

# CO<sub>2</sub> Quality Specification



# 1. Introduction

Establishing an open access CO<sub>2</sub> transmission infrastructure relies on effective coordination among all stakeholders throughout the value chain, from Injection Site to sequestration or utilisation sites. A fundamental element of this collaboration is the clear definition of the CO<sub>2</sub> quality to be transported via the vapor pipeline network.

To promote a unified approach across the value chain, this document presents a CO<sub>2</sub> Specification for transmission of CO<sub>2</sub> by Fluxys c-grid Antwerp.

The development of this CO<sub>2</sub> quality specification has been guided by several key considerations:

- **Network integrity:** Ensuring the safe and efficient transport of CO<sub>2</sub> by pipeline without compromising the system's integrity. Preserving the integrity of the entire value chain is crucial, and well-defined CO<sub>2</sub> specification plays a vital role in strengthening carbon capture and storage (CCS) reliability.
- **Interoperability:** Actively participating in the creation of future systems and infrastructures, with the aim of establishing a unified CO<sub>2</sub> baseline, supporting the development of a single European CO<sub>2</sub> market.
- **Operational safety:** Identifying and managing both direct and indirect risks to people and the environment, ensuring safe operations at all stages.

This document and the specifications herein supersede the Antwerp@C specification for the Gaseous CO<sub>2</sub> specification dated October 2023 published on Port of Antwerp Bruges website.

## 2. Disclaimer

The specification for CO<sub>2</sub> presented in this document is reflecting the best knowledge available at the moment of the publication. This quality specification may be subject to evolution based on internal and external research, requirements or decisions by regional government or regulatory bodies, and European CO<sub>2</sub> quality standards initiatives. The information contained in this document reflects common work of Fluxys group as infrastructure operator, together with partners on the capture-to sequestration logistic chains solutions.

The CO<sub>2</sub> specification is publicly disclosed for information purposes only and on a strict non-reliance basis. Fluxys c-grid Antwerp undertake any commitment or liability whatsoever with respect to the publication of this specification.

### 3. CO<sub>2</sub> operating conditions

CO<sub>2</sub> operating conditions refer to the conditions at which the Network User delivers its CO<sub>2</sub> for transport. CO<sub>2</sub> will be injected into the Local CO<sub>2</sub> Network at the Connection Point at the CO<sub>2</sub> Injection Station.

The pressure operating conditions are outlined in Fluxys c-grid Antwerp Connection Agreement Schedule 3 - Technical Requirements for CO<sub>2</sub> Injection Stations. The document provides guidance for connecting CO<sub>2</sub> Injection Stations to the Local CO<sub>2</sub> Network, including the minimum requirements for the Network User's metering and safeguarding systems.

The operating conditions for temperature at the Connection Point:

Temperature setpoints	
Maximum Acceptable Operating Temperature	40 °C
Minimum Acceptable Operating Temperature	10 °C

### 4. CO<sub>2</sub> quality specification

Following the initial release of the CO<sub>2</sub> Gaseous specification, Fluxys c-grid Antwerp has continued to advance in the development of CO<sub>2</sub> quality standards in consultation with all relevant stakeholders.

Throughout this process, Fluxys c-grid Antwerp has engaged extensively with prospective Network Users of the Local CO<sub>2</sub> Network, both in one-to-one discussions as in group sessions. Fluxys c-grid Antwerp had particular attention on ensuring interoperability with Adjacent CO<sub>2</sub> Networks, recognising its importance for a robust and accessible infrastructure. In addition, Fluxys group and its partners have carried out a comprehensive laboratory test programme to further create a reliable system.

Each Network User is individually responsible for supplying CO<sub>2</sub> that meets at all times the required specifications across all parameters. This responsibility is essential to maintain open access and reliable operation for all Network Users.

The Network User shall inform Fluxys c-grid Antwerp of any impurities which are expressly listed in the specification and expected to be present in its CO<sub>2</sub> stream up to the allowed thresholds. Furthermore, the Network User is required to specify any components believed to be present in the CO<sub>2</sub> stream that are not expressly included in the specification. Once these components are identified, they will be subject to a risk assessment and evaluated in collaboration with all stakeholders in the value chain.

The CO<sub>2</sub> quality specification for transmission is set out in the following table and applies at every point where CO<sub>2</sub> enters and leaves the network. The specification is designed for CO<sub>2</sub> transport in vapor phase and will continue to evolve as new research and testing results become available.

The CO<sub>2</sub> specification listed is based on laboratory testing with limited residence time.

## The Fluxys c-grid Antwerp CO<sub>2</sub> vapor specification

Category	Component	Unit	Requirement	
<b>Purity</b>	<b>CO<sub>2</sub></b>	<b>% mol</b>	<b>≥ 98 <sup>(1)</sup></b>	
<b>Non-condensables</b>	<b>H<sub>2</sub></b>	<b>% mol</b>	<b>≤ 0.75</b>	Sum ≤ 2
	<b>N<sub>2</sub></b>	<b>% mol</b>	<b>≤ 2</b>	
	<b>Ar</b>	<b>% mol</b>	<b>≤ 0.4</b>	
	<b>CH<sub>4</sub></b>	<b>% mol</b>	<b>≤ 0.15</b>	
	<b>CO</b>	<b>ppm mol</b>	<b>≤ 100</b>	
<b>Reactive and polar components</b>	<b>O<sub>2</sub> <sup>(2)</sup></b>	<b>ppm mol</b>	<b>≤ 10</b>	S <sub>tot</sub> <sup>(3)</sup> ≤ 4,5
	<b>H<sub>2</sub>S</b>	<b>ppm mol</b>	<b>≤ 0.5</b>	
	<b>SO<sub>3</sub></b>	<b>ppm mol</b>	<b>≤ 0.1</b>	
	<b>SO<sub>x</sub></b>	<b>ppm mol</b>	<b>≤ 4</b>	
	<b>NO<sub>x</sub> <sup>(4)</sup></b>	<b>ppm mol</b>	<b>≤ 1.35</b>	
	<b>H<sub>2</sub>O <sup>(5)</sup></b>	<b>ppm mol</b>	<b>≤ 30</b>	
	Ethanol	ppm mol	≤ 0,94	
	Methanol <sup>(6)</sup>	ppm mol	≤ 70	
	HCN	ppm mol	≤ 20	
	NH <sub>3</sub>	ppm mol	≤ 3	
	Total amine compounds	ppm mol	≤ 1	
	Glycol	ppm mol	≤ 0.15 (MEG); ≤ 0.15 (TEG)	
	Acetic Acid	ppm mol	≤ 1	
	Ethylene (C2)	ppm mol	≤ 45	
<b>Organic compounds</b>	<b>Ethane (C2) <sup>(7)</sup></b>	<b>ppm mol</b>	<b>≤ 330</b>	Sum ≤ 9,6 (VOC)
	C3+ (hydrocarbons) with below sublimits	ppm mol	≤ 1010	
	<b>Propane (C3)</b>	<b>ppm mol</b>	<b>≤ 1010</b>	
	<b>Butanes-Pentanes (C4-C5)</b>	<b>ppm mol</b>	<b>≤ 750</b>	
	Hexanes-Heptanes (C6-C7)	ppm mol	≤ 69	
	Octanes-Nonanes(C8-C9)	ppm mol	≤ 7,4	
	Methyl acetate	ppm mol		
	Acetone	ppm mol		
	Hexanal	ppm mol		
	Diethyl ether	ppm mol		
	Acetonitrile	ppm mol		
	1,2,4-Trimethylbenzene	ppm mol	≤ 4,5	
	1-Propanol	ppm mol	≤ 0,9	
2-Butanol	ppm mol	≤ 0,9		
BTEX <sup>(8)</sup>	ppm mol	≤ 0,1		
Formaldehyde + Acetaldehyde	ppm mol	≤ 10		
<b>Solids</b>	Mercury (Hg)	ppb mol	≤ 0.06 equivalent to 0.5 µg/Nm <sup>3</sup>	
	Full removal cut-off diameter <sup>(9)</sup>	µm	≤ 3.8 mg/Nm <sup>3</sup> max. diameter 10µm	
	<b>Dew point</b>		<b>≤ -10 °C at 20 barg (Gas phase)</b>	
<b>Legend:</b>				
ppm: parts per million				
ppb: parts per billion				
µm: micrometer				
<sup>(1)</sup> Subject to further alignment along the value chain				
<sup>(2)</sup> Volumes, originating from within the Antwerp Local Network physically going the A@C Terminal, value remains temporary at 40ppm. Subject to gather experimental data to further align between 40 and 10ppm.				
<sup>(3)</sup> S <sub>tot</sub> : Total sulphur means all components containing sulphur. Subject to further alignment along the value chain				
<sup>(4)</sup> NO <sub>x</sub> : The sum of 50% NO and NO <sub>2</sub>				
<sup>(5)</sup> Volumes, originating from within the Antwerp Local Network physically going the A@C Terminal, value remains temporary at 50ppm. Subject to gather experimental data to further align between 50 and 30ppm.				
<sup>(6)</sup> Values up to 125ppm temporary after startup and shutdown are accepted				
<sup>(7)</sup> Values up to 1050ppm temporary during operational upsets and with limited outages, are accepted on a case-by-case evaluation				
<sup>(8)</sup> BTEX: Benzene, Toluene, Ethylbenzene, Xylene				
<sup>(9)</sup> Full removal cut-off diameter shall not exceed 1µm for 50wt%, 5µm for 95wt% and 10µm for 99 wt%. Subject to further alignment along the value chain				
Other impurities that are not present in the table should be risk evaluated on a case-by-case basis				
Impurities highlighted in bold will be measured online by Fluxys c-grid Antwerp. The Network User will perform online measurement on the impurities in bold as a <u>minimum requirement</u> , pending his choice he can measure online on more components.				