HyDelta

WP2 – Odorisation of Hydrogen

D2.5 – Advice on odorant choice

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Executive summary

This report is part of HyDelta work package 2 “Odorisation”. The research question within this part of the HyDelta program was:
“what is the odour strength and odour characteristic of candidate odorants in hydrogen and how do these relate to the odour characteristic and odour strength in natural gas?”
With the results of this research, the studies that have been done before within this work package and a literature search on foreign experiences, an attempt has been made to provide preliminary advice on a suitable odorant for hydrogen.

The research into the smell of three selected odorants THT, GASODOR® S-free and 2-hexyne, shows that the smell of all three odorants in hydrogen is comparable to the smell in natural gas. This applies to the perceptibility of the odours, the perceived odour strength and the perceived odour characteristics. The same dosage of odorant can be used for hydrogen as is required for natural gas. Based on the findings from the HyDelta program Work Package 2, it is possible to make a choice for an odorant for hydrogen on the short term, but not yet for the long term. The three odorants studied each have specific advantages and disadvantages. Some properties are not yet fully known.
An important consideration will be whether the public recognizes and associates the odour with gas and whether the odour perception will lead to an action, such as turning off the gas supply.

If the use of fuel cell applications should increase strongly and no cleaning is applied just before the fuel cell, the choice of odorant is not yet clear. THT seriously affects the performance of polymer fuel cells, GASODOR® S-free also adversely affects the performance and the influence of 2-hexyne is not yet known. Several properties of 2-hexyne for an odorant have not yet been tested and it has not yet been investigated whether this odorant can be produced in an economical way.

THT seems to be the best choice for the first hydrogen projects in the public gas supply. The main reasons for this are that there is not (yet) an ideal candidate odorant available and also because too much knowledge is still lacking to apply a new sulphur-free odorant.

The most important missing knowledge questions are:
• how do remnants of THT in the network affect the functioning of the new odorant?
• how does the odorant behave when released into the soil after a gas leakage?
• how is the smell perceived by the public?

These questions have already been answered for THT. In addition, the smell of THT is known to the public and the alarming effect of THT has been proven.
In the long term, when fuel cells are widely used, there is a need for an odorant that does not affect the performance of fuel cells, does not cause harmful environmental effects and has a repulsive and characteristic odour.

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1. Introduction

This report is part of HyDelta work package 2 “Odorisation”. The research question that will be answered within this part of the HyDelta program is:
What are the odour strength and odour characteristics of candidate odorants in hydrogen and how do these relate to the odour characteristics and odour strength in natural gas?
These questions will be answered by a test with an odour panel.
An attempt is also being made to make a recommendation for an odorant for hydrogen using the results of HyDelta research already carried out from work package 2 “Odorisation”.
The international experiences are collected by means of a short literature study and concern the application of odorants for natural gas, the switch to another odorant in the gas supply and the first experiences with the odorization of hydrogen.

The results of this analysis as well as the results of the odour panel will be summarized in a semi-quantitative assessment of the relevant aspects for the application of an odorant in hydrogen. This assessment can be used as an aid to identify missing knowledge about odorants and may also be helpful to make a preliminary choice of a hydrogen odorant.

2. Odour testing of three odorants in hydrogen

At the DNV laboratory, Kiwa Technology and DNV performed an odour test with three odorants in hydrogen and in natural gas. The following key questions were relevant:

- what is the smell of the odorant in hydrogen compared to that in natural gas?
- what is the odour strength of the odorant in hydrogen compared to that in natural gas?
- can the odorant in hydrogen be smelled even at low concentrations?

The purpose of these tests is to determine whether a mixture of an odorant in hydrogen has a comparable odour and odour strength as the comparable mixture of an odorant in natural gas. This is important if the same odorant is used in natural gas, and the aim is to approach the recognizability of the familiar and already familiar odour to the public as much as possible. Possible trend differences as a result of the influence of the type of gas (natural gas or hydrogen) on the odour can also be investigated.

By measuring the odorant at two different dilution levels, it can be checked whether the odorous character is preserved at different dilutions of the odorant. This is one of the requirements mentioned in NEN-EN-ISO13734 as a requirement for an odorant in gas [1].

From the experiences of the odour panel it is possible to determine whether the odour is experienced as alarming.

2.1 Preparation of the gas mixtures

For the preparation of the hydrogen/odorant gas mixtures, hydrogen of a high purity (minimum 99.999% by volume) is used and odorant has been added.

For the natural gas mixtures, unodorized G-gas from the Ommen gas station was taken and compressed up to 100 bar in steel cylinders. Analysis of the gas showed that there is 0.41 ppm hydrogen sulphide (H_2S) in this gas. Odorant has been added to this gas.

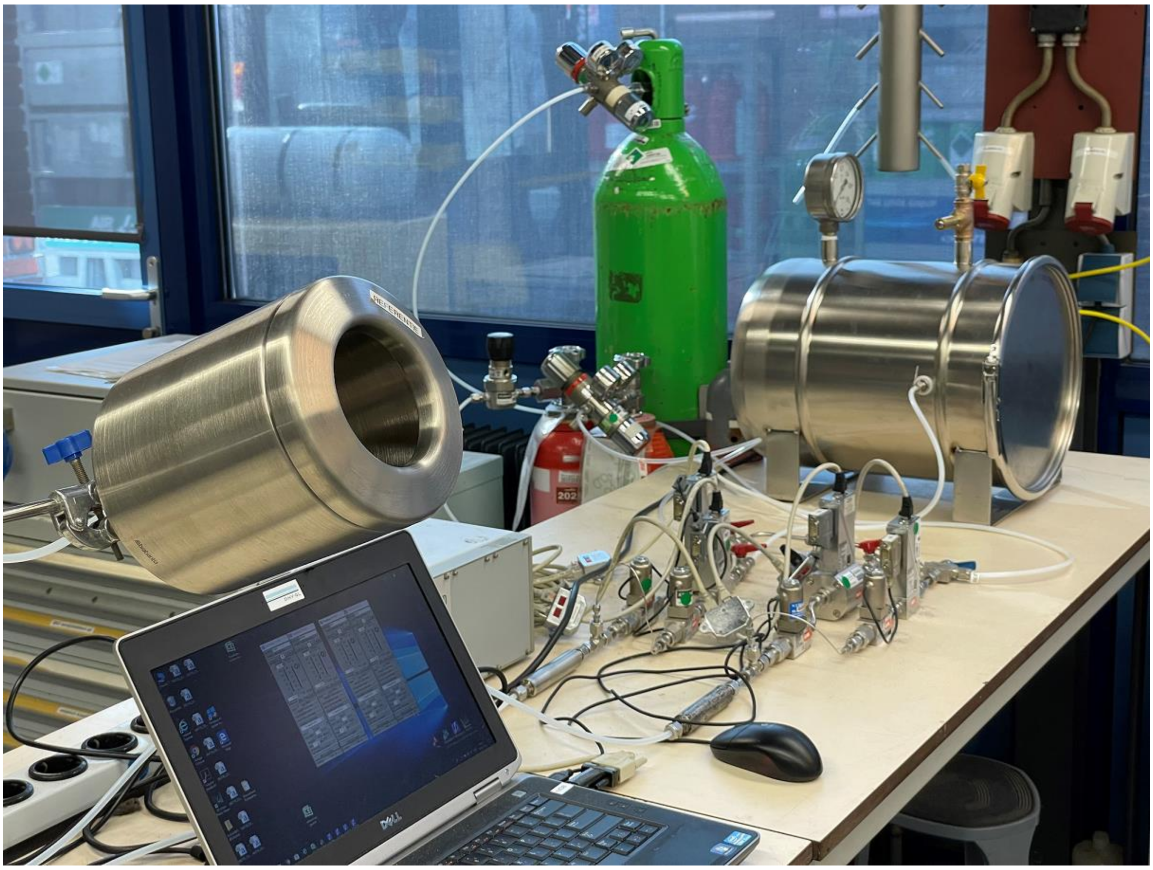
Two of these odorants, Tetrahydrothiophene (THT) and GASODOR® S-free were chosen in determining the scope. In addition, a third odorant (2-hexyn) was selected in the first phase of the HyDelta research WP2: “Odorisation of hydrogen” [2].

For this study, the nominal amount of odorant was measured. This means the guideline value of the odorant.
In practice, the value may vary due to under-odorization, over-odorization or due to possible adsorption of odorant on the pipe wall.
The nominal value for THT is specified in the MR gas quality and is 18 mg/m^3(n) [ref]. GASODOR® S-free is not used in the Netherlands, but it is in Germany. For Germany, the nominal value is defined in DVGW-Arbeitsblatt G 280-1 and is 14 mg/m^3(n) [3].
For 2-hexyn, the nominal value was set at 15 (mg/m^3(n)) in a previous study by comparing the odour strength with that of THT [2].

2.2 Execution of the test

The test was performed with a total of 8 panel members. The panel members have not been tested in advance for their sense of smell, but are all involved in gas technology and are therefore familiar with the smell of natural gas.

Two sniffing funnels are located to each other. An air-diluted natural gas-odorant mixture is presented in one of the funnels and an air-diluted hydrogen-odorant mixture is presented in the other funnel. The ratio of gas to air can be set by means of mass flow controllers.
The panel members do not know which mixture (hydrogen/odorant/air and natural gas/odorant/air) belongs to which funnel, nor do they know which odorant is offered.



Figuur 1: picture of the setup of the odour test

Two dilutions are offered sequentially:

1. A mixture of 1% natural gas or hydrogen in air.
2. A mixture of 0.1% natural gas or hydrogen in air.

The first dilution is equivalent to 20% of the lower explosion (LEL) in air. This is the standard odour test where 99% of people should be able to perceive a smell.

The second dilution is a test to determine whether the odorant can also be smelled at low concentrations in air, namely ten times lower than the 20% LEL limit, and to check whether the odour character is the same at a different dilution.

The panel members can always make a comparison between the two scented beakers. The findings are recorded in a form shown in Table 1.

Table 1: fill-in form for the odour tests

Sample X		Sample Y	
Do you notice a smell?	Yes/No	Do you notice a smell?	Yes/No
How do you describe the smell?		How do you describe the smell?	
How is the odour strength?	Very weak/ weak / good/ strong	How is the odour strength?	Very weak/ weak / good/ strong
Does the smell match Y?			
If not, what is the difference?			

The panel members were called in pairs in total for three times (three odorants at two dilutions) for the odour test. This is to prevent the panel members influencing each other through verbal or non-verbal communication.

The odour strength is specified in the categories very weak, weak, good and strong. The panel members have no reference as to what constitutes a weak or strong odour, but by comparing the two odours smelled in one session, it is possible to verify whether or not the perceived odour strength within one session is judged to be equivalent.

In an attempt to quantify the notion of odour strength, the mean score for the panel members who can perceive an odour is mentioned. 1 point is given for "very weak", 2 points for "weak", 3 points for "good" and 4 for "strong".

2.2 Results

Results are discussed per odorant type.

2.2.1 THT

Table 2 shows the results of THT in natural gas and hydrogen.

Table 2: results 1:100 diluted and 1:1000 diluted THT in natural gas and in hydrogen

	THT in natural gas	**THT in hydrogen**
dilution rate	1:100	1:100
smell perceptible	8x yes (100%)	8x yes (100%)
smell description	5x THT, 2x THT/H_2S, 1x “different”	8x THT
odour strength	2x weak 3x good 3x strong	6x good 2x strong
average odour strength	2.9	3.3
does the smell match?	5x yes	
What is the smell difference?	2x: THT/H_2 a bit stronger 1x THT/NG has sulphur odour	

	THT in natural gas	THT in hydrogen
dilution rate	1:1000	1:1000
smell perceptible	7x yes (87,5%)	7x yes (87.5%)
smell description	6x THT, 1x chemical unpleasant	6x THT, 1x chemical unpleasant
odour strength	1x very weak 3x weak 3x good	1x very weak 2x weak 4x good
average odour strength	2.3	2.4
does the smell match?	2x yes	
What is the smell difference?	2x THT/H_2 weaker 1x THT/H_2 sweater 1x THT/H_2 sharper 2x N/A	

The perceptibility of the odour for THT is complete for 1 in 100 diluted gas. This applies to both THT in natural gas and in hydrogen. For 1 in 1000 diluted gas, the observability is almost complete. One panel member perceives no odour for both THT in natural gas and in hydrogen.
THT is a well-known smell for the panel members. The smell is recognized 7 times in natural gas and 8 times in hydrogen. For natural gas, it is noted twice that there is a hydrogen sulphide odour to the gas. This is consistent with the presence of 0.41 ppm H_2S in the tested natural gas. According to the Ministerial Regulation on gas quality, a maximum of 5 grams of inorganic sulphur compounds is allowed in natural gas [4]. For hydrogen sulphide alone, this would amount to a maximum of 3.5 ppm.
The hydrogen sulphide odour is no longer noticed in the gas that has been diluted 1 in 1000. 6 out of the 8 panel members identify THT as an odour and 1 panel member assesses the odour as “chemically unpleasant” for both THT in natural gas and in hydrogen.

The odour strength for THT in hydrogen is judged to be slightly stronger than in natural gas, but the difference is small. The odour strength in 1000 times diluted gas is judged to be slightly less strong, which is to be expected. The odour strength is assessed equally at this dilution for THT in natural gas and in hydrogen.

<u>Conclusions odour tests THT:</u>
The smell THT is recognized by almost all panel members in both natural gas and hydrogen. The odour strength in 1 in 100 diluted hydrogen is judged to be slightly stronger than for natural gas. The odour character in 1000 times diluted gas is the same for THT in natural gas and for hydrogen.

All in all, virtually no difference has been observed between the odour strength of THT in hydrogen and that in natural gas with regard to perceptibility, odour character, odour strength and odour resistance at dilution. THT can therefore be used as an odorant in hydrogen on the basis of these investigated properties.

2.2.3 GASODOR® S-free

Table 3 shows the results of GASODOR® S-free in natural gas and hydrogen.

Table 3: results 1:100 diluted and 1:1000 diluted GASODOR® S-free in natural gas and in hydrogen

	GASODOR® S-free in natural gas	GASODOR® S-free in hydrogen
dilution rate	1:100	1:100
smell perceptible	8x yes (100%)	8x yes (100%)
smell description	2x Gas odor S-free 1x repellent 1x polyester 1x metallic 3x “don’t know”	2x Gas odor S-free 1x repellent 1x polyester 1x metallic 3x “don’t know”
odour strength	1x weak 2x good 1x good/strong 4x strong	1x weak 1x good 1x good/strong 5x strong
average odour strength	3.4	3.6
does the smell match?	6x yes	
What is the smell difference?	1x THT/H_2 is more stale 1x not comparable	

	GASODOR® S-free in natural gas	GASODOR® S-free in hydrogen
dilution rate	1:1000	1:1000
smell perceptible	8x yes (100%)	8x yes (100%)
smell description	2x GASODOR® S-free 1x chemical 1x macaroon 1x stale 3x “don’t know”	2x Gas odor S-free 1x chemical 1x macaroon 1x stale 3x “don’t know”
odour strength	3x very weak 3x weak 2x good	2x very weak 4x weak 2x good
average odour strength	1.9	2
does the smell match?	6x yes	
What is the smell difference?	1x Sfree/H_2 stronger 1 x not comparable	

The perceptibility of the odour for GASODOR® S-free is complete for 100 diluted gas. This applies to GASODOR® S-free in natural gas as well as in hydrogen. The observability is also complete for 1 in 1000 diluted gas.

GASODOR® S-free is professionally known to some of the panel members and this odour is recognized by 2 panel members. Furthermore, the characteristics are called “repelling”, “polyester” and “metallic”. 3 panel members cannot name the smell. About half of the panel members recognize the smell or find it repulsive. Given the small number of panel members, it is difficult to draw conclusions from this, but the desired odorant function of alarming has only been partially observed in this panel. This seems inherent to the type of odorant and this applies to both GASODOR® S-free in natural gas and in hydrogen. This will be further explained in chapter 3.

For 1 in 1000 diluted gas, the names are slightly different and the term "repellent" is no longer mentioned. There is, however, full agreement between the designations of the odour characteristic of GASODOR® S-free in hydrogen and natural gas. The odour strength for GASODOR® S-free in hydrogen is almost equal to that in natural gas. The odour strength in 1000 times diluted gas is judged to be less strong, which is to be expected. The odour strength is equally assessed at this dilution for GASODOR® S-free in natural gas and in hydrogen.

Conclusions odour tests GASODOR® S-free :
The odour GASODOR® S-free is recognized by 2 panel members. About half of the panel members recognize the smell or find it repulsive. The other panel members have various other names for the odour in both natural gas and hydrogen, but the names are the same for GASODOR® S-free in natural gas and in hydrogen.
The odour strength and odour character are equally assessed for GASODOR® S-free in natural gas and in hydrogen. The name of the odour is slightly different for 1 in 1000 diluted gas than for 1 in 1000 diluted gas. However, the names given to the odour are the same for natural gas and hydrogen for 1 in 1000 diluted hydrogen.
The function of the odorant GASODOR® S-free in hydrogen is equivalent to GASODOR® S-free in natural gas.

2.2.4 2-hexyne

Table 4 shows the results of 2-hexyne in natural gas and hydrogen.

Table 4: results 1:100 diluted and 1:1000 dilutes 2-hexyne in natural gas and in hydrogen

	2-hexyne in natural gas	2-hexyne in natural gas
dilution rate	1:100	1:100
smell perceptible	8x yes (100%)	8 x yes (100%)
smell description	2x THT, 1x hexyne, 1x polyester glue, 1x burning, 1x pungent 2x “don’t know”	1x THT, 1x hexyne, 1x fruity, 1x polyester glue, 1x burning, 1x alarming, 1x pungent, 1x “don’t know”
odour strength	1x very weak 1x weak 1x good 4x good/strong 1x strong	1x very weak 6x good 1x good/strong
average odour strength	3	2.8
does the smell match?	3x yes	
What is the smell difference?	3x hexyne/H_2 stronger 1x hexyne natural gas has sulphur odour 1x hexyne/H_2 more artificial	

	2-hexyne in natural gas	2-hexyne in hydrogen
dilution rate	1:1000	1:1000
smell perceptible	6x yes (75%)	6x yes (75%)
smell description	1x THT 1x polyester glue 1x pungent 1x sharp 1x annoying 1x “don’t know”	1x THT 1x alarming 1x pungent 1x reluctant 1x polyester glue 1x “don’t know”
odour strength	3x very weak 3x weak	1x very weak 5x weak
average odour strength	1.5	1.8
does the smell match?	4x yes	
What is the smell difference?	2x hexyne/H_2 weaker	

The odour is perceptible to all panel members at 1 in 100 dilution. At a 1 in 1000 dilution, two panel members no longer perceive the odour.

The odour is associated with THT by 2 (for natural gas) and 1 panel member (for hydrogen) respectively. In this respect the alarm function is therefore sufficient. This also applies to the names penetrant and 1 panel member who is familiar with the odour of 2-hexyn and names it as such. All in all, half of all odour names can be associated with a degree of alarm.

For 1 in 1000 diluted gas, 2 panel members can no longer perceive the odour. Before a possible introduction of this odorant, experiments with a larger panel would have to be done to show whether this indicates a coincidence or whether this is a systematic trend.
The odour names change at 1 in 1000 diluted gas, but in 3 out of 8 panel members, names such as pungent, alarming THT and repellent are still mentioned, all of which can be associated with an alarming effect. Odour strength is logically judged to be weaker for 1 in 1000 diluted gas, but the strength is approximately the same for 2-hexyne in natural gas as in hydrogen. It is striking that three

panel members believe that 2-hexyne in hydrogen (diluted 1 in 1000) smells slightly stronger, while the average odour strength rating indicates a fractionally lower odour strength.

At 1 in 1000 diluted gas it is mentioned twice that 2-hexyne in hydrogen has a weaker odour than 2-hexyne in natural gas, while the average indication of the odour strength indicates a fractionally stronger odour.

Conclusions odour tests 2-hexyne:
Half of the panel members associate the smell with some degree of alarm. This applies to both natural gas and hydrogen. In this respect, this odorant scores no worse than the THT and GASODOR® S-free odorants, which are already being used in several countries as odorants for natural gas distribution. The results of the odour tests give rise to some doubts whether the odour can be properly detected even at a higher degree of dilution. This should be verified using a larger panel.
In terms of odour properties, 2-hexyne in hydrogen behaves similar to 2-hexyne in natural gas.

3. Experiences with choosing an odorant

This chapter describes experiences with the choice of an odorant when switching to another type of odorant. With regard to the choice of an odorant for hydrogen, only the choice that has been made in the United Kingdom for demonstration projects in the built environment is known.

3.1 Odorants in Europa

The association "Marcogaz" has conducted a survey among its members on the practice of odorization in the various countries [5].
In terms of odorant choice, THT is the most widely used odorant in Europe. In Spain, France, the Netherlands, Switzerland, Portugal, Greece, Norway and Poland, almost all gas in the public gas supply is odorized with THT.
THT is the most commonly used odorant in Germany, Austria, Belgium, Denmark and Slovakia. In Italy 40% of natural gas is odorized with THT.
In Romania, the natural gas is odorized with ethyl mercaptan. This odorant is also used to give a scent to LPG. LPG is a mixture of mainly propane and butane. In the United Kingdom, a mixture of tertiary butyl mercaptan and dimethyl sulphide is used. In the Czech Republic, a mixture of tertiary butyl mercaptan and dimethyl sulphide is mainly used.
The above odorants are all sulphurous. The sulphur-free odorant GASODOR® S-free is used in Germany for 21% of the distributed gas. In Austria, Switzerland and the Czech Republic GASODOR® S-free is used for a very small part of the gas supply.

3.2 The perception of an odorant

Research by the former GDF Suez among 2,000 people gives a good picture of how a scent is experienced by the public. A total of three scents were presented via a scent card, whereby the scent is released after rubbing [6].
In the first instance, no context was given and the respondents do not know what the aim of the research is. The first question is what is the first association related to the smell.
The panel was then asked whether the smell evokes a sense of danger and, if so, how great this feeling is on a scale of 1 to 10.
Then they were asked whether they wanted to assign the smell to one of the following seven categories: gas, rotten eggs, paint, burning smell, petrol tar and garlic. Several categories could be mentioned.
The main outcome was that of the three odorant scents studied (THT, tertiary butyl mercaptan (TBM) and GASODOR® S-free), THT was identified most directly with a gas odour, namely 43% of the panel. For TPM this was 28% and for GASODOR® S-free it was 17%. In this context it is relevant that in France THT is used as an odorant and this may explain the differences between them, but nevertheless THT is not directly associated with gas by the majority of the panel either.

The second research question concerns the degree of danger that the odour evokes. Two trends emerge from this:
• the degree of danger is perceived as higher when the smell is the first to evoke 'gas' by a respondent and can in that case be called high for all types of odorant;
• THT is most associated with danger, hereafter TBM and then GASODOR® S-free.

An initial association with gas is therefore essential to achieve a high level of alarm followed by action. The results are summarized in Table 5.

Table 5: rating of an odorant on the association danger (1 to 10)

odorant	average	At 1st association with gas	others
THT	7,3	8,7	5,9
TBM	6,4	8,5	5,2
GASODOR® S-free	5,3	7,9	4,6

The "guided association", meaning that panel members are allowed to identify the odour in seven categories, gives a somewhat higher response to the association "gas" than to the free association. The results are shown in the spider diagram (Figure 2).

The conclusions that can be drawn from this are that THT is first associated with gas in the guided association. For TBM this is less and TBM is also highly associated with rotten eggs. GASODOR® S-free is the least associated with gas of the three odorants in the guided association,. For GASODOR® S-free, garlic, burning smell, paint and gasoline are also often mentioned.

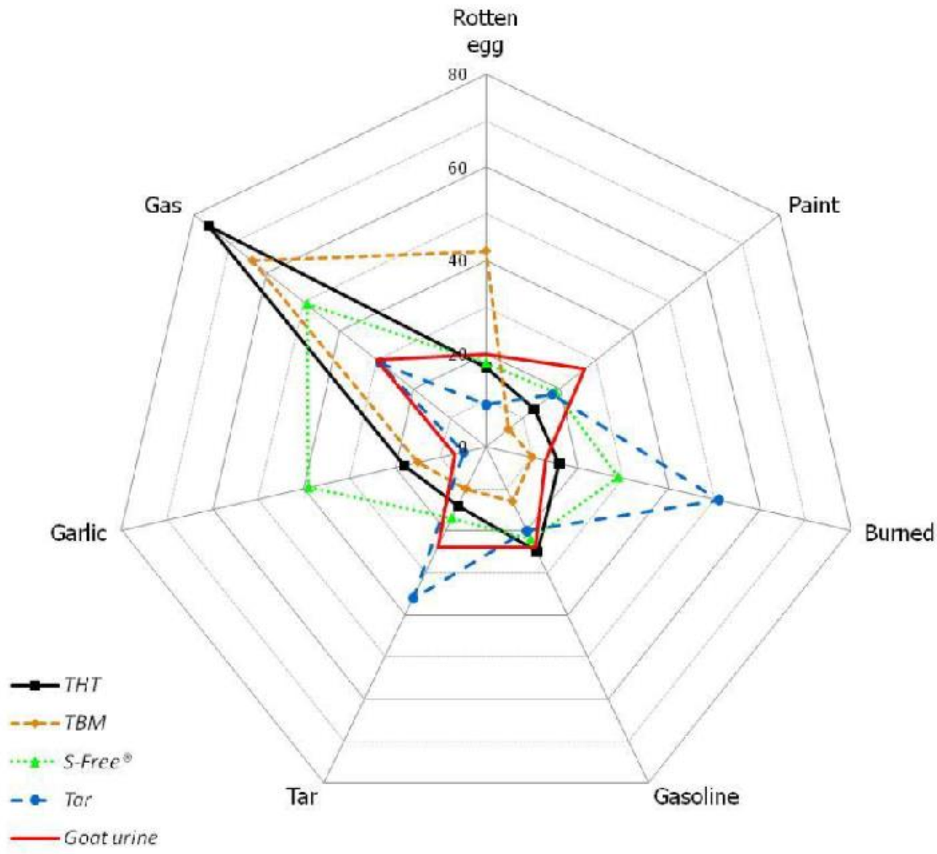


Figure 2: response to a guided association of odours (the presented odours "tar" and "goat urine" are not discussed further here)

When the question is then asked whether the odour is associated with "certainty", "probably", "probably not" or "certainly not" with gas, the same trend can be seen. It is striking that also for THT 16% of the panel members say that the smell is certainly not gas. This may be because the panel members themselves do not have a natural gas connection. This is quite common in France.

It is also possible that the panel members have never been in contact with the smell of natural gas. This background information is not mentioned in the publication of the study. It is also striking that 45% of the panel members do not associate the smell GASODOR® S-free with gas, even after a guided questioning.

For an overview of the results of the conducted association of the gas odour, see Table 6.

Table 6: guided association of the odour with gas smell

Degree of certainty	THT	TBM	GASODOR® S-free
certainly	55	55	21
probably	28	28	32
probably not	5	10	15
certainly not	11	15	30

3.3 Experiences with a change of odorant

In Germany, the odorant GASODOR® S-free has been abandoned in some gas supply areas. This has not been published but this has been communicated within GERG, the European gas research group. The reason given for this was that the smell of GASODOR® S-free is often associated with paint smell.

GASODOR® S-free was introduced in Germany at the time to reduce sulphur oxide emissions. The research of GDF Suez (see section 3.2) shows that GASODOR® S-free is associated by many people with other odours including paint smell [6].

This indicates that the introduction of a new type of odorant that is not based on sulphur-containing compounds, a broad investigation into the odour experience is essential.

3.4 Experiences with choosing a hydrogen odorant

In England the choice has been made for the type of odorant that is already known, namely the odorant NB (mixture of tertiary butyl mercaptan and dimethyl sulphide). One of the reasons is that there is certainty about a good response (an alert, followed by an action) from the public to a gas leak. When using a different odorant, the question is what this response will be [7].

In the Hy4Heat report “Hydrogen odorant” the odorant NB is recommended with the justification that it is effective and not harmful to gas pipes and combustion appliances [8]. In addition, it is the cheapest option for odorization. If fuel cells are used in bulk, the choice of odorant should be reconsidered as NB contains sulphur, although cleaning (polishing) for the fuel cell is also an option. A more detailed description of the choice can be found in the HyDelta report 2.4 “The risk of not odorising hydrogen” [9].

3. The choice of an odorant for hydrogen

The choice of an odorant for hydrogen can be taken on several grounds:

• intrinsic requirements for an odorant such as: stability, odour resistance upon dilution, toxicity;
• familiarity with the smell;
• association with danger;
• environmental aspects (emissions);
• harmfulness to combustion applications;
• harmfulness to fuel cells;
• cost.

The HyDelta study on odorants has investigated a number of the above mentioned aspects. Not all questions on the aspects have been answered in the study.

For example, report 2.3 recommended testing the effect of temperature increase due to gas expansion for the odorant 2-hexyne. It is also not clear for 2-hexyne whether it will be available at an acceptable price level. For ordering small quantities, 2-hexyne is very expensive (about €6 to €7 per gram). It is possible that scaling up to a large production unit can lead to lower prices [10].

The studies of GDF Suez as well as the experiences in Germany and also the small panel trial described in this report cast doubt on the suitability of GASODOR® S-free as an odorant based on its association with other odours.

At the moment there is not enough information to give an advice about an odorant. When no fuel cell applications are used, THT is recommended as an odorant for the time being. No fuel cells have yet been provided for the first hydrogen projects in the public gas supply. When fuel cells are used, either a cleaning unit will have to be placed in front of the fuel cell, or a sulphur-free odorant will have to be used, which has been shown to have no adverse effect on the polymeric fuel cell.

There are also questions about the following aspects:
• how do remnants of THT in the network affect the functioning of the new odorant?
• how does the odorant behave when released into the soil after a gas leak?
• how is the smell perceived by the public?

In Table 7 below, the current knowledge of odorants has been converted into a semi-quantitative assessment:

Table 7: semi-quantitative review of three odorants

Eigenschap	THT	GASODOR® S-free	2-hexyn
stability in hydrogen	++	++	+
odour strength in hydrogen	++	++	++
alarming	+	-	+
familiar with the smell	+	-	0
environmental aspects	--	+	+
burning applications	++	++	++
polymer fuel cells (PEM FC)	--	-	?
Cost	+	+	--

4. Conclusions

The research into the smell of three selected odorants THT, GASODOR® S-free and 2-hexyne, shows that the smell of all three odorants in
hydrogen is comparable to the smell in natural gas. This applies to the perceptibility of the odour, the perceived odour strength and the perceived odour characteristic.

There is doubt about the alarming function of GASODOR® S-free. This doubt applies to the use of this odorant in natural gas as well as in hydrogen. In the panel test, this type of odorant is relatively often associated with other odours that do not immediately trigger an action in the event of a gas leak. This doubt is confirmed by an earlier large-scale odour test by GDF Suez among 2000 panel members.

Based on the findings from the HyDelta program Work Package 2, it is not yet possible to make a choice for an odorant for the long term.
Each odorant evaluated in this study has pros and cons, and an ideal candidate is not yet available.
An important consideration will be whether the public recognizes and associates the odour with gas and whether the odour perception will lead to an action, such as closing the gas supply.

For THT, the odorant that is already known to the public, the alarming effect has been proven and if fuel cells are not used or are only used very sporadically in the public gas supply, this seems to be the logical choice for the first hydrogen projects.

References

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