# Example of $CO_2$ Product Specifications

*Table 1: Examples CO2 Product Specifications across projects in North America, Europe and the United Kingdom*

| Parameter | Unit | Alberta Carbon Trunk Line (ACTL) [a 1] | Kinder Morgan [b 2] | EU's DYNAMIS Project [3] | Northern Endurance Partnership Network [4] | Porthos[5] | Northern Lights [c 6] |
|---|---|---|---|---|---|---|---|
| Transportation Method | | Pipeline | Pipeline | Pipeline | Pipeline | Pipeline | Ship & Pipeline |
| Pipeline Location | | Canada | USA | Europe | UK | Netherlands | Norway |
| Project Status | | Operating | Operating | Recommended Limit (not a pipeline operator) | Under Development | Under Development | Operating |
| Final use of $CO_2$ | | EOR | EOR | Not specified | Offshore storage | Offshore storage | Offshore storage |
| $CO_2$ Source | | Pre-Combustion $CO_2$ | Natural $CO_2$ | Pre-combustion $CO_2$ | Pre-combustion & Post Combustion $CO_2$ | All sources of $CO_2$ | All sources of $CO_2$ |
| $CO_2$ Phase | | Supercritical/Dense phase | | | | Gaseous phase | Liquid phase |
| $CO_2$ | mol % | ≥95 | ≥ 95 | >95.5 | ≥96 | ≥ 95 | ≥99.81 |
| $H_2$ | mol % | <1[d] | ≤ 4 | <4 (All non-condensable gases) | ≤0.75 | 0.75[d] | ≤0.005 |
| $N_2$ | mol % | <1[d] | | | ≤ 4 (Combined limit)[e] | ≤ 2.4[d] | ≤0.005 |
| Ar | mol % | <1[d] | | | | ≤0.4[d] | ≤0.001 |
| $CH_4$ | mol % | <1[d] | | <4 for aquifer <2 for EOR | | ≤1[d] | ≤0.001 |
| CO | mol% | 1[d] | — | 0.2 | ≤0.1 | ≤0.075[d] | ≤0.01 |
| $O_2$ | ppmv | <1000 | | 100-1000[f] | ≤10 | ≤40[d] | ≤10 |
| | ppmw | | ≤ 10 | — | — | — | — |
| $H_2O$ | lbs/mmscf | ≤10 | ≤ 30[g] | — | — | — | — |
| | ppmv | | | <500 | ≤50 | ≤ 70 | ≤30.0 |
| $NO_x$ | ppmv | <100 | — | <100 | ≤5 | ≤5 | ≤1.5 |
| $SO_x$ | ppmv | <100 | — | <100 | ≤10 | Total sulfur containing compounds[h] ≤20 ppmv Of which H2S ≤ 5 ppmv | ≤10 |
| $H_2S$ | ppmv | ≤ 10 | ≤ 20 | 200 | ≤ 5 | | ≤9 |
| Total Sulphur | ppmv | ≤ 16 | | — | — | | — |
| | ppmw | | ≤ 35 | | | | |
| Hydrocarbons (HCs) | mol% | ≤ 2[i] | ≤ 5[i] | — | * | | ≤0.11[j] |
| $NH_3$ | lbs/mmscf | ≤ 3 | — | — | — | — | — |
| | ppmv | | | | ≤10 | ≤ 3 | ≤10 |
| Amines | lbs/mmscf | ≤ 3 | — | — | — | — | — |
| | ppmv | | | | ≤1 | ≤ 1 | ≤10 |
| Glycol | lbs/mmscf | ≤ 3 | | — | | | Not allowed[m] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | gal/mmscf | | ≤ 0.3 [k] | | | Dew point specification[l] | |
| | ppmv | | | | ≤1 | | |
| Methanol | lbs/mmscf | ≤ 3 | — | — | ≤350 ppmv cumulative methanol and ethanol (ethanol ≤50 ppmv) | ≤ 620 | ≤30 |
| Ethanol | ppmv | — | — | — | | ≤ 20 | ≤1 |
| Mercury | ppbv | <100 | — | — | ≤ 2.5 | — | ≤0.3 |
| Particulates | µm | No solid particles | — | — | — | — | ≤1 |
| Formaldehyde | ppmv | — | — | — | ≤20 | ≤10 for total aldehydes | ≤20 |
| Acetaldehyde | ppmv | — | — | — | ≤20 | | ≤20 |
| Cadmium | ppmv | — | — | — | ≤0.005 | — | Included in limit for solids |
| Thallium | ppmv | — | — | — | ≤0.012 | — | |

[a] The $CO_2$ shall be delivered at 17,926 kPag (2,600 psig) and less than 40 °C (104 °F), with no free liquids including lube oils or glycol. The ACTL limits for $SO_x$ and $NO_x$ reads as "Less than 100 ppm for $SO_x$ or $NO_x$ by volume," and the Knowledge Centre's interpretation of this is that the limit applies to each component. This observation is similar to that provided for $NH_3$, amines, glycol and methanol.

[b] $CO_2$ product temperature should not exceed 120 °F and pressure not less than 1300 psig.

[c] A pressure range from 13 bar(g) to 15 bar(g) and a corresponding temperature range of approximately -26.5 ° C to -30.5 ° C. If the vapor above the liquified $CO_2$ is within the reference conditions, both the liquid $CO_2$ and the $CO_2$ vapor in all pressure-connected storage tanks shall be deemed to be within the reference conditions. The reference conditions are with respect to vapor above the liquified $CO_2$ in a storage tank.

[d] For non-condensable components ($N_2$, $O_2$, $H_2$, $CH_4$, CO and Ar), the total amount should be limited to less than 4 mol%.

[e] Cumulative limit for inert gases and non-condensable limit (including light hydrocarbons). For total aliphatic hydrocarbons (C2 to C10) ≤ 1200 ppmv; aromatic hydrocarbons (C6-C10, including benzene, toluene, ethylbenzene, xylene (BTEX), limit is ≤0.1 ppmv; Total volatile organic compounds (excluding CH4, total aliphatic HC (C2-C10), methanol, ethanol and aldehydes) ≤ 10 ppmv, Total carboxylic acid and amide compounds ≤ 1 ppmv; Total phosphorous containing compounds ≤1 ppmv;

[f] For EOR applications.

[g] Contains no free water, value for water in the vapor phase.

[h] Sulfur containing compounds —carbonyl sulfide (COS), dimethyl sulfide (DMS), H2S, SOx, mercaptans

[i] Dewpoint not to exceed -20 °F (-7 °C).

* Heavy hydrocarbons should not shift the dew point below that of pure CO2 (e.g. n-C4: ≤0.25 mol%, n-C6: 250 ppmv, n-C10: 5 ppmv)

[j] 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.

[k] At no time shall such glycol be present in a liquid state at the pressure and temperature conditions of the pipeline.

[l] Dew point limit value measurements (for all liquids, i.e for complete CO2 composition) < -10 C (at 20 bara).

[m] Specifically for triethylene glycol (TEG), for monoethylene glycol (MEG) ≤ 0.005 ppmv [6].

Conversion from mol % to ppmv is by a factor of ×10,000

[1] "Alberta Carbon Trunk Line project : knowledge sharing report, 2021," 2021. Accessed: Jan. 08, 2024. [Online]. Available: https://open.alberta.ca/dataset/675aa1b2-64a9-4539-9e22-1a2ff78d2029/resource/f8acc319-abbd-44e4-9984-729a13a5db0a/download/energy-actl-knowledge-sharing-2020-detailed-report.pdf

[1] K. Havens, "CO2 Transportation Indiana Center for Coal Technology Research Discussion Topics," 2008. Accessed: Nov. 07, 2024. [Online]. Available: https://www.purdue.edu/discoverypark/energy/assets/pdfs/cctr/presentations/Havens-CCTR-June08.pdf

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[1] "Northern Endurance Partnership." Accessed: Apr. 01, 2025. [Online]. Available: https://northernendurancepartnership.co.uk/

[1] "Project - Porthos." Accessed: Apr. 03, 2025. [Online]. Available: https://www.porthosco2.nl/en/project/

[1] "Webinar on updated CO2 specifications for the Northern Lights value chain - Northern Lights." Accessed: Nov. 13, 2024. [Online]. Available: https://norlights.com/news/webinar-on-updated-co2-specifications-for-the-northern-lights-value-chain/