Dilution cryostat

The liquid helium is transferred from the 2000 l dewar on the target platform to gas-liquid separator (2). The cold gas coming from the separator is used to cool 80 K and 4 K thermal screens (9). From the bottom part of the separator (2) liquid helium is taken through the needle valves NV1 to fill the $^4$He evaporator (3) and NV4 to cool the microwave cavity (7). NV5 is connected to the top of the separator and is used for precooling of the $^4$He evaporator (3). Typical operation temperature of the $^4$He evaporator (3) is 1.3 K. The cavity (7) is around 3 K.

The dilution cryostat is filled with mixture of $^3$He/$^4$He. The $^3$He evaporator or still (4) is typically at 0.6 K. Below 0.87 K the mixture separates into $^4$He rich and $^3$He rich phase. In the mixing chamber (6) when the $^3$He atoms are moved from the $^3$He rich phase to $^4$He rich phase energy is removed from the system. This dilution cooling allows to achieve target material temperatures below 50 mK.

The price of helium-$^3$He gas in CERN magazine (SCEM 60.26.30.320.8) August 2007 is 404 CHF/l. The $^4$He gas with purity 46 (SCEM 60.26.30.310.0) is 15.7 CHF/m$^3$.

Fig. 1. Dilution cryostat flow diagram from Ref. [Doshita 2004]. (1) liquid helium buffer dewar, (2) gas/liquid phase separator, (3) evaporator, (4) still or $^3$He evaporator, (5) main heat exchanger, (6) mixing chamber, (7) microwave cavity, (8) magnet liquid helium vessel, (9) thermal screens, (10) $^3$He roots blowers, (11) $^4$He roots and rotary pumps, (12) helium recovery line. The white arrows indicate the flow of $^4$He gas and black arrows the flow of $^3$He gas.

See also DilCryoPres, PolTargTemp, PolTargSlow, PolTargPump, PolTargHolder and PolTargDiluFlow.
Links

http://wwwcompass.cern.ch/compass/detector/target/welcome.html

http://na47sun05.cern.ch/target/outline/dilref.html

http://ltl.tkk.fi/ltresearch.html


http://en.wikipedia.org/wiki/Liquid_helium

http://www.uoregon.edu/~rjd/vapor1.htm

References


J.G.M. Kuerten et. al., *Thermodynamic properties of liquid 3He-4He mixtures at zero pressure for temperatures below 250 mK and 3He concentrations below 8%*, Cryogenics **25** (1985) 419.


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