

Leak Rate for the Old LN2 Heat Exchanger in HEUB

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- Introduction
- Old LN2 Heat Exchanger and Leaks
- Leak Rate
- Summary

Usage and Leak of Helium Gas

- Normal usage and loss of helium gas in the B902 cryogenic operation was unusually large.
- From 2000 through 2003, we used an average of 3.5 tube trailer per month (each trailer is $\sim 50,000$ standard cubic foot).
- The helium usage equals ~ 250 SCFH, standard cubic foot per hour.
- Extensive effort has been spent on leak check. Many leaks were identified and repaired, but no change on gas usage.

Leakage in the Old HEUB - LN₂ HX

- Diagnosis suggested leak is likely to come from one “major” source.
- On 11/8/03, W. McKeon and G. Herbst found a large leak from H.P. to nitrogen side of the LN₂ heat exchanger in HEUB refrigerator.
- When helium is at 235 psia, the leak is ~ 150 SCFH (rough measurement) using a Dwyer flowmeter calibrated for air (requires extrapolation for helium).
- However, we believed this is the main helium leak.
- A new HX is ordered and installed.

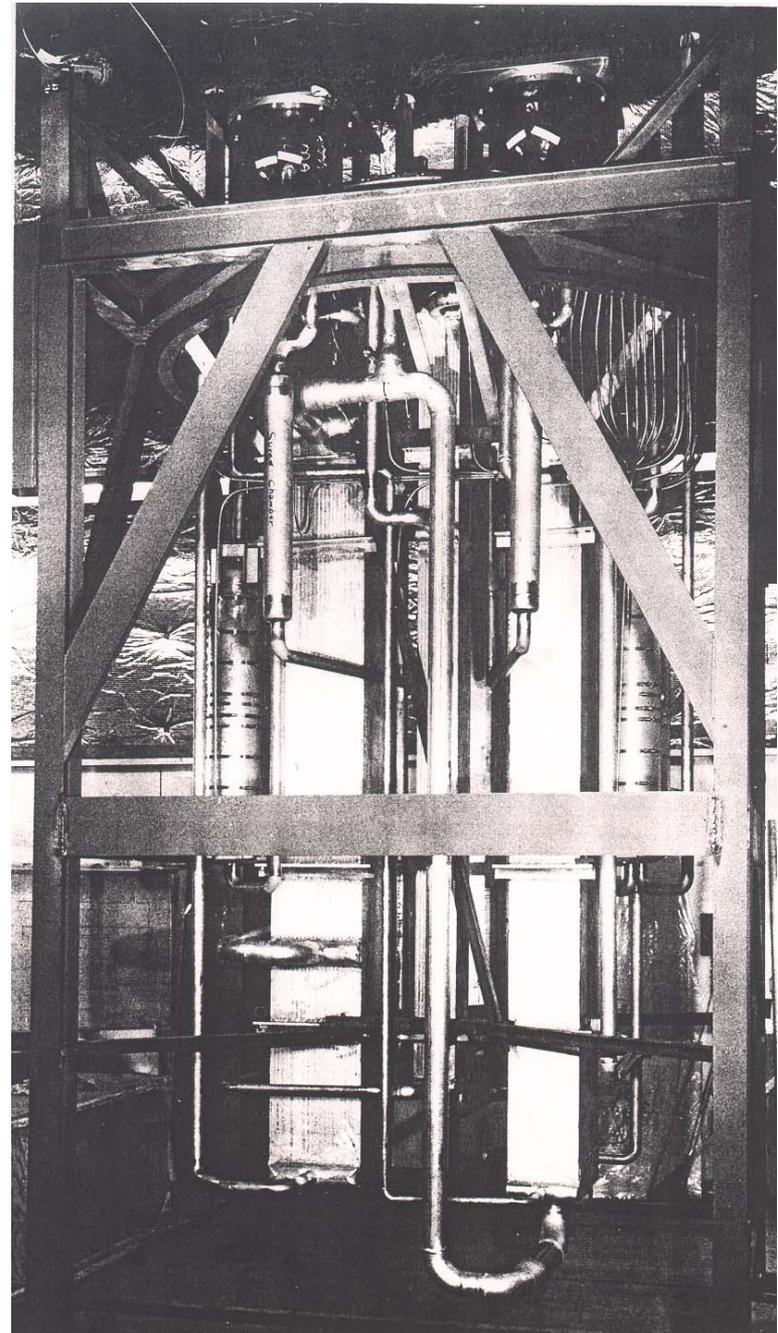
Leak Rate of the Old HEUB - LN₂ HX

- The old HX is laid on test bench for leak measurement.
- H.P. stream is pressurized using both N₂ and Helium gas, flow from the N₂ and L.P. sides are measured.
- It turns out leak occurs not only from H.P. to the nitrogen side, but also from H.P. to L.P.
- Dwyer flowmeter were used to measure the flow.
- We found that leak from H.P. to L.P. is about 2.5 times that from H.P. to N₂.
- Description of the HX and leak rates are given below.

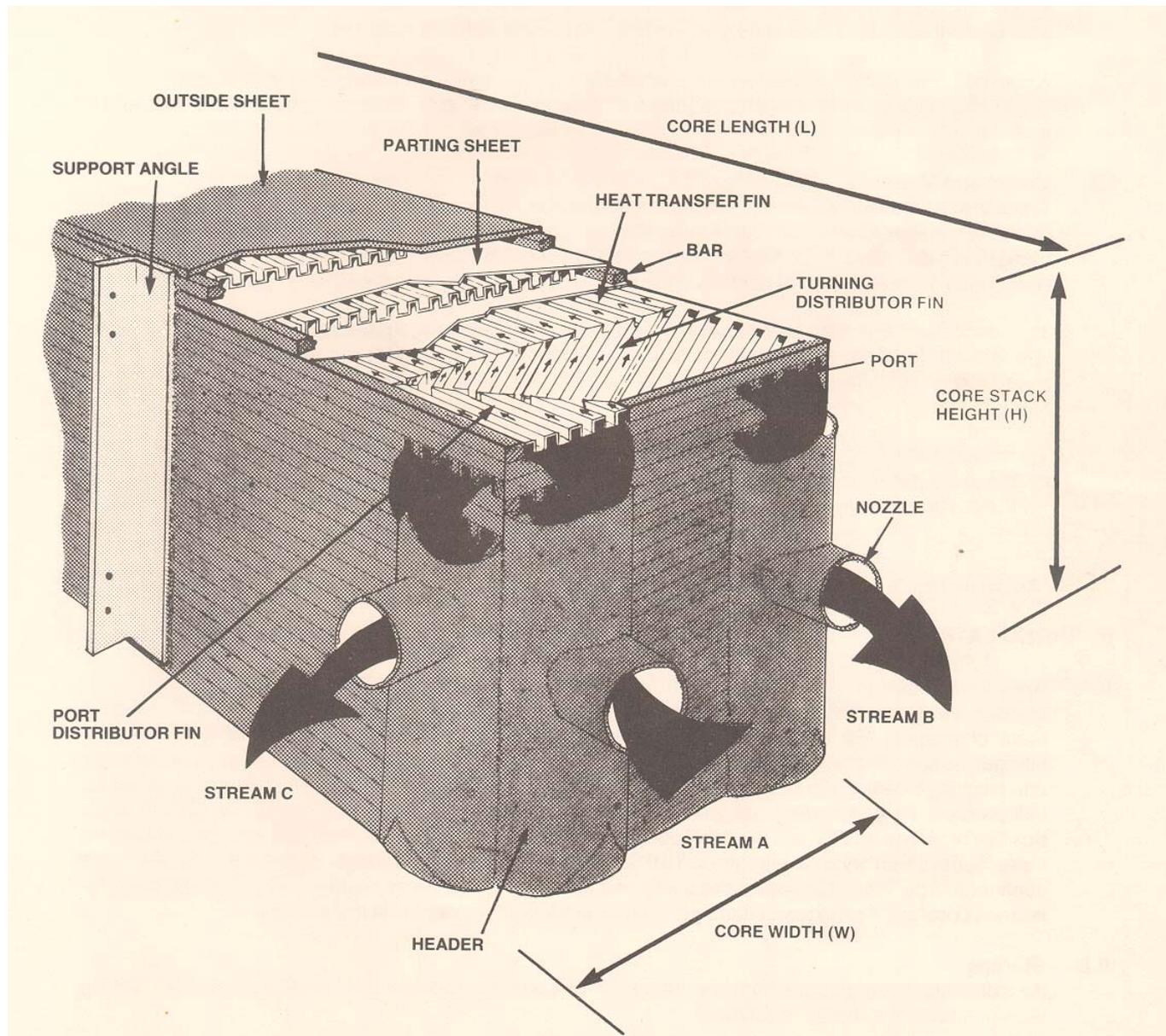
LN₂ Heat Exchanger and Leakages

- HX has three streams: H.P, L.P. and LN₂
- H.P. helium is cooled by L.P. helium and liquid nitrogen in counter flow configuration.
- Leakages of helium could occur from H.P. to L.P. stream and to nitrogen stream.
- Leakage from H.P. to L.P. causes inefficiency to the cryogenic system.
- Leakage from H.P. to nitrogen causes loss of helium gas and operating efficiency.

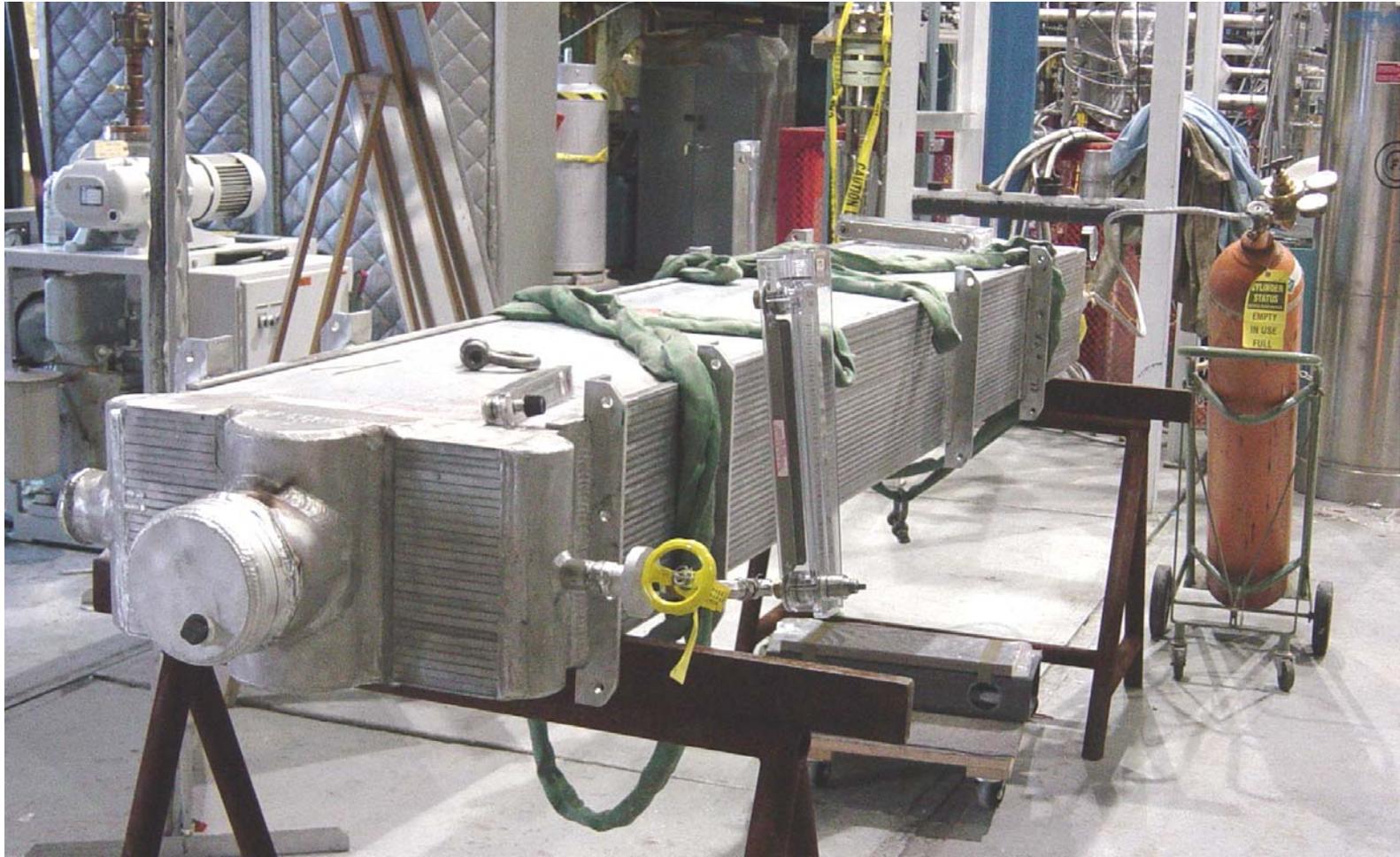
Front view of HEUB
cold box, LN₂ HX is
on the exchanger on
the right



Basic Components of a Brazed Aluminum HX (Cutaway)



Old LN₂ HX on the Bench for Measuring Leak Rates
The HX is mounted vertically in the refrigerator with warm end, left in the figure, mounted in top.



Leak Test of Old LN2 HX at 150 psi

1/27/04

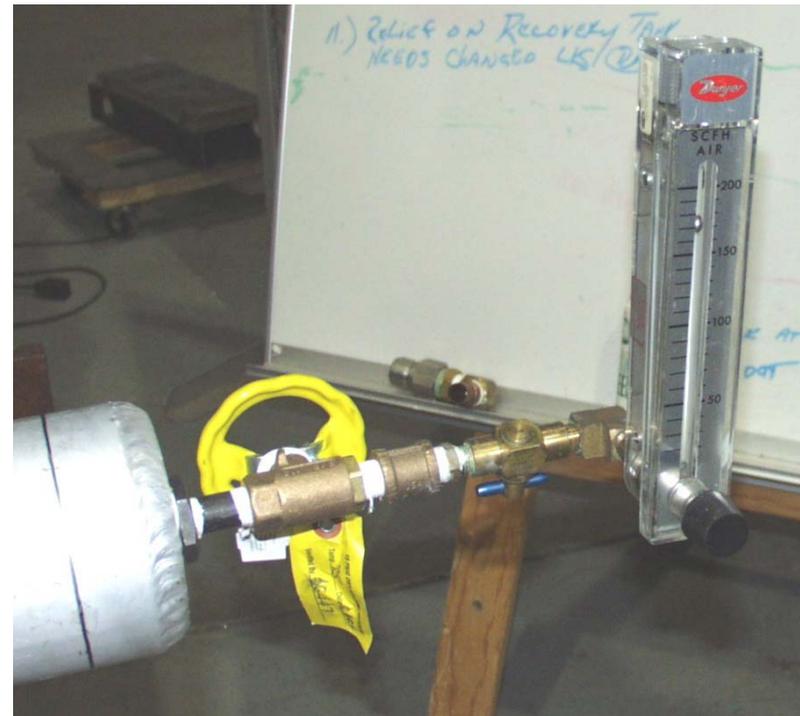
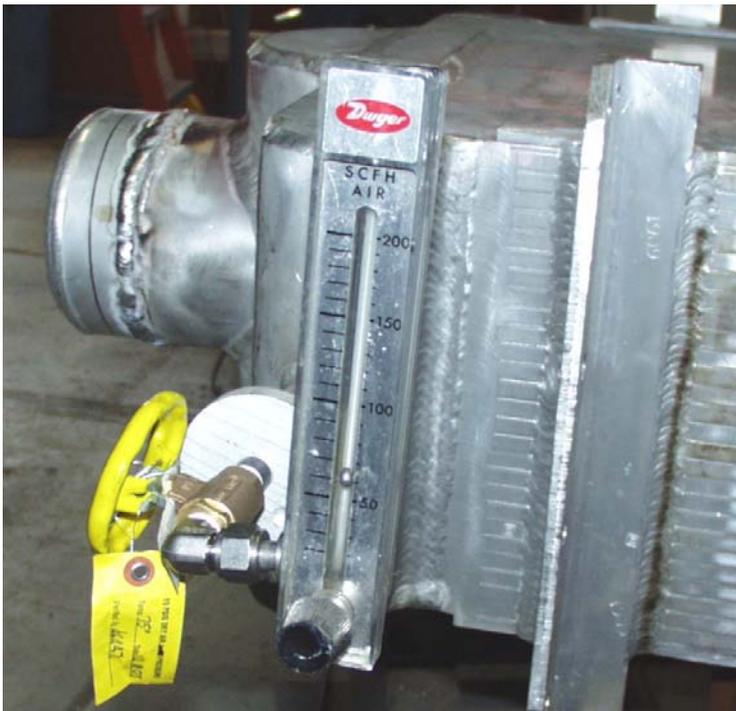


Pressurize H.P. side and measure flow from N2 side and L.P. side.

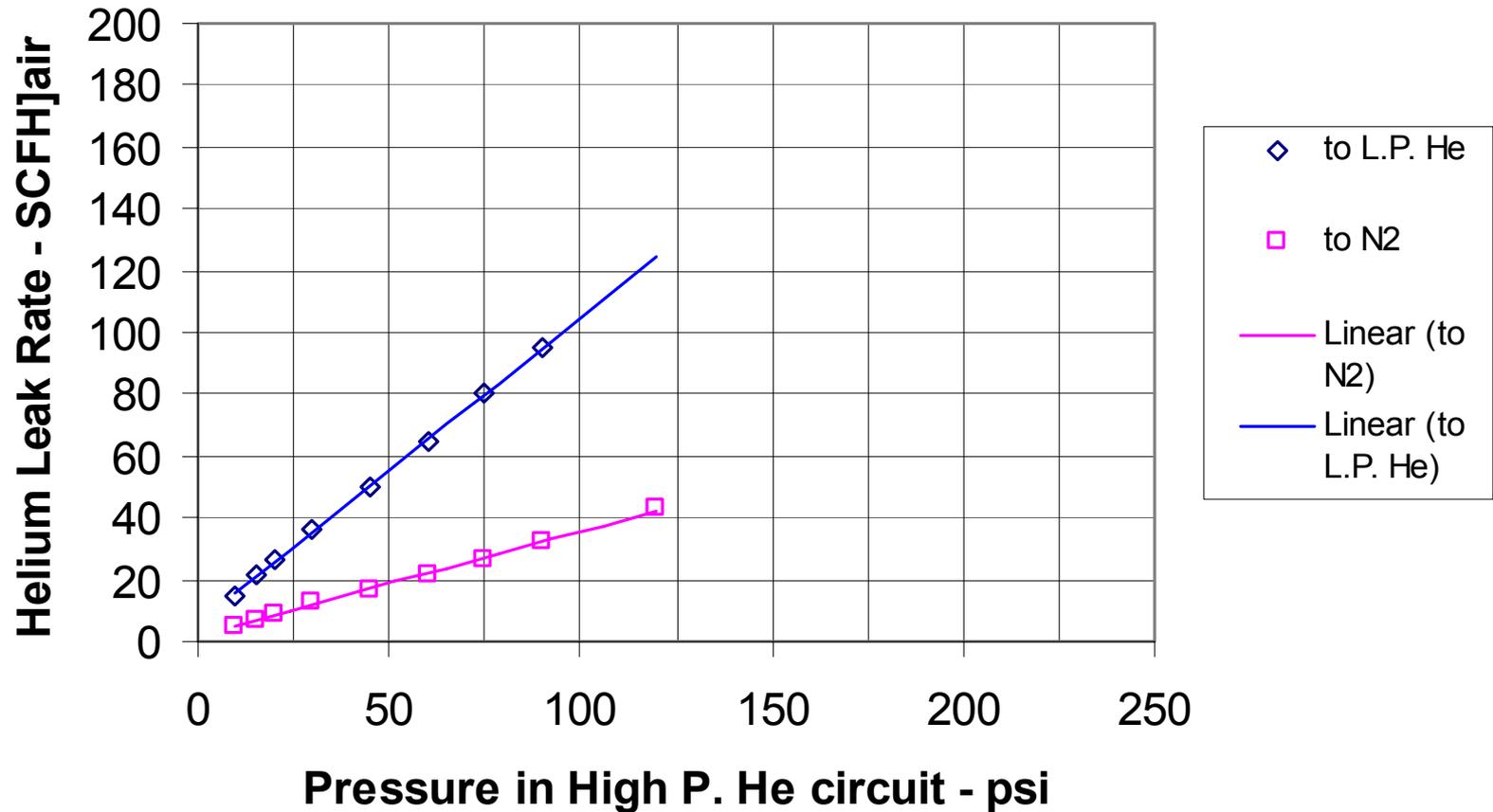
Left: Pressure on H.P. side – He at 150 psi

Lower right: Leak to L.P. – 170 SCFH]air

Lower left: Leak to N2 side – 65 SCFH]air



Leak Rate of HEUB LN2 HX from H.P. Helium Side Using Helium Gas through Dwyer Flowmeters – 1/27/04

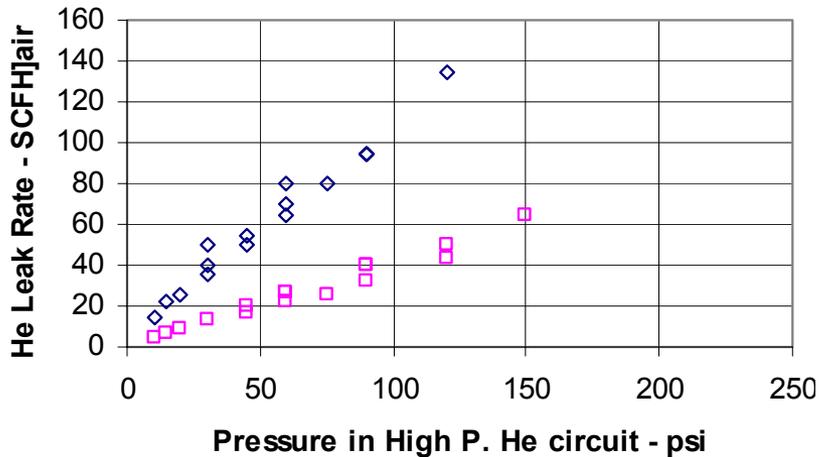


Leak Rate At Operating Pressure

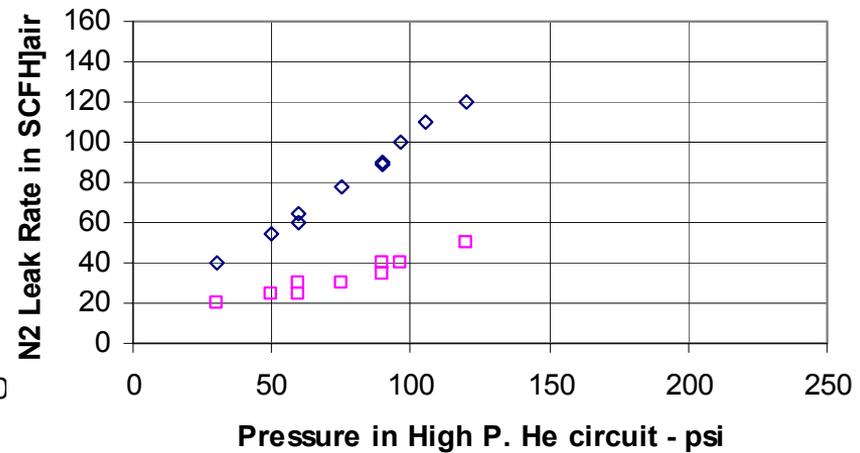
- Operating pressure for the H.P. stream of HEUB is 16 atm (235 psia or 220 psi).
- Since the leak rate increases linearly with pressure, the flow from H.P. to N₂ side will be 79 SCFH_{air} at 220 psi as extrapolated from 43 SCFH_{air} at 120 psi.
- To get actual flow for helium, correction factor of 2.7 [square root of (29.2/4)] should be applied on the Dwyer flowmeter.
- Thus the helium leak equals to ~ 213 SCFH
- At 213 SCFH, the amount of helium loss equals 153,000 St. cubic foot per month – ~ 2.8 tube trailers per month.
- In terms of mass flow, the helium flows are 0.27 and 0.81 g/s for leak from H.P. stream to N₂ and to L.P. respectively.

Leak Rate from H.P. Helium Side to N₂ and L.P.
Using Helium (left figure) and N₂ (right figure)
Reading from Dwyer flowmeters are basically the same
as expected

Using Helium Gas - 1/27/04



Using N₂ - 1/26/04



◇ to L.P. He
□ to N₂

Leak Test of Old LN2 HX at 120 psi

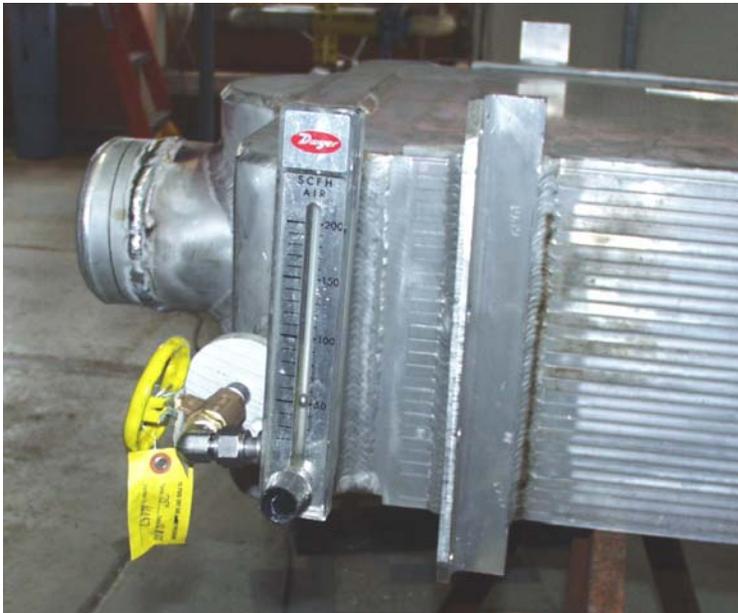
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Left, H.P. – He at 120 psi

Lower right, Leak to L.P. – goes up to 190 SCFH]air mysteriously

Lower left, Leak to N2 line – 50 SCFH]air



Leak Test of Old LN2 HX at 90 psi

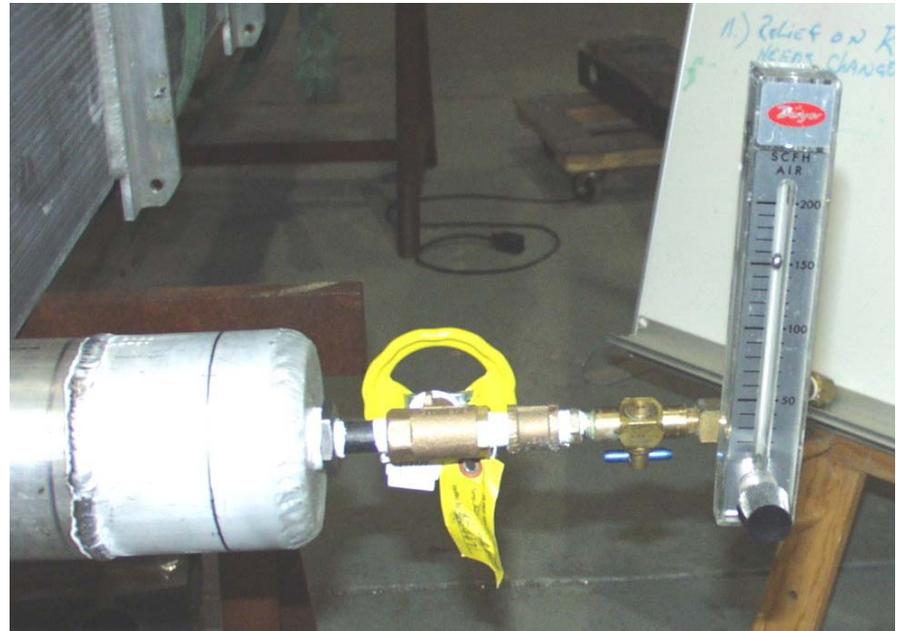
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Left, H.P. – He at 90 psi

Lower right, Leak to L.P. – goes up to 150 SCFH]air mysteriously

Lower left, Leak to N2 line – 40 SCFH]air



Deformation on the outer shell in the cold end, the Old LN2 HX may not be repairable.



Summary

- Flow measurements confirm large helium leaks in the old LN2 HX in HEUB refrigerator
- Leak occurred from H.P. stream to both L.P. and LN2 sides
- Leak from H.P. to LN2 contributes to loss of helium gas
- Measurement for leak rate of ~ 2.8 tube trailer may not be accurate.
- With the new LN2 HX installed, we hope to see saving of 2 tube trailer per month in the future.
- From the deformation of the old HX, we suspect the Old HX is not repairable.