Example of Oxygen Depletion Calculations

Nitrogen is the main component of air and is present at approximately 78% by volume, the other major components being oxygen, approximately 21% and argon, approximately 1%. Depletion of the concentration of oxygen can have an effect on life. An atmosphere containing less than 18% oxygen is potentially hazardous and entry into areas with atmospheres less than 20% oxygen is not recommended. Asphyxiation due to low oxygen concentrations is often rapid and with no prior warning.

If you are using liquid nitrogen or non-hazardous compressed gases (DG class 2.2) in cylinders, you should be aware of the potential for oxygen depletion in the work or storage area. This can be calculated, typically assuming that all power to ventilation systems has failed (eg in a fire or a blackout) and a sudden spillage of liquid nitrogen or release of gas.

Resulting Oxygen Concentration (%):

$$\%O2 = 100 \text{ X } \frac{0.2095 \text{ x } (\text{Vr} - \text{Vg})}{\text{Vr}}$$

Vr = room volume (m^3)

Vg = maximum gas release (m^3)

A G size cylinder of an inert gas contains approximately 6-8 m^3 of gas. For liquefied gases, the expansion ratios are – N_2 678, Ar 824, He739, ie 1 L of liquid nitrogen produces 678 L of or 0.678 m^3 of gas.

A typical laboratory in the School of Chemistry is approximately 250 m^3 (eg level 1, 109-125 and 152-173) is *ca* 8.75 x 7.5 x 3.0 m (ie Vr = 200 m^3) or in GCF (eg level 3, 302-306 and 310-315) is *ca* 6.25 x 12.50 x 3.5 m (ie Vr = 270 m^3)

A 25L dewar of liquid nitrogen would produce 25 x 0.678 = 16.95 m^3 of gas (Vg).

Therefore:

$\%O_2$ = 0.2095 x (250 – 16.95)/250 = 19.5%

If the calculation suggests a resultant oxygen content below 18% then further controls should be considered, such as a) smaller dewar capacities b) low oxygen alarm c) reticulated gas supply.

References:

AS: 1894-1997 The Storage and Handling of Non-flammable Cryogenic and Refrigerated Liquids

BOC Guidelines for Gas Cylinder Safety