Protocol for using dry ice (frozen carbon dioxide) in the animal rooms at BOZO

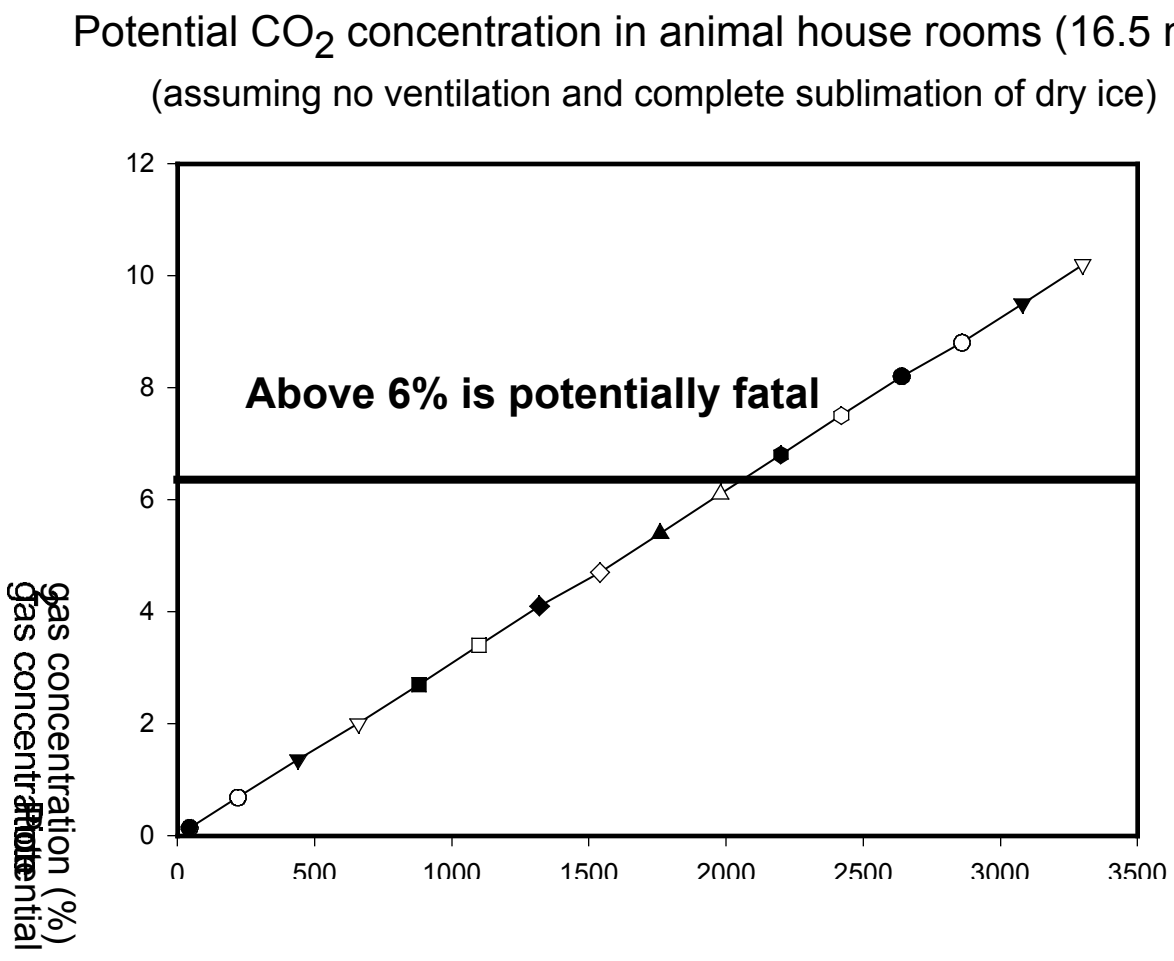
Ian Wallis (June 3, 2002)

Personnel must be aware that using dry ice in enclosed places is dangerous. For example, the CO_2 gas emanating from a small esky containing 3 kg of dry ice is potentially fatal. Moreover, CO_2 sublimes at -78°C so gas concentrations can build quickly. Making oneself aware of the danger and taking simple precautions can make the use of dry ice much safer.

Required information

1. **Know how much CO_2 you are using and the volume of the air it dissipates into**. Weigh the CO_2 you intend using (grams) and convert the value to moles (one mole of CO_2 weighs 44 g). Calculate the volume of the room in litres. Each of the animal rooms is approximately 16.5 m^3 or 16,500 litres.

2. **Calculate the potential concentration of CO_2 if all of the dry ice vapourises and if there is no room ventilation.** One mole or 44 g of dry ice produces 22.4 litres of CO_2 gas. The following graph and table show the potential concentration of CO_2 in the animal rooms (3 x 2.5 x 2.2 m^3) if the air is not replenished.



3. **Be aware of the dangers imposed by different concentrations of CO_2.** The natural concentration of CO_2 in the air is approximately 0.03 %. Little danger is imposed by concentrations of even 100 times this amount, ie 3%. However, be aware that the concentration builds quickly as shown by the table below and the figure above. A person exposed to concentrations of 7 % or 70,000 ppm for just a few minutes may lapse into unconsciousness with little or no warning. Such concentrations are easily reached if a small esky (ca 6 L) of dry ice is left in an unventilated space the size of the animal rooms (16,500 L or 2,600 times larger than the esky).

   Because it is heavier than air, CO_2 replaces air in poorly ventilated spaces resulting in a lowering of the oxygen concentration. Thus, CO_2 is a simple asphyxiant (ie it precludes access to oxygen) and induces conditions like headaches, dizziness, shortness of breath, drowsiness, nausea and eventually unconsciousness.

CO_2 used (g)	**CO_2 used (Moles)**	**CO_2 gas (L)**	**CO_2 gas (% in 16,500 L room)**	**Danger**
44	1	22.4	0.14	No danger
220	5	112	0.68	
440	10	135	1.36	
660	15	336	2.0	
880	20	448	2.7	
1100	25	560	3.4	
1320	30	672	4.1	Some danger
1540	35	784	4.7	
1760	40	896	5.4	
1980	45	1008	6.1	Potentially fatal
2200	50	1120	6.8	
2420	55	1232	7.5	Fatal with a few minutes exposure
2640	60	1344	8.2	Fatal with a few minutes exposure
2860	65	1456	8.8	Fatal with a few minutes exposure
3080	70	1568	9.5	Fatal with a few minutes exposure
3300	75	1680	10.2	Fatal with a few minutes exposure

Precautions

1. Use as little CO_2 as possible.
2. Know the danger that this imposes in the given environment.
3. Do not store dry ice in an unventilated room or in a room with animals.
4. Place warning signs on all entrances to rooms containing dry ice and keep doors locked.
5. Ventilate rooms by leaving doors open for several minutes before entering rooms that contained dry ice in the past 12 hours.
6. If the calculated maximum potential concentration of CO_2 in a room exceeds 3 % or 30,000 ppm then two people must be present upon opening the room if the door has been closed for more than 5 hours.
7. **Never carry dry ice in a car**. Doing so is not only extremely dangerous but it is also illegal in many institutions, like ANU. The exception is a vehicle, like a utility, where the dry ice can be separated from the passenger compartment. Note that the boots of many cars are not separate compartments.

Attachment: safety information. See also http://bozo-server.anu.edu.au/chemgold/
