


Odorisation in Europe

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The MARCOGAZ overview

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OF THE EUROPEAN NATURAL GAS INDUSTRY

E. Salati, W. Borghols, A. Casola, Q. Degroote, J. Dehaeseleer, F. Humhal, H. Kaesler, U. Klaas, A. Louvat, B. Metz, J. Pardinas, H. Vinck

Marcogaz Odorisation WG

Content

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- Who is MARCOGAZ ?
- Odorisation practices
- Odorisation plants
- Odorants used in Europe
- Odorisation control
- Odorisation costs in Europe
- Others issues: masking effects, etc.
- New MARCOGAZ activities
- Conclusions

Who is MARCOGAZ ?

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- **MARCOGAZ is the Technical Association of the European Natural Gas Industry.**

- **MARCOGAZ is a non-profit International Association, created in 1968, with the chief mission to serve its Members as the European platform for any technical issue regarding natural gas.**

The WG Odorisation

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- **Is active in collecting information from 19 EU Countries to share knowledge on the odorisation process.**

- **Is focusing on different items:**
  - legal aspects
  - verification
  - plants
  - required concentrations and odorants' composition
  - odorisation costs
  - methods & instruments to check the odorisation

Odorisation pratices

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Odorisation practices:

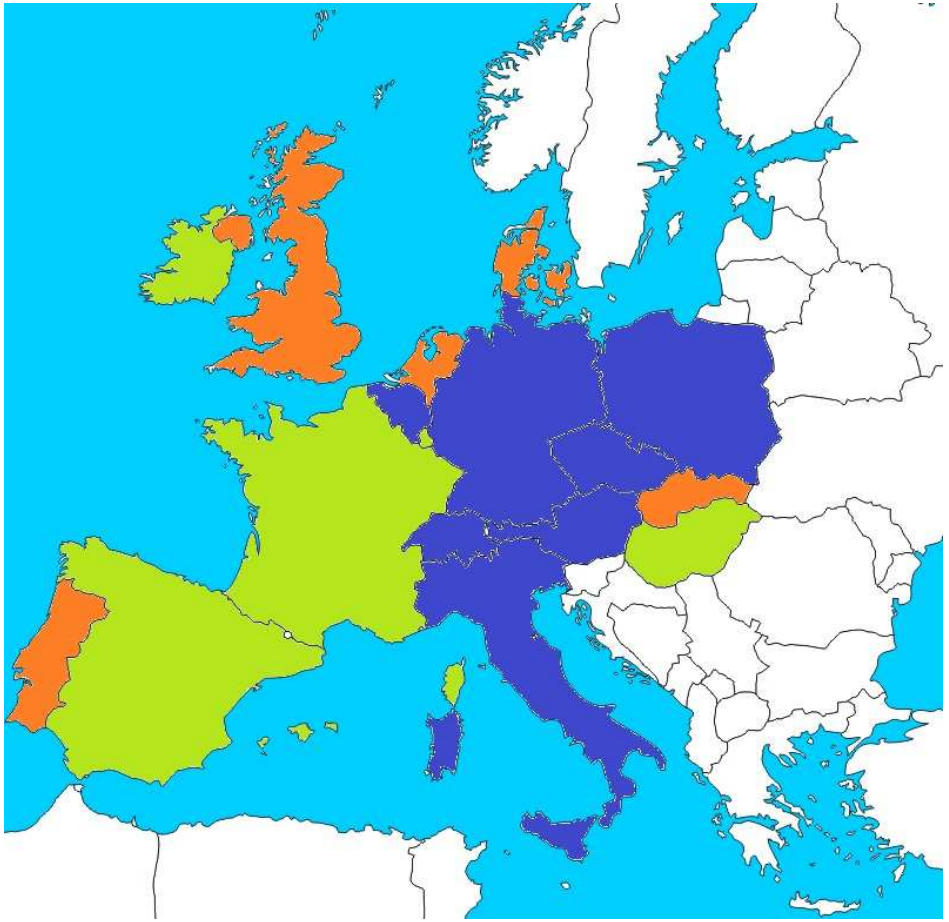
green: distribution network + transmission network odorised

orange: distribution network odorised + transmission network partly odorised:

- **Distinction between transit and national transport**

blue: mainly distribution network odorised

Note: All the distribution networks are odorised



Odorisation plants

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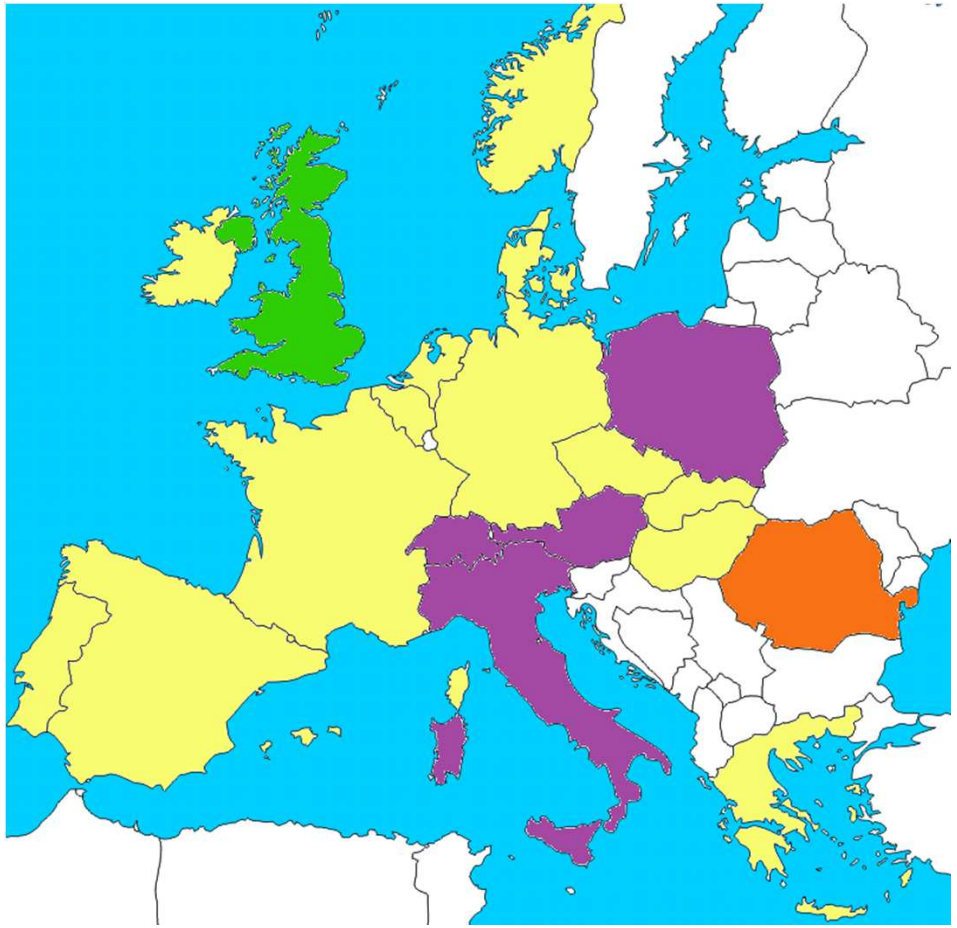
3 technologies used:

- ***Electronic pumps:*** the injection is powered by a mechanical system
- ***Pneumatic pumps:*** the injection is assured by a difference of pressure
- ***Bypass systems:*** based on partial flow from the stream of the natural gas through the odorant tank, without need of electrical power

Odorisation plants:

Yellow: use of electronic pumps
Green: use of pneumatic pumps
Orange: use of pneumatic pump and bypass system
Purple: use of the three technologies



Odorants used in Europe

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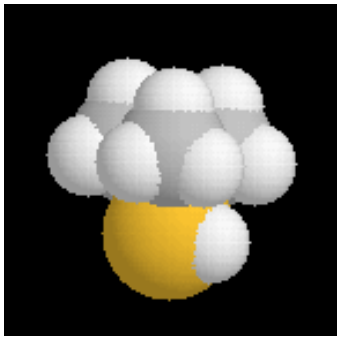
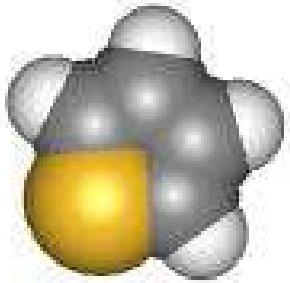
- **4 types of odorants mostly used:**
  - THT (most used)
  - Sulfur-Free
  - Blend with TBM and DMS
  - Blend with TBM, IPM and NPM





Odorants used in Europe

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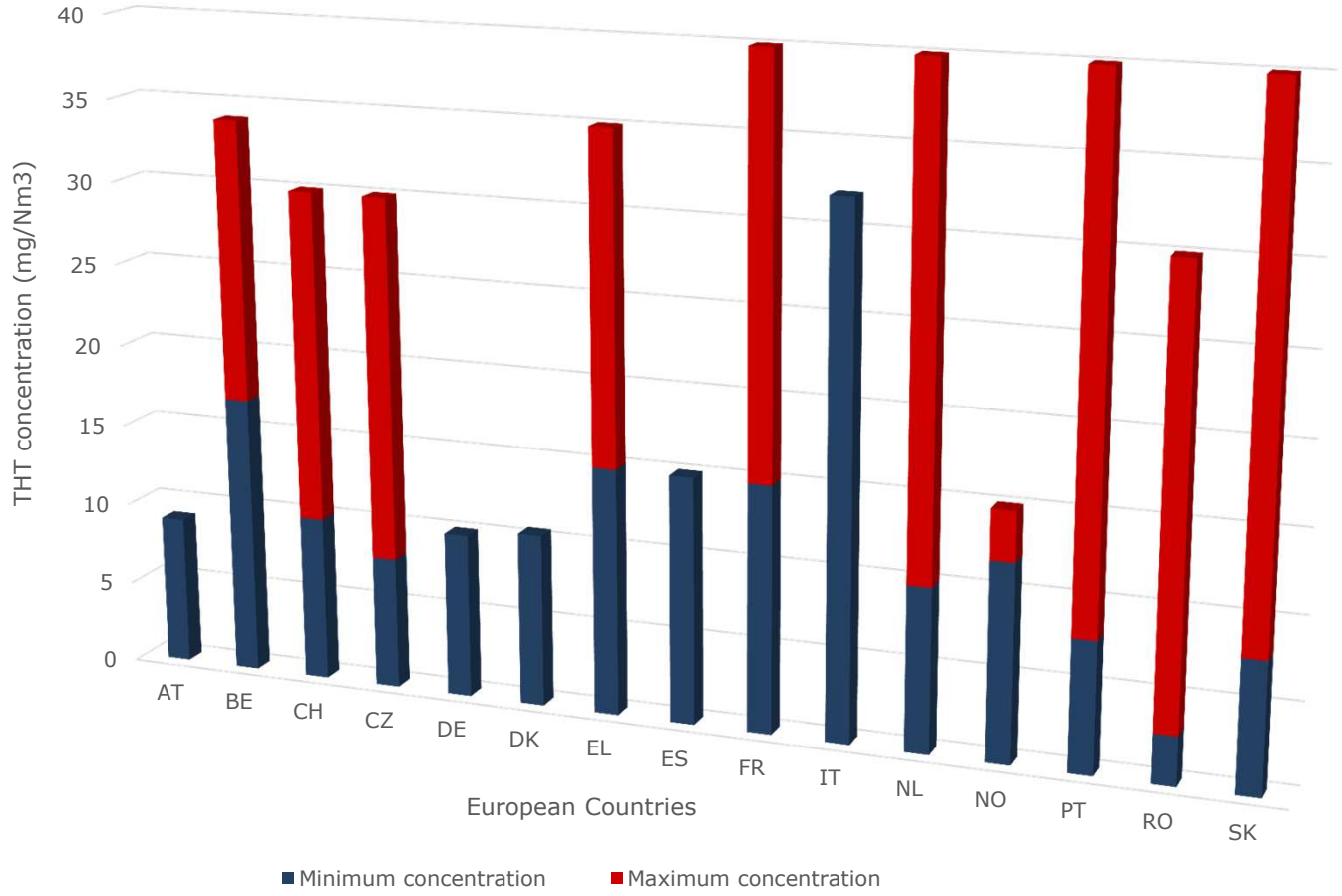
➢ THT: comparison of required concentrations in the different Countries



Odorants used in Europe

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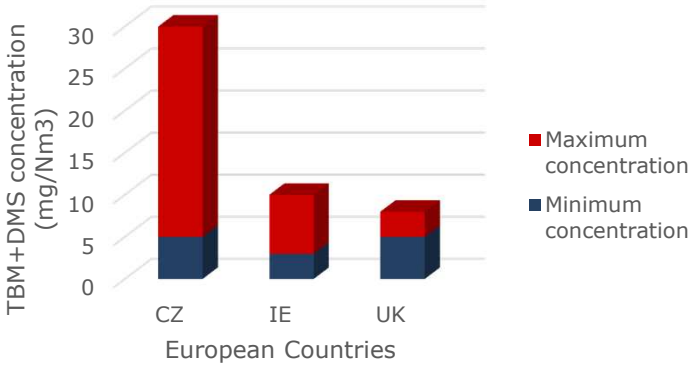
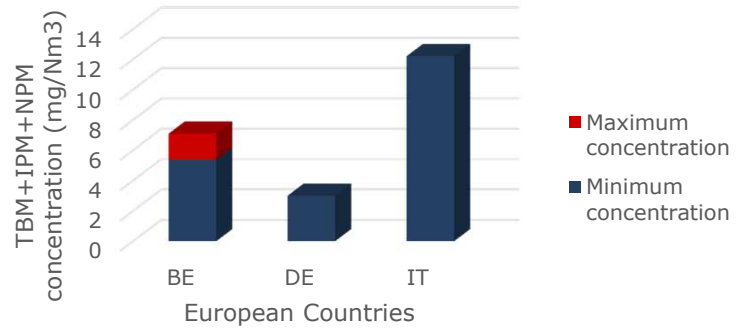
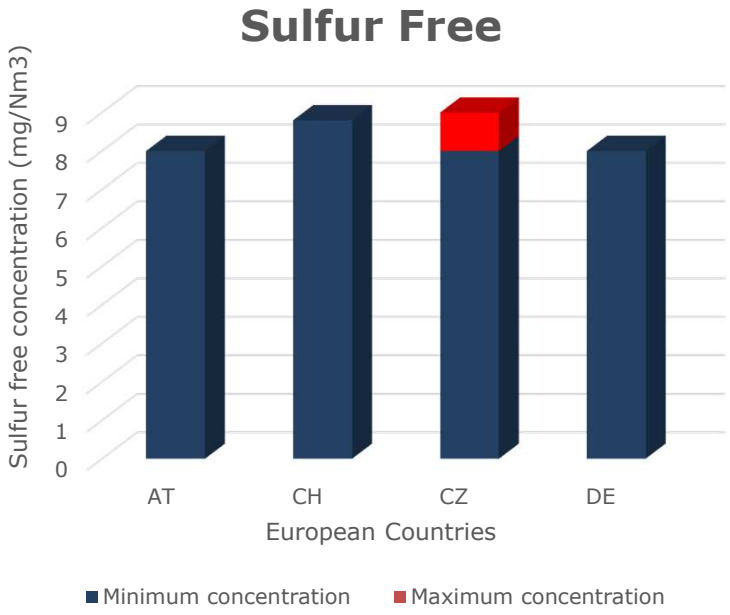
TBM-DMS blend



TBM-IMP-NPM blend



Sulfur Free



Odorisation control

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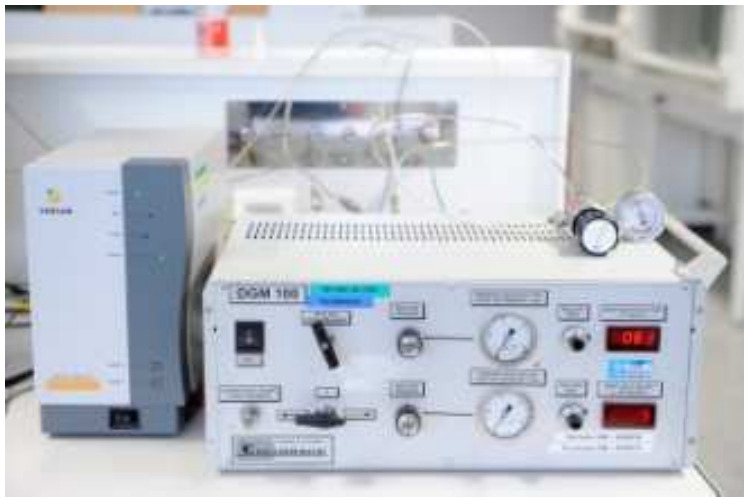
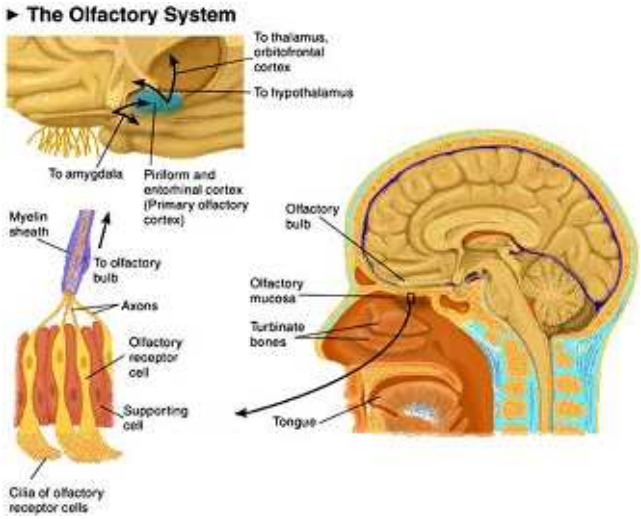
➢ 2 ways to control gas odorisation:

- ➢ Olfactory measurement (use of human noses)
- ➢ Analytical measurement (use of detectors/analyzers)





Odorisation control – Olfactory measurements

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- **Smell**
  - measured as olfactive degree
  - typical requirement for Odorisation
  - but in Europe is often substituted by odorant concentration

- **In 7 countries smell is directly checked (in 4 countries smell is the primary method to check odorisation)**

- **Different scales exist: Sales, VDI 3382-1, ISO/CD 18222**

Odorisation controls - Olfactory tests

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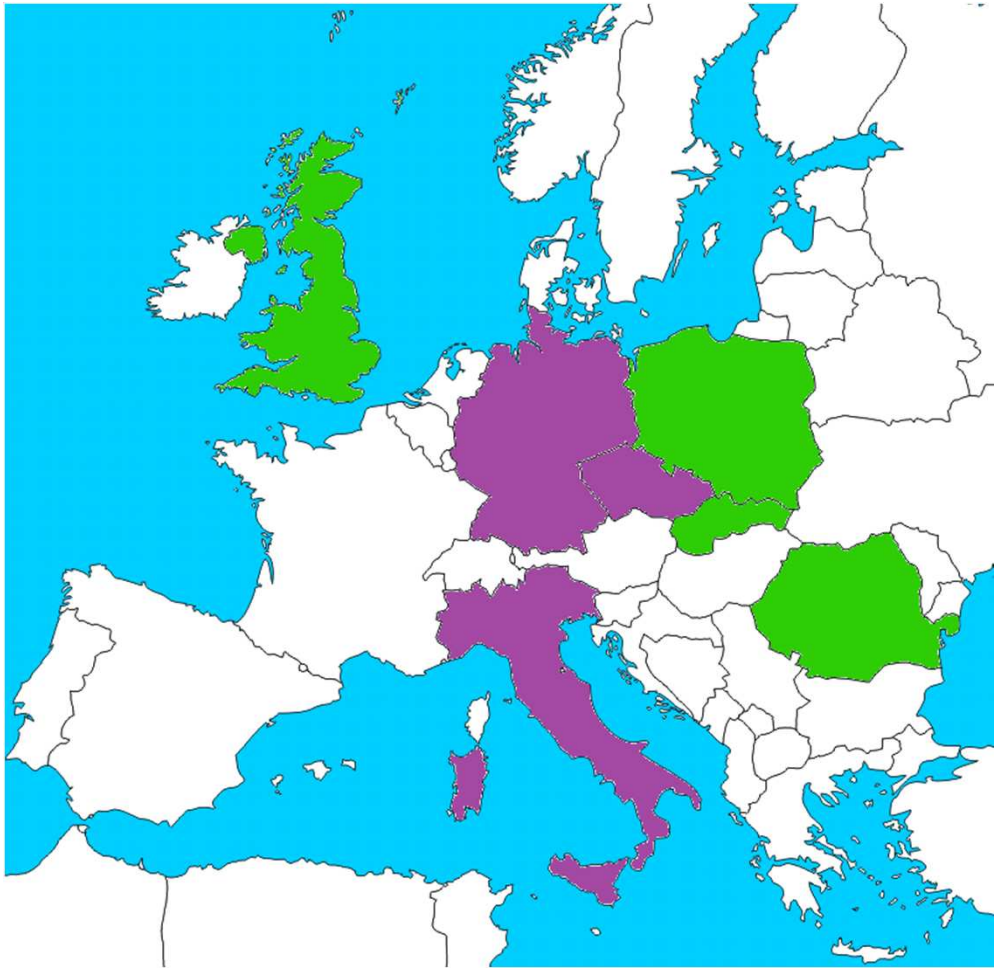
Olfactory Tests
Countries where olfactory tests are used

green: countries where olfactory tests are the primary method to check odorisation

purple: other countries where olfactory tests are admitted

Note: in Italy smell checks are legally accepted, but the Regulatory Body take into account (for taxation incentives) only gas chromatographic determination



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- **In Europe, the requirement is mostly expressed as a minimum odorant concentration, instead of an odour intensity.**

- **The reason is that an odorant concentration is easier and cheaper to check and to prove, than a smell.**

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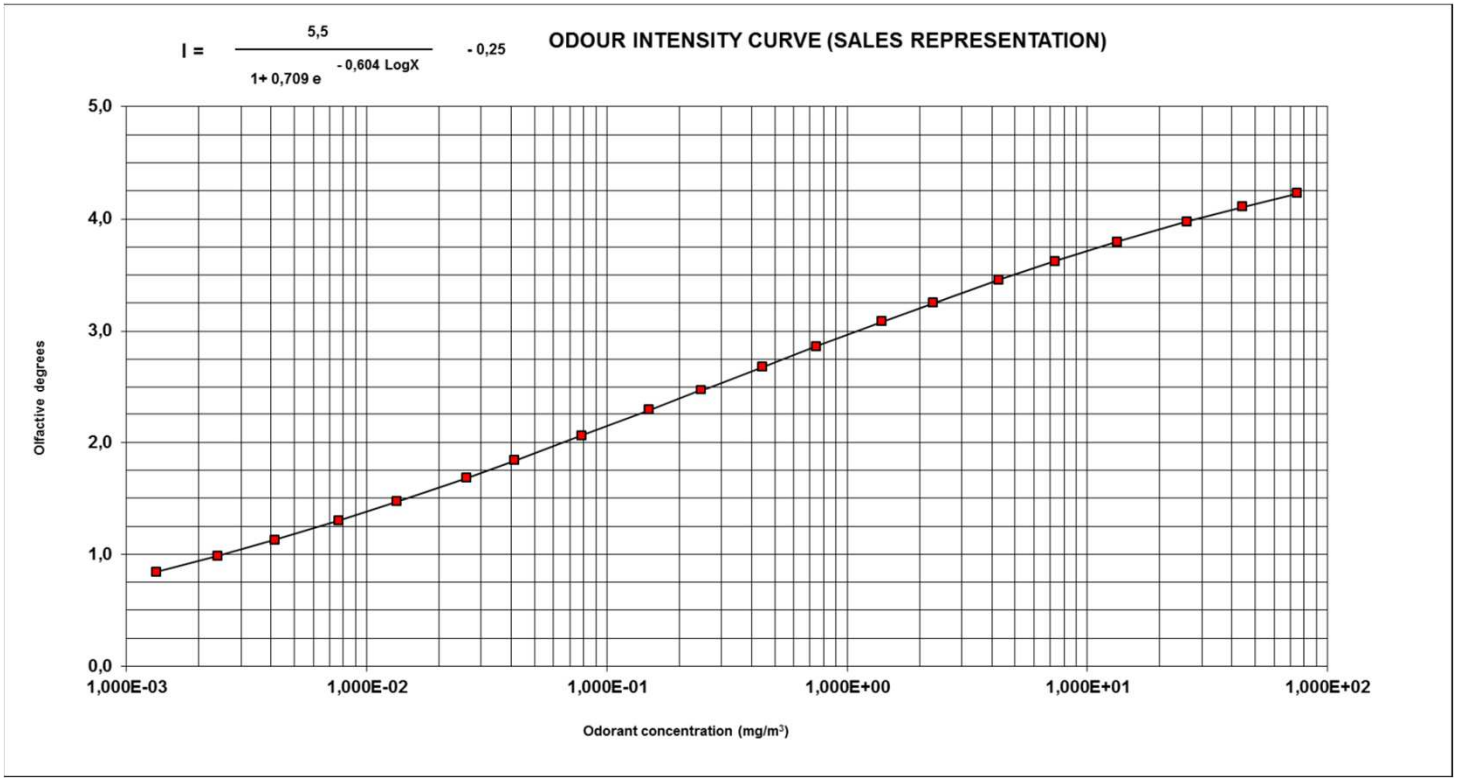
- **The odorant concentration usually is derived from the odor intensity curve of the odorants in air.**



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- **Specific case:**

  In one Country (Italy) the concentrations are stated with olfactory tests on odorant in actual distributed gases, to take into account possible masking effects from the minor components of natural gas, such as natural sulphides or mercaptans which can be present in the Italian gases.

Odorisation controls - Analytical measurements

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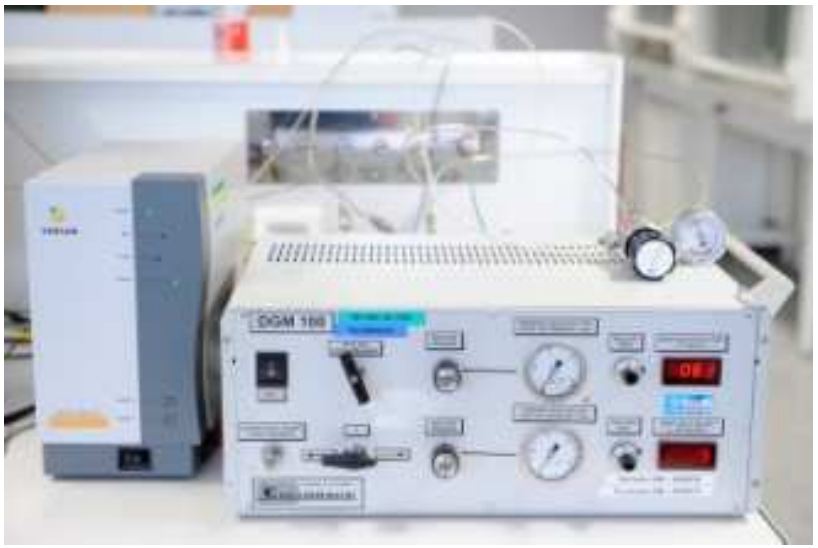
➢ 2 types of analytical measurements

- ➢ GC analyzers
- ➢ Specific sensor



Odorisation controls

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- **GC analyzers are widely used**
- **2 types of GC:**
  - Portable instruments, i.e. microGCs with TCD detector
  - Laboratory instruments:

    Sulphur dedicated GC (detectors dedicated to sulphur analysis, i.e. PFPD/FPD)

Benefits	Drawbacks
Fast (analysis in few minutes)	Limited sensitivity (ppm)
Easy to use and transport outside the laboratory	Limited selectivity (possible interferences)

Benefits	Drawbacks
Selectivity	Non transportable (if not installed to a specific vehicle)
High sensitivity (tens of ppb)	Analysis much longer

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Use of sensors

- Advantages: portable, easy to use, cheap, fast answer
- Drawbacks: little sensitivity and possibility of interferences
- Main use: use as "indicators", time of measurement very fast

Odorisation controls

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- **Usually the controls are performed at the end points of the Distribution pipes.**
- **Sometimes at the entry points of the Distribution grids (City Gate).**
- **Controls at the Transit or Transport grids can be carry out in some cases, when odorant injection is executed before distribution.**

Others issues - Exchange of odorised gas

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- **Some exchange of odorised gas may occur due to local connections between networks. This is known to happen between France and Spain, France and Switzerland, Hungary and Austria, for instance.**

Others issues - Masking effects

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- **Usually no masking effects reported from mixture of different sulphur odorants.**

It is difficult to predict the strength of smell of the mixture.

- **In case of mixtures of Sulphur odorants and Sulfur-free odorants, no public data are available yet**

Need to perform olfactory tests to get knowledges on the behavior of the mixture in terms of odour ?

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➢ Injection of new gases (biomethane) on the grid:

- ➢ New interest on possible masking effects, since the upgrading process may leave some odoriferous trace components, not known by the Gas Industry
- ➢ But no data available yet

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The costs are highly influenced by:

- Configuration of the grid: dimension, shape, consumptions, location of the connections of the customers (usually to the distribution grid; sometimes directly to the transmission grids), etc…
- Type and size of plants and their remote monitoring
- Requested odorant concentrations
- Frequency of the odorisation controls
- Special constraints by law and/or National Authorities

New MARCOGAZ activities

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- **Following recent developments in the Gas Industry, the WG is studying:**
  - Odorisation of small flow grids or small flow gas injection sites (e.g. injection of biomethane, small LNG grid)
  - Odorisation of CNG for vehicles
  - Online odorant concentration measuring system
  - List of international standards and biographical collection of work on Odorisation

Conclusions

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- **Odorisation of distributed gases is required for safety reasons.**
- **Basis of the requirements is that the smell shall be perceived before a given concentration of gas in air.**
- **To obtain this result, different technical approaches are possible.**
- **MARCOGAZ WG Odorisation is collecting data from several EU Countries to share knowledge on the odorisation process.**
- **Information available on the MARCOGAZ website: www.marcogaz.org**

Thank you !

eugenio.salati@italgas.it
amelie.louvat@engie.com
jos.dehaeseleer@marcogaz.org

marcogaz
TECHNICAL ASSOCIATION
OF THE EUROPEAN NATURAL GAS INDUSTRY

Avenue Palmerston 4
1000 Brussels
BELGIUM
T:+32 2 237 11 39
www.marcogaz.org

Annex A - Requirements

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Country	Requirement in olfactory degrees
CZ	Level 3, Table 1, A 3, TPG 918 01
IE	Level 2 Sales
IT	Level 2 Sales (applied only for odorant and gases not included into UNI CIG 7133, otherwise the minimum concentration is applied)
PL	Not specified
PT	Not specified
RO	Level 2 Sales
UK	Level 2 Sales

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Sales scale

Table 1 — Odour intensity and corresponding sensation

Odour intensity olfactory degrees	Sensation
0	No odour
0,5	Very feeble odour (limit of odour perception)
1	Feeble odour
2	Medium odour (alert level)
3	Strong odour
4	Very strong odour
5	Maximum odour (upper limit of perception)

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Odour levels and odour intensities according to VDI 3882-1 (Germany)

0	no odour	
1	very weak odour	threshold intensity
2	weak odour	
3	readily perceptible odour	warning intensity
4	strong odour	
5	very strong odour	
6	maximum odour intensity	no further increase in intensity possible

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The NF X 43-103 scale (France)

0	*No odor*
1	*Very feeble odor*
2	*Feeble odor*
3	
4	*Medium odor*
5	
6	*Strong odor*
7	
8	*Very strong odor*
9	
10	*Maximum odor*

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ISO/CD 18222

Odor intensity (olfactory degrees)	Definition
0	No odour
1	Detection threshold
2	
3	Certainty threshold
4	
5	
6	
7	
8	
9	
10	Terminal threshold

Annex C - Required concentrations of Odorants: THT

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Country	Percent consumption (%)	Minimum concentration (mg/m³)	Maximum concentration (mg/m³)	Typical concentration (mg/m³)
AT	93%	9,0	As required at the endpoint	12-14
BE	-	17	34	20
CH	100%	10	30	15-30
CZ	10%	8	30	12
DE	55 – 70%	10	Not specified	15 – 18
DK	100%	10,5 (at consumer location)	Not specified	11-17
EL	100%	15	35	20
ES	100%	15-trans. 18-dist.	Not specified	22
FR	100%	15	40	25
IT	50%	32	As required at the endpoint	-
NL	100%	10	40	18
NO	100%	12	15	-
PL	100 %	Not specified	Not specified	25
PT	100%	8	40	24
RO	100%	3	30	8
SK	59 %	8 mg/Nm3	40	18

Required concentrations of Odorants: SULPHUR FREE

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Country	Percent consumption (%)	Minimum concentration (mg/m³)	Maximum concentration (mg/m³)	Typical concentration (mg/m³)
AT	2%	8,0	As required at the endpoint	10
CH	<0,1%	8.8	-	12 14
CZ	1%	8	9	8,8
DE	25%	8	Not specified	11 – 15

Required concentrations of Odorants: TBM + DMS

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Country	Percent consumption (%)	Minimum concentration (mg/m³)	Maximum concentration (mg/m³)	Typical concentration (mg/m³)
CZ	89%	5	30	10
IE	100%	3	10	6
UK	100%	5	8	6

Required concentrations of Odorants: TBM + IPM + NPM

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Country	Percent consumption (%)	Minimum concentration (mg/m³)	Maximum concentration (mg/m³)	Typical concentration (mg/m³)
BE	-	5,4	7,1	6
DE	15-17%	3	Not specified	5-8
IT	50%	9,3 (as TBM) 12,2 (total)	As required at the endpoint	-

Odorants

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Odorant	Composition %										%S
	THT Tetra hydro thiophene	**TBM** Tertiary Butyl Mercaptan	**IPM** Isopropyl Mercaptan	**NPM** Normal Propyl Mercaptan	**MES** Methyl Ethyl sulfide	**DMS** Diethyl sulfide	**EM** Ethyl Mercaptan	**EA** Ethyl Acrylate	**MA** Methyl Acrylate	**EMP** 2-Ethyl-3-Methyl pyrazin	
Formula	C_4H_8S	$C_4H_{10}S$	C_3H_8S	C_3H_8S	C_3H_8S	C_2H_6S	C_2H_6S	$C_5H_8O_2$	$C_4H_6O_2$	$C_7H_{10}N_2$	
Molecular weight	88,2	90,2	76,2	76,2	76,2	62,1	62,1	100,1	86,1	122,2	
Sulphur Free								66 %	32 %	2 %	**0,0**
THT+ EA (Ethyl Acrylate)	12 %							88 %			**4,4**
THT+TBM	70 %	30 %									**36,1**
THT	100 %										**36,4**
TBM+IPM+NPM		76 %	16 %	8 %							**37,1**
TBM+MES		80 %			20 %						**36,9**
TBM+DMS (UK+IE)		80 %				20 %					**38,8**
TBM+DMS (CZ)		65 %				35 %					**41,2**
EM							100 %				**51,6**

Odorisation controls: more information

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Country	Kind of requirement (legal or technical regulation, voluntary)	Who does perform the control (third part or not)	Frequency: continuous (CI) or periodical inspection (P)
AT	Legal requirement	Grid operator	yearly
BE	Legal requirement (Royal Decree 28.06.1971)	Third party	P (min./ 3 months)
CH	Technical rules (SVGW G11)	Third party	P (min. 4 times / year)
CZ	Technical rules (TPG 918 01, TPG 905,01)	DSO	P / 6 months
DE	Legal requirement *and* Technical rules (DVGW G 280-1)	Grid operator	P (2 x p.a.) Sometime CI near injection
DK	Regulation (Danish Safety Technology Authority)	Grid Operator	P (2 times per year)

Odorisation controls: more information

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Country	Kind of requirement (legal or technical regulation, voluntary)	Who does perform the control (third part or not)	Frequency: continuous (CI) or periodical inspection (P)
EL	Regulation	DSO	P
ES	Legal (Government)	DSO (CI) and third part (P)	CI P (1/month)
FR	Regulation (Transport) Voluntary (Distribution)	Grid Operator	CI. (Transport) P (Distribution)
HU	Regulation	Third party	CI - P
IE	Technical rules (Code of Operations)	TSO/Third Party	P (Monthly)
IT	Legal (Law 1083/71) *and* Regulation (ARG/Gas 574/13)	Grid operator	6 months

Odorisation controls: more information

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Country	Kind of requirement (legal or technical regulation, voluntary)	Who does perform the control (third part or not)	Frequency: continuous (CI) or periodical inspection (P)
NL	Regulation	Grid operator	P (3 weeks)
NO	Voluntary	Grid operator	P
PL	Technical rules (Dz.U. 2010, No 133, 89 PN-C-04751:2011, PN-C-04753:2011)	DSO and/or grid operator	P (2 weeks) Ci
PT	Voluntary	TSO (O&M Department)	CI and P (monthly)
RO	Technical rules (SR 13406, SR 3317)	Grid operator	P/ 3 monts
SK	Legal requirement (State legislation)	DSO	CI – P, 6-months
UK	Regulation	DSO	CI – P

Sulphur and odorants

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Country	Odorant	Minimum Sulphur concentration (mg/m3) (n)	Maximum Sulphur concentration (mg/m3) (n)	Typical Sulphur concentration (mg/m3) (n)
AT	THT	3,3	-	4,7
BE	THT	6,2	12,4	7,3
BE	TBM+IPM+NPM	2,0	2,6	2,2
CH	THT	3,6	10,9	8,2
CZ	THT	2,9	10,9	4,4
CZ	TBM+DMS	2,1	12,4	4,1
DE	THT	3,6	-	6,0
DE	THT + EA	0,3	-	0,6
DE	TBM+IPM+NPM	1,1	-	2,4
DK	THT	3,8	-	5,1
EL	THT	5,5	12,7	7,3
ES	THT	6,5	-	8,0
FR	THT	5,5	14,5	9,1
HU	THT + TBM	4,7	9,0	5,8
IE	TBM+DMS	1,2	3,9	2,3
IT	THT	12,3	-	14,7
IT	TBM+IPM+NPM	4,8	-	5,8
NL	THT	3,6	14,5	6,5
NO	THT	4,4	5,5	5,2
PL	THT	-	-	9,1
PT	THT	2,9	14,5	8,7