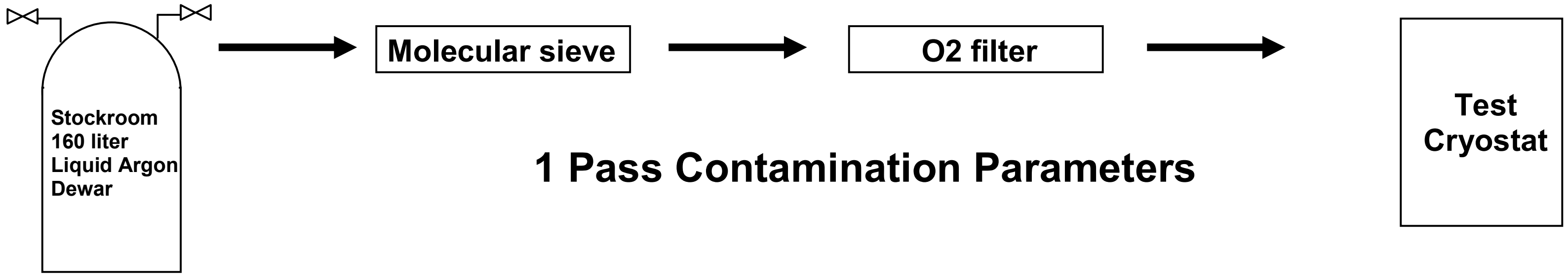
Terry Tope 2/22/06

1 Pass Contamination Parameters



<u>Stockroom 160 liter Liquid Argon Dewar</u>
491.2 lb. or 222.8 kg Argon
4750 ft^3 or 134,560 liters warm gas
1 ppm O_2 by volume = 0.18 g O_2 (observed)
1 ppm O_2 by weight = 0.22 g O_2
10 ppm H_2O by molar fraction = 1.0 g H_2O (literature, maximum)

<u>Molecular sieve with Sigma-Aldrich 5A material</u>
8 x 12 mesh (1.68 to 2.38 mm diameter beads)
Surface area of ~570 m^2/gram
1.72 Liter volume, 1212 grams of filter material
H_2O adsorption (warm) may be as high as 21.7% by weight or 263 grams H_2O

<u>MVE Test Cryostat</u>
178 liter volume, 546.5 lb or 247.9 kg
Cannot fill beyond 145.5 liters, 446.7 lbs. or 202.6 kg
100 ppt O_2 by weight in 145.5 liters is 2.026×10^{-5} g or 0.0153 cm^3 gas.

Evacuated to 2×10^{-6} Torr prior to filling. If remaining gas was all air, then O_2 fraction would be 1.30×10^{-7} g or 9.84×10^{-5} cm^3. However, remaining gas is mostly water vapor.

Cryostat surface area = 19,468 cm^2
Ratio of volume to surface area = 109 cm^2/Liter

A monolayer of oxygen covering the entire cryostat surface area would contain 5.17×10^{-4} g of oxygen which is an equivalent contamination removal of 2.5 ppb. Icarus claims 1/10 of a monolayer can form.

<u>O_2 filter with Engelhard Copper Alumina Catalyst CU-0226S</u>
14 x 20 mesh (0.841 to 1.41 mm diameter beads)
Surface area of 200 m^2/gram
1.72 Liter volume, 1393 grams of filter material

Filter O_2 capacity for FLARE purity requirements is unknown.
Filter dynamic capacity is flow rate dependent.
1.72 liters of atmospheric air contains 0.478 g O_2.

H_2O adsorption (warm) may be as high as 25% by weight or 348 grams H_2O (Trigon customer experience)
1.72 liters of atmospheric air with a 5 °C dew point contains 0.01 g H_2O.

During regeneration 1.125 g H_2O is produced for each gram of O_2 removed from filter.
Filtering $2Cu_{(s)} + O_{2(g)} \rightarrow 2CuO_{(s)}$
Regeneration $CuO_{(s)} + H_{2(g)} \rightarrow Cu_{(s)} + H_2O_{(g)}$
Filter contains 10% Cu by weight, or 139.3 grams. If all the Cu could be reacted, 35.0 g O_2 would be removed from the Argon.

Relationship between H_2O adsorption and O_2 capacity is unknown.

Flow rate thru filter was 48.8 volume changes per hour without molecular sieve and 34.8 volume changes per hour (1.0 LPM) with molecular sieve
At 1 LPM flow velocity in filter is 1.35 ft/min.

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2/20/06

Filter information needed to design O_2 filtration for large tanks.

- **Determine O_2 capacity of filter without water loading by using a molecular sieve as a pre-filter.**
  - **O_2 source can be a calibrated mix of argon and oxygen in a vendor supplied bottle.**
  - **The hazard of pure oxygen should be avoided.**
  - **Using compressed air for the O_2 source will contain N_2 which may affect purity monitor signal.**
  - **O_2 can be mixed into liquid with pressurized sample of known volume.**
  - **Sample introduction technique has to be developed.**
  - **O_2 in source liquid argon should also be measured.**
  - **Is O_2 adsorbing in addition to chemically bonding?**

- **Determine effect of warming up and cooling down filter.**
  - **Is O_2 released?**
  - **Is water released?**
  - **It may be possible to examine this with an RGA while the filter warms up.**

- **Determine the relationship between flow rate and dynamic filter capacity.**

- **Determine H_2O loading effect on filter O_2 capacity**

- **Characterize molecular sieve at cryogenic temperatures.**
  - **What is the H_2O capacity?**
  - **Is the filter loading with O_2 and N_2?**
  - **RGA and dewpoint analyzer are possible tools**

- **Determine how many regenerations are possible before filter deteriorates.**