg/m^3 DCM	PE, PVC, Rubber, POM
12	Natural gas	Rubber
13	2 vol% propene	Rubber

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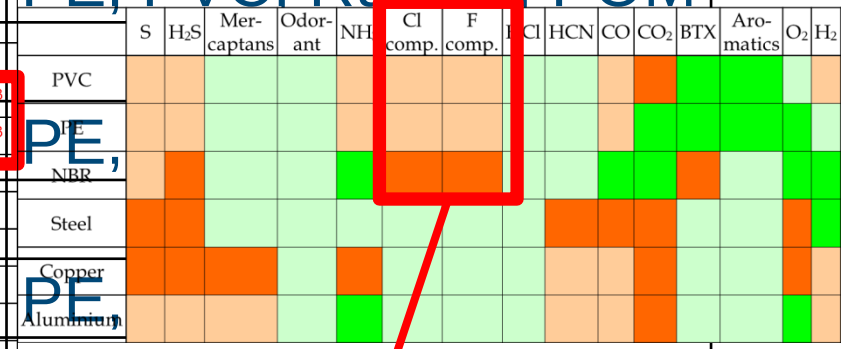


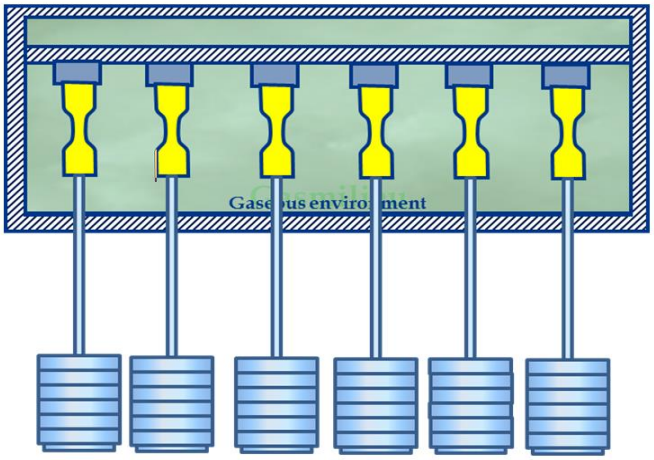
Metallic materials – Gaseous environments

#	Gas conditions				Pressure	Materials
	RH (%)	CO_2 (vol%)	O_2 (vol%)	H_2S (ppm)		
1	100	10	0.5	34	30 mbar	Steel (incl. weld), copper, aluminium
2	100	0	0.5	34		
3	100	10	0.1	34		
4	100	10	0.01	34		
5	100	50	0.01	160		
6	100	50	0.01	160	8 bar	
7	50	50	0.01	160	30 mbar	
8	100	50	3	160		
9	100	0	3	160		
10	100	50	3	0		

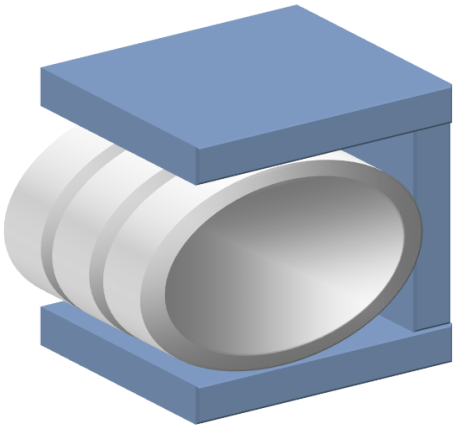
With Design of Experiments (DoE) minimum amount of Gaseous environments

Polymeric materials – ESC

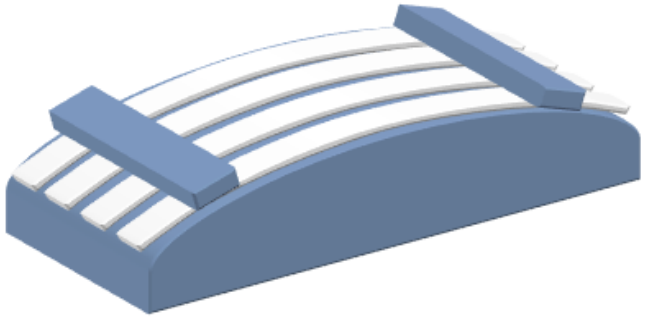
Constant load



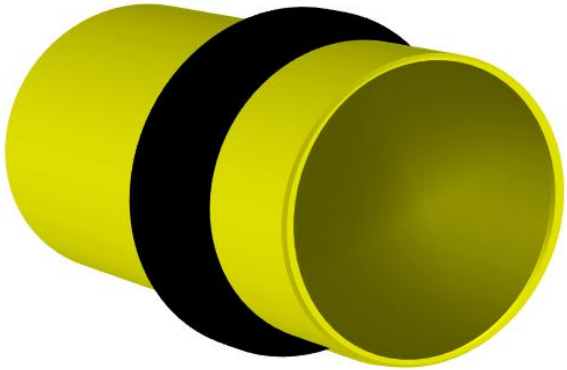
U-Clamp



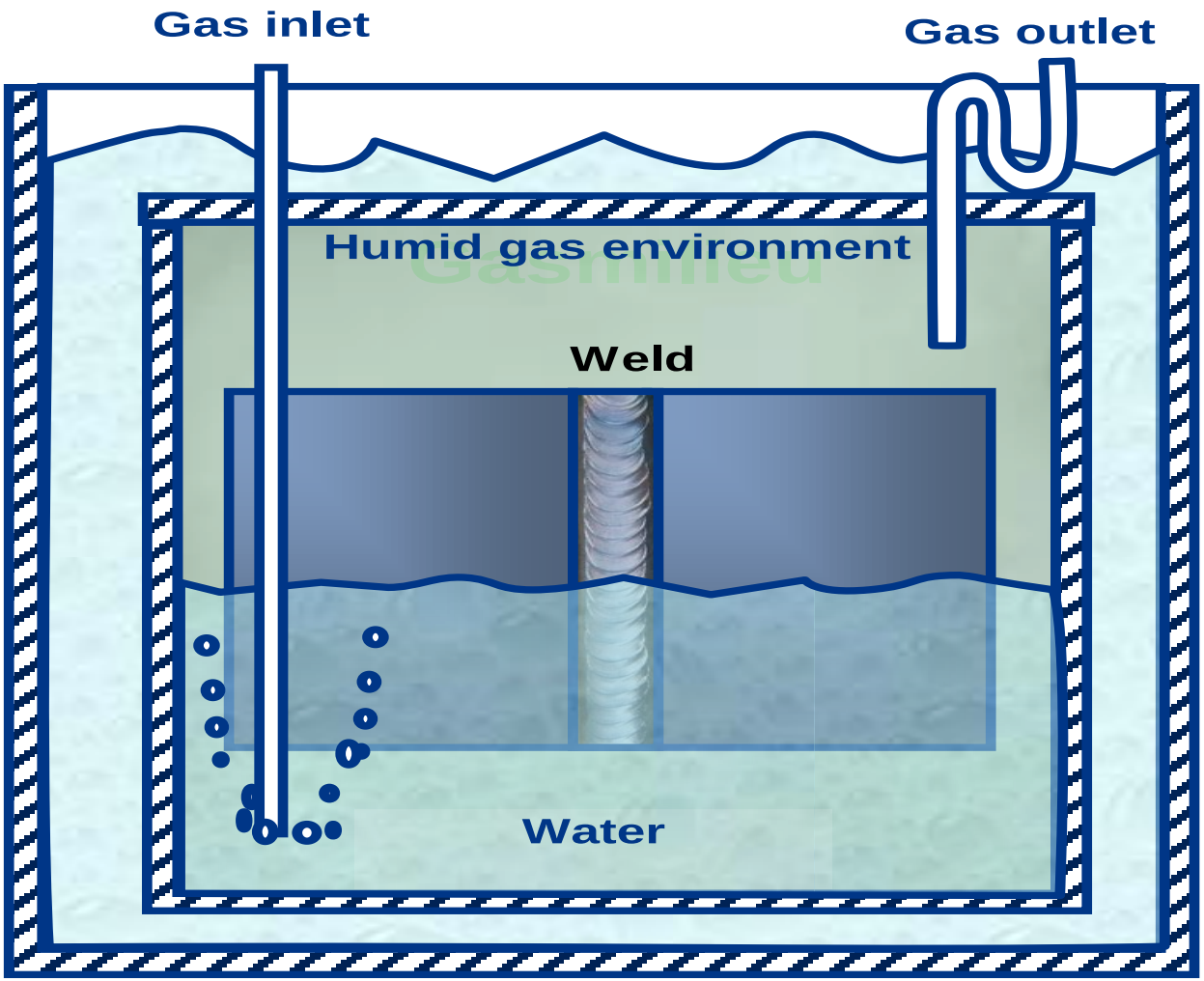
Marbone Clamp



Rubber rings over pipe



Metallic materials – Corrosion



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Labexperiments – Challenges

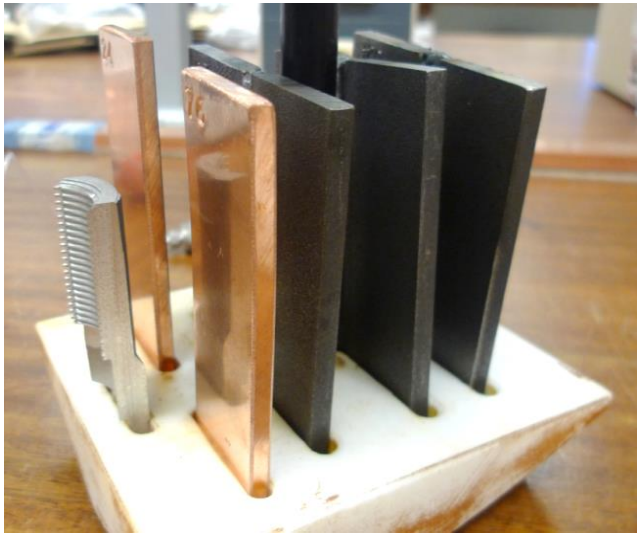
- High amount of samples
  - 1300 polymeric
  - 360 metallic

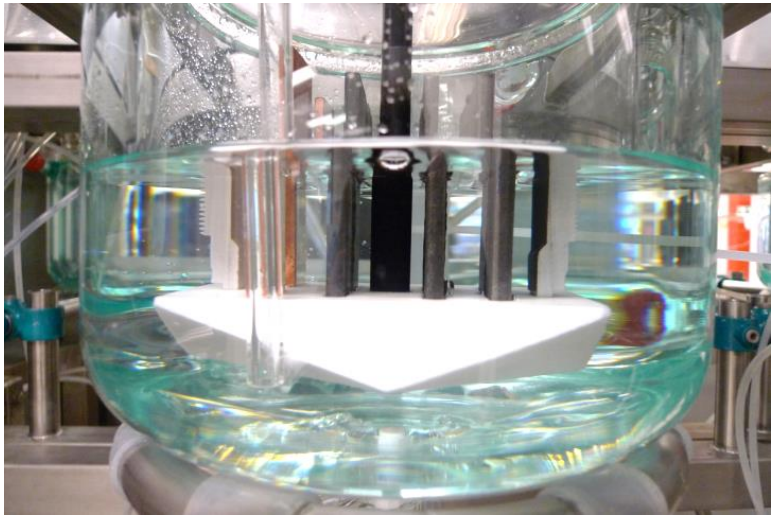
- Safety
  - High pressure (97/23/EC, PED)
  - Toxic and flammable environment
    - ❑Alarm & ventilation systems
    - ❑ATEX

- Test period for 2 years
  - Constant concentration levels for 23 gases

Labexperiments – Polymeric materials

Labexperiments – Metallic materials





Current status

- Experiments are in final stage!
  - Samples are taken out and tested
- Results will be published in 2015!
  - Abstract submitted for WGC 2015 in Paris, France

Questions

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Partner for progress

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