Position Paper

December 2025

Hydrogen Quality Standardisation

Chemical Industry Views

We urge standardisation bodies to deliver on the mandate of the revised Gas Directive and facilitate the transport of 'hydrogen of a high grade purity taking into account hydrogen end-users' quality requirements' for safe, reliable and environmentally responsible operations. **We consider a hydrogen purity level ≥ 99.9%-mol to deliver on that mandate and cost-optimally facilitate the hydrogen economy across the value chain.**

Feedstock use dominates the hydrogen consumption in the chemical industry – and is highly sensitive to even low concentrations of contaminants and variations in quality. Its volumes are an essential part of the hydrogen economy. It deserves dedicated attention.

Hydrogen quality – supplied within well-defined bands for trace contaminants - is not a technical detail, but a fundamental determinant of whether renewable and low-carbon hydrogen can and will be used to reduce emissions the chemical sector[1]. On the path to climate neutrality the importance of hydrogen for our sector, both as energy and as a feedstock, is expected to increase. The chemical industry is already the third largest consumer of hydrogen today, after refining and fertilisers.

Low-purity specifications will undermine the hydrogen economy: Where lower specifications do not meet the needs of off-takers, they necessitate additional investments in hydrogen purification assets at end-user level and raise operating costs. The associated cost and resulting permitting implications may well deter consumers from connecting to the backbone – and thus locking-in on-site fossil hydrogen production. Without these additional volumes, the transport costs for the remaining users may rise.

We urge policy makers to:

1. **Adopt a minimum hydrogen purity standard of ≥ 99.9 mol-% in the EU hydrogen backbone to facilitate the development of the EU hydrogen economy.** Include strict limitations on specific contaminants that cause degradation of process catalysts or present process safety or environmental hazards.
    a. This specification ensures that the total concentration of non-hydrogen compounds, including inert gases and hydrocarbons, does not exceed 0.1 %. As outlined below, this standard presents a balanced solution addressing technical feasibility and requirements of industrial users, while also supporting economic efficiency.
2. **Safeguard the hydrogen quality in existing networks**.
    a. Individual processes may require higher purity and/ or other process conditions still[2]. It is important that these processes can continue to be supplied via dedicated pipelines.

[1] The Carbon Managers - Modelling possible pathways for the EU chemical sector's transition towards climate-neutrality and circularity with iC2050.

[2] These include, but are not limited to: aniline, peroxide, propylene-oxide, polyethylene and butanol.

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Proposed Cefic hydrogen quality and process specification

Based on a preliminary analysis the of the hydrogen quality specifications applicable to a variety of chemical processes, including those for the production of aniline, butanol, butanediol (BDO), hydrogen-peroxide, propylene-oxide and polyethylene, alcohols, solvents, and ammonia, amongst others, we propose the hydrogen specification as listed in **table 1** below.

We point in particular to the parameters for catalysts poisons such as CO, O_2, total sulphur and halogens which are lower than those suggested by previous studies on the subject. For instance, DNV[3,4] developed two comprehensive studies on the subject of hydrogen network quality optimisation, commissioned by the Dutch Ministry of Economic Affairs and Climate Policy – but suggested higher value for each contaminant.

Similarly, a recent study commissioned by the European Commission[5] and conducted by a consortium of LBST-DBI-DNV-Trinomics outlines a spectrum of quality parameters, grouped into three sets of specifications. **Even at the highest specification included in the study (99.97%), we notice that individual contaminant thresholds are set beyond what some feedstock applications in the chemical industry can tolerate**. The difference between Cefic's proposal and those thresholds identified in the Commission's study may be explained by the differences in the consulted stakeholders. For setting a robust quality level, though, we emphasise that **a comprehensive mapping of current and future stakeholder needs is an indispensable precondition.**

In the table below, we have included the quality specifications of the >99.5 mol-% scenario of the LBST-DBI-DNV-Trinomics study commissioned by the European Commission as a reference scenario, as that scenario emerged as cost-optimal within their work.

Furthermore, additional contaminants related to the production methods of hydrogen, such as mercury, MEA/DEA (from CO_2 removal) and lubricants (from hydrogen compression), were missing from the LBST-DBI-DNV-Trinomics specifications and have been added in Cefic's proposal.

Table 1: Proposed Cefic hydrogen quality and process specification for European hydrogen transport networks at the exit point.

Parameter	**Units**	**Cefic proposal**	**LBST-DBI-DNV-Trinomics 2025**
Hydrogen	mol%	≥ 99.9	> 99.5
Inerts (N2, Ar, He)	mol%	≤ 0.01	< 0.5
Hydrocarbons, including CH4	mol%	≤ 0.001	< 0.5
Water - dewpoint	molppm	≤ 5	-8 at 70 bar
Oxygen	molppm	≤ 0.1	≤ 10
Carbon Dioxide	molppm	≤ 0.1	≤ 20
Total S content (incl. H2S)	molppm	Concentration below the detection limit (0)	≤ 3

[3] Kwaliteitseisen voor waterstof t.b.v. het transportnet, DNV KIWA, Report No. ESNL.10332299, Rev. 0, 25-May-2022

[4] A follow-up study into the hydrogen quality requirements, DNV, 28-Aug-2023

[5] Study on hydrogen quality in dedicated infrastructure and standardisation - Publications Office of the EU

Halogen compounds	molppb	Concentration below the detection limit (0)	≤ 50
Carbon Monoxide	molppm	≤ 0.1	≤ 20
Ammonia	molppm	≤ 1	≤ 10
Temperature (entry)	°C	5 - 40	
Temperature (exit)	°C	Ambient to 40	

Additional parameters, not featured in the work of DNV:

Mercury	wtppm	≤ 0.05	
MEA/DEA	wtppm	≤ 0.1	
Oil	wtppm	≤ 1	
Arsenic	molppm	Concentration below the detection limit (0)	
Phosphorus	molppm	Concentration below the detection limit (0)	

Background

Hydrogen purity of ≥ 99.9 mol-% is both technically feasible and economically desirable. Previous comprehensive studies by DNV[6,7] point in a similar direction.

DNV's first study (2022) found a system-wide cost-optimum at 99.9 mol-% - but resorted to recommending 98 mol-% over fears that the higher purity was not technically feasible in the short-term. The lower figure reflected concerns around the possible presence of trace hydrocarbons, as well as contaminants such as sulphur, mercury and others in repurposed natural gas pipelines. Operators of salt caverns raised similar concerns.

A 2023 update to the study later found that these concerns may have been overstated. The updated study suggested that re-purposed natural gas pipelines and salt caverns could in-fact support purity levels of at least 99.5 mol-%. The Commission's LBST-DBI-DNV-Trinomics points in a similar direction.

There are reasons to believe that still higher purity levels are technically feasible in the short-term in re-purposed transport and salt cavern storage assets. Research performed on the only known use case, in which an existing 12 km natural gas pipeline was converted to low-purity (70 vol% H_2) hydrogen[8], indicates that a relatively simple combination of pipeline pigging and repeated nitrogen purge quickly reduced hydrocarbon contaminants and water concentrations well below the requirements. More sophisticated cleaning techniques could be developed and applied to further eliminate concerns and instil trust for hydrogen network operators to accept higher purity specifications.

Experience with existing salt caverns for hydrogen storage suggests the same. Beaumont, Texas and Moss Bluff, Texas, feature two of only a handful of operational salt caverns for hydrogen storage. Both caverns have been purposely designed and leached for hydrogen storage and dryer units guarantee that

[6] Kwaliteitseisen voor waterstof t.b.v. het transportnet, DNV KIWA, Report No. ESNL.10332299, Rev. 0, 25-May-2022

7 A follow-up study into the hydrogen quality requirements, DNV, 28-Aug-2023

[8] "Conversion of a natural gas pipeline to hydrogen transport and the effects of impurities on the hydrogen quality", Gas Analysis 2022, 11th International Gas Analysis Symposium & Exhibition, 17-20 May 2022, Paris, France.

water is removed from the hydrogen product exiting the cavern. Based on feedback from hydrogen off-takers in the region, the hydrogen meets the ≥ 99.95% product specification of the connected networks.

The purity standard the EU sets today ought to guide investments and avoid stranded assets. A successive upgrading of standards risks investments in stranded assets for purification that can be avoided by setting a single, high level of purity in the backbone.

Preventing quality variability is an important aspect of safety in industrial processes. In certain chemical processes, such as methane chlorination, high hydrogen purity is essential for maintaining safety. Shares of blended hydrogen possible reacting with chlorine could undermine safety standards. This is particularly problematic when the quality of hydrogen varies, making technical adaptations more difficult. A stable purity level at the exit point at ≥ 99.9 mol-% therefore helps ensure safe operations.

Purification should prioritise stable hydrogen quality at the exit point. That contributes to a more cost-effective and streamlined hydrogen supply system. It avoids the loss of value from blending high-purity hydrogen into a lower-purity grid and ensures that contamination is cost-effectively addressed, regardless of its source (storage, transport, backflows of odorised hydrogen from the distribution level,…). Namely, efficiency gains are greatest when hydrogen is purified at the source, where large-scale processing enables better optimisation and lower unit costs. Conversely, site-specific purification requires establishing tailor-made solutions for each end-user depending on the setup of their facility, the integrated cluster and permit allowances.

Benefits for fuel purpose. Burning high purity hydrogen also improves the efficiency of the combustion process and lower the emissions of other components (like SOx, NOx, etc.).

Promote access to high purity hydrogen through public grids. The EU Gas Package puts limits on capacity and network extensions for existing private networks – possibly raising a barrier to accessing high purity hydrogen for consumers not already connected to a private network and unable to purify on-site.

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About Cefic
Cefic, the European Chemical Industry Council, founded
in 1972, is the voice of large, medium and small chemical companies across Europe, which provide 1.2 million jobs and account for 15% of world chemicals production.