

About CO₂ specifications

CO₂ specifications are vital in the CCS industry due to safety and integrity of the infrastructure, regulatory compliance, monitoring, and measurement of abated volumes for carbon credit/certificates and financial transactions. Hence, knowing impurities within the CO₂ is a critical aspect of safe operations. As the CCS industry have picked up the pace over the past few years, new understanding of risks and uncertainties associated with impurities is acquired, both through testing and studies. The EU Commission also underlines in their recently published Industrial Carbon Management Strategy that standards on CO₂ are needed.

Based on new insight and associated risk and uncertainties the CO₂ specifications in Northern Lights existing infrastructure have been revisited. Specific areas have been acknowledged where impurities can have a negative impact on the integrity of the infrastructure, which is built and will be ready for receiving CO₂ in 2024. Additionally, the allowable impurities in the CO₂ have been expanded to allow additional customer segments to enter the Northern Lights value chain. The updated Northern Lights JV DA CO₂ specification considers the following aspects:

01

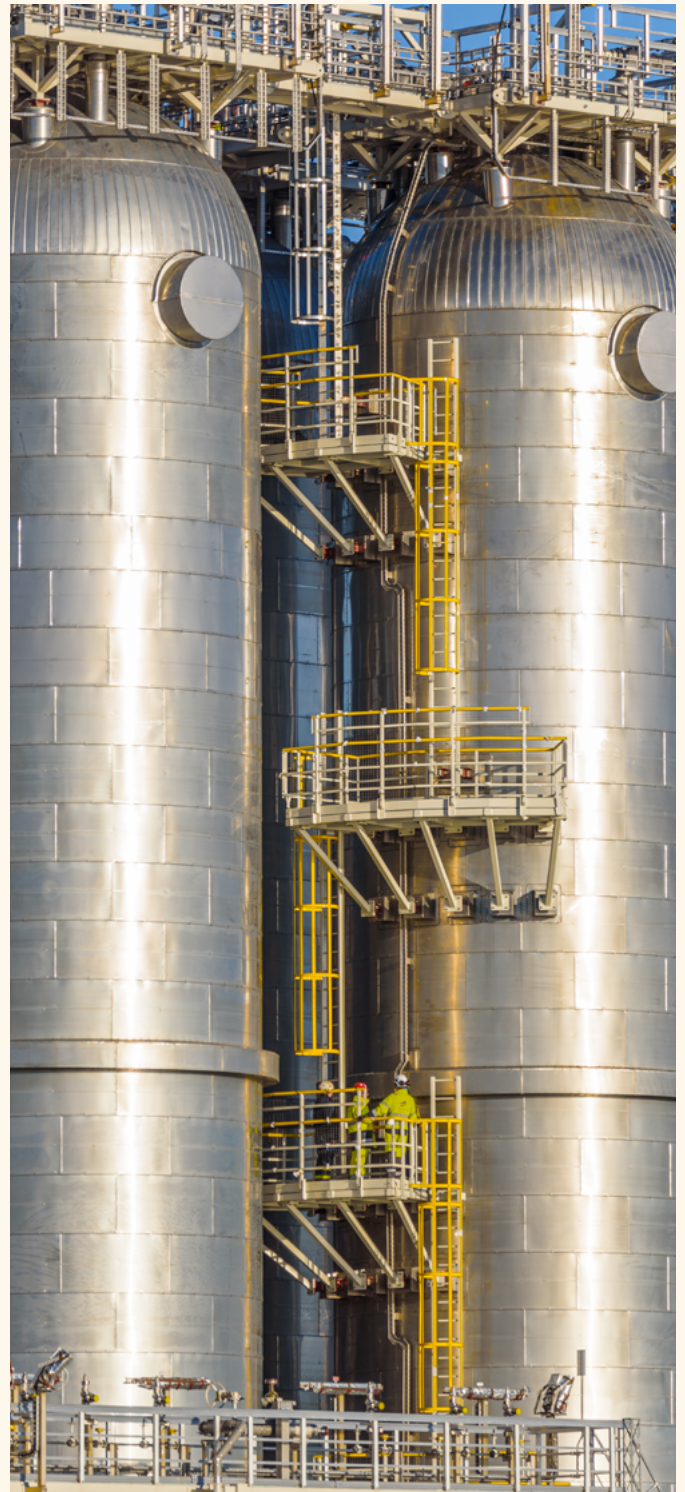
New insight into cross reactions between existing and new components and development of corrosive fluids

02

Northern Lights existing design and infrastructure versus the tolerance and impact of corrosive fluids

03

Portfolio of customers and need to expand allowable impurities to expand industry segments



Statement from DNV



The CO₂ product specification for the Northern Lights JV DA has been developed by a task force, led by DNV, and with contribution from subject matter experts from DNV, Northern Lights JV DA and the owner companies (Equinor, Shell and TotalEnergies). The limits defined are based on state-of-the-art knowledge from the latest research findings, publicly available industry knowledge and expertise from Northern Lights JV DA owner companies and DNV. The CO₂ specification is updated to ensure material integrity, operability, health, safety, and environment considerations for the customers and Northern Lights JV DA value chain (temporary storage, ships, onshore and offshore facilities).

Liquid CO₂ (LCO₂) Quality Specifications

Component	Unit	Limit for CO ₂ Cargo within Reference Conditions ¹	
Carbon Dioxide (CO ₂)	mol-%	Balance (Minimum 99.81%)	
Water (H ₂ O)	ppm-mol	≤ 30	
Oxygen (O ₂)	ppm-mol	≤ 10	
Sulphur Oxides (SO _x)	ppm-mol	≤ 10	
Nitrogen Oxides (NO _x)	ppm-mol	≤ 1.5	Updated component
Hydrogen Sulfide (H ₂ S)	ppm-mol	≤ 9	
Amine	ppm-mol	≤ 10	
Ammonia (NH ₃)	ppm-mol	≤ 10	
Formaldehyde (CH ₂ O)	ppm-mol	≤ 20	
Acetaldehyde (CH ₃ CHO)	ppm-mol	≤ 20	
Mercury (Hg)	ppm-mol	≤ 0.0003	Updated component
Carbon Monoxide (CO)	ppm-mol	≤ 100	
Hydrogen (H ₂)	ppm-mol	≤ 50	
Cadmium (Cd), Thallium (Tl)	ppm-mol	Sum ≤ 0.03	Moved to solids
Methane (CH ₄)	ppm-mol	≤ 100	
Nitrogen (N ₂)	ppm-mol	≤ 50	
Argon (Ar)	ppm-mol	≤ 100	
Methanol (CH ₃ OH)	ppm-mol	≤ 30	New component
Ethanol (C ₂ H ₅ OH)	ppm-mol	≤ 1	
Total Volatile Organic Compounds (VOC) ²	ppm-mol	≤ 10	
Mono-Ethylene Glycol (MEG)	ppm-mol	≤ 0.005	
Tri-Ethylene Glycol (TEG)	ppm-mol	Not allowed	
BTEX ³	ppm-mol	≤ 0.5	
Ethylene (C ₂ H ₄)	ppm-mol	≤ 0.5	
Hydrogen Cyanide (HCN)	ppm-mol	≤ 100	
Aliphatic Hydrocarbons (C ₃ +) ⁴	ppm-mol	≤ 1,100	
Ethane (C ₂ H ₆)	ppm-mol	≤ 75	
Solids, particles, dust	Micro-meter (µm)	≤ 1	

1) Reference Conditions means, with respect to vapour above the liquified CO₂ in a storage tank, a pressure range from 13 bar(g) to 15 bar(g) and the corresponding temperature range of approximately from -26.5 degree Celsius to -30.5 degree Celsius, respectively. If the vapour above the liquified CO₂ is within Reference Conditions, both the liquified CO₂ and the CO₂ vapour in all pressure-connected storage tanks shall be deemed to be within Reference Conditions.

2) Total Volatile Organic Compounds (VOC) in addition to the ones listed separately in this specification, i.e., Ethanol, Methanol, Formaldehyde, Acetaldehyde, and BTEX, and includes the following components: 1-propanol < 1 ppm-mol, 2-butanol < 1 ppm-mol, 1,2,4-trimethylbenzene < 5 ppm-mol, Methyl acetate < 10 ppm-mol, Acetone < 10 ppm-mol, Hexanal < 10 ppm-mol, Diethyl ether < 10 ppm-mol, and Acetonitrile < 10 ppm-mol. Other VOCs are not allowed

3) BTEX refers to the following chemical compounds: Benzene, Toluene, Ethylbenzene and Xylene.

4) Total amount of hydrocarbons not to exceed 1,100 ppm-mol. Individual limits for groups of HCs: C3 < 1,100 ppm-mol, C4-C5 < 815 ppm-mol, C6-C7 < 75 ppm-mol, C8-C9 < 8 ppm-mol. C10+ not allowed.