TOXICITY OF CO_2

Although CO_2 is a constituent of air (around 385 ppm), exposure to high CO_2 concentrations can lead to asphyxiation, similar as for inert gases and intoxication.

- Asphyxiation is a condition of severely deficient supply of oxygen to the body that arises from being incapable of normal respiration. Asphyxia is usually characterized by air hunger, but the urge to breathe is triggered by rising carbon dioxide levels in the blood rather than diminishing oxygen levels;
- The toxic effects of CO_2 are due to the influence it has on the pH of the blood and thereby effecting the respiratory, cardiovascular and central nervous systems. Thus CO_2 exposure can give rise to a variety of effects, including an increase in inhalation and heart rate, in blood pressure and it can induce cardiovascular effects. The absence of an effective remedial action will lead to unconsciousness, brain damage or death.

For health and safety issues the DYNAMIS project defined impurity specifications for potentially harmful components like CO and H_2S, based on their relative health impact compared to pure CO_2 in case of a release to atmosphere.

In other words the level of impurities shall not have a more harmful effect on people's health compared to pure CO_2 as long as remaining below the values given in Table 2. When comparing these numbers to the data in Table 1 it appears that pre-treatment may only be required for oxy-fuel capture units, due to too high levels of NO_x and SO_x. Pre- and post-combustion capture streams show impurity levels below the limits set by the DYNAMIS project.

In Table 3 the health risks of the most common impurities of the CO_2 stream are given and the Material Safety Data Sheets (MSDS) of these components are attached to this report.

Table 2: DYNAMIS CO_2 quality recommendations.

Component	**Concentration**
H_2O	500 ppm
H_2S	200 ppm
CO	2000 ppm
O_2	Aquifer < 4 vol%, EOR 100 – 1000 ppm
CH_4	Aquifer < 4 vol%, EOR < 2 vol%
N_2	< 4 vol % (all non condensable gases)
Ar	< 4 vol % (all non condensable gases)
H_2	< 4 vol % (all non condensable gases)
SO_x	100 ppm
NO_x	100 ppm
CO_2	>95.5 %

Table 3: Risks of most common impurities in CO_2 streams.

Compound	Health risks
CO	Influence on blood and nervous system which could lead to respiration disturbances and brain damage. Higher concentrations could lead to respiration disturbances, damage to the hart and vascular system, unconsciousness, seizures and death.
N_2	Difficulty in breathing and in serious cases unconsciousness.
O_2	None.
Ar	Difficulty in breathing and in serious cases unconsciousness.
CH_4	Could induce a suffocating effect.
H_2	Could induce a suffocating effect.
NO_2	Irritating for eyes, nose and respiration system, could cause a lung edema, lowering of the blood pressure and in serious case even death. Prolonged/repeating exposure could induce methaemoglobine formation and affection to the lungs.
SO_2	Corrosive for eyes, skin and respiratory system, may cause lung edema and death.
H_2S	Irritating for eyes, nose and respiration system. Could cause a lung edema, fatigue, convulsions, psychical disturbances, paralysis of the nervous system and death.

The maximum exposure limit of CO_2 depends on the exposure time: a higher CO_2 concentration has got a lower maximum exposure time. The safety study assesses the acute effects of CO_2 to determine the possibility of fatalities and does not consider injuries or the possible long-term effects of CO_2exposure. The time to death is dependent on the concentration and exposure duration as well as the health conditions of a person. The methodology used to determine the number of fatalities from a case of CO_2 exposure is described in reference 1.

Table 4: CO_2 concentrations used for the consequence and risk calculations

Concentration (ppm)	Type of value	Reference
27,500	Alarm value, below this value no serious harm on humans is expected.	Publication of the VROM Inspection: Intervention values dangerous goods 2006.
50,000	LC01 (Lethal Concentration 01), 1 % of the humans exposed for 30 minutes are expected to die.	Tebodin probit relation.
100,000	LC100 (Lethal concentration 100), 100% of the humans exposed for 30 minutes are expected to die.	Tebodin probit relation.

Figure 6 depicts the Tebodin probit relation, which was developed by Tebodin for Shell, for the CO_2underground storage project at Barendrecht, The Netherlands.

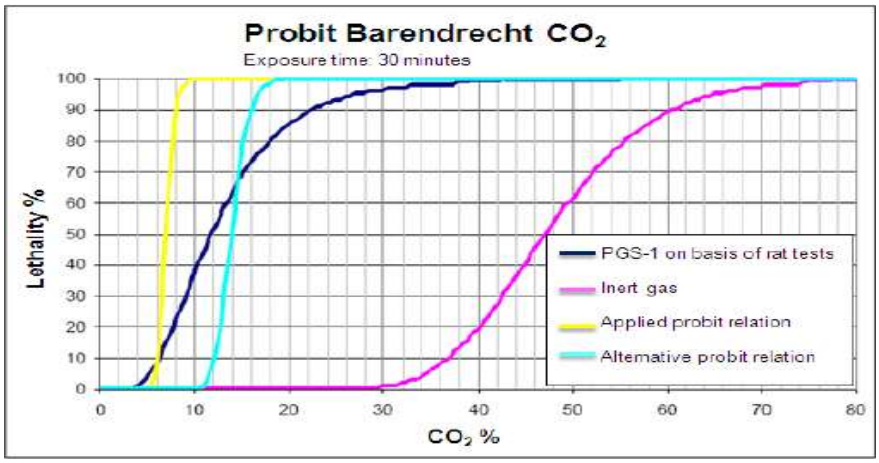

Figure 6: Tebodin probit relation

Source: http://hub.globalccsinstitute.com/publications/co2-liquid-logistics-shipping-concept-llsc-safety-health-and-environment-she-report/33