LEAKAGE RATES FOR CRYOLAB VALVES

DØ Engineering Note: 3740.510-EN-192

J. M. Wendlandt

November 2, 1988

Approved:

SYM	REVISION	DATE	APPD
A	REDRAWN, REVISED PURCHASE P/N'S, ADDED NOTES	3-6-86	CH
B	Δ ITEM 5 F/m - 035 TO - 032	3-31-86	
C	FIND #6 WAS X82-CHS16-6 PER ECR # 0945	4-18-86	CH

STEM ϕ .490/.489 OD

NOTE:

1. CLEAN PER CPS 8288.
2. ASSEMBLE PER CP6 8269-4M.

UNLESS OTHERWISE SPECIFIED,
DIMENSIONS ARE IN INCHES AND TOLERANCES ARE:

FRACTIONS	DECIMALS	ANGLES
UNDER 1" $\pm 1/64$	.X ± 0.050	$\pm 1^\circ$
1" $\pm 1/32$	.XX ± 0.015	
2" $\pm 1/16$	.XXX ± 0.007	

ALL SHARP EDGES 0.007 ALL MACHINED SURFACES 125

BONNET
ASSEMBLY

Cryolab

SAN LUIS OBISPO, CALIFORNIA

DATE OF ORIGINAL DRAWING:
4-19-83

DWN CH 3-6-86
CHK *[Signature]* 3-7-86
ENGR

SCALE: NONE SHEET 1 OF 2

CODE IDENT 16570 REV: C
NEXT ASSY

DWG NO: 6CV8-812-5L1

This note summarizes a brief study on the leakage rates of cryolab valves due to the failure of the valve packings. The Δr gap between the shaft and the packing, the fluid(Ar or N2), the Δp (atm) between the fluid and atmosphere, and the initial temperature of the escaping gas were varied to determine the resulting leakage rate. The heat leak in watts required to vaporize the liquid which provides the indicated flow rates is also included in the results. The following equation with the units indicated on the spread sheets was used for the calculations:

$$\dot{M} = \sqrt[1.8]{\frac{\Delta P}{\Delta L} \left(\frac{1}{4.98 \times 10^{-9}} \right) \frac{\rho}{(\mu)^{0.2}} \left(r_1^2 - r_2^2 \right)^{1.8} \left(r_1 - r_2 \right)^{1.2}}$$

Units: atm, cm, g, s

The dimensions used in the calculations were acquired over the telephone and/or found on the enclosed drawing from Cryolab. There is no implication that Cryolab was any better or worse than other valve manufacturers. They were kind enough to provide the detail needed for this study. The fluid properties were found in Ar and N2 Property handbooks. The results of this study are shown graphically and listed on accompanying spread sheets. The spread sheets and graphs can be found on the disc JW4 in the MassFlow folder.

11-8-88

Temperature	ΔP (atm)	ΔL (cm)	dens. (g/cm ³)	μ g/cm-s	r1 (cm)	r2 (cm)	M (g/s)	ft ³ /min	Watts to Vaporize
300K N2	1	5.715	0.0017077	0.00017962	0.6223	0.62103	0.02179256	0.04055595	4.36
300K Ar	1	5.715	0.002413	0.0002291	0.6223	0.62103	0.02570286	0.03382496	5.14
90K Ar	1	5.715	0.008273	0.0000758	0.6223	0.62103	0.05762822	0.07583874	11.53
80K N2	1	5.715	0.00670851	0.00005559	0.6223	0.62103	0.05309122	0.09880277	10.62
300K N2	2	5.715	0.00227705	0.0001797	0.6223	0.62103	0.03757928	0.06993503	7.52
300K Ar	2	5.715	0.003216	0.0002292	0.6223	0.62103	0.0443108	0.05831301	8.86
90K Ar	2	5.715	0.010774	0.0000784	0.6223	0.62103	0.09771846	0.1285975	19.54
80K N2	2	5.715	0.00876454	0.00005777	0.6223	0.62103	0.09013784	0.16774651	18.03
300K N2	3	5.715	0.0027326	0.00017977	0.6223	0.62103	0.05209068	0.09694076	10.42
300K Ar	3	5.715	0.003855	0.0002293	0.6223	0.62103	0.0613824	0.08077924	12.28
90K Ar	3	5.715	0.0122747	0.0000803	0.6223	0.62103	0.13125411	0.1727304	26.25
80K N2	3	5.715	0.01039241	0.00005928	0.6223	0.62103	0.12376404	0.23032488	24.75

$\Delta r = \text{"inches"} \quad 0.0005$

11-8-88

Temperature	ΔP (atm)	ΔL (cm)	dens. (g/cm ³)	μ g/cm-s	r1 (cm)	r2 (cm)	M (g/s)	ft ³ /min	Watts to Vaporize
300K N2	1	5.715	0.0017077	0.00017962	0.6223	0.61976	0.06911639	0.1286256	13.82
300K Ar	1	5.715	0.002413	0.0002291	0.6223	0.61976	0.08151813	0.10727786	16.30
90K Ar	1	5.715	0.008273	0.0000758	0.6223	0.61976	0.18277131	0.24052704	36.55
80K N2	1	5.715	0.00670851	0.00005559	0.6223	0.61976	0.16838196	0.31335882	33.68
300K N2	2	5.715	0.00227705	0.0001797	0.6223	0.61976	0.1191849	0.22180309	23.84
300K Ar	2	5.715	0.003216	0.0002292	0.6223	0.61976	0.14053433	0.18494318	28.11
90K Ar	2	5.715	0.010774	0.0000784	0.6223	0.61976	0.30991989	0.40785458	61.98
80K N2	2	5.715	0.00876454	0.00005777	0.6223	0.61976	0.28587748	0.532018	57.18
300K N2	3	5.715	0.0027326	0.00017977	0.6223	0.61976	0.16520868	0.30745335	33.04
300K Ar	3	5.715	0.003855	0.0002293	0.6223	0.61976	0.19467793	0.25619615	38.94
90K Ar	3	5.715	0.0122747	0.0000803	0.6223	0.61976	0.41628016	0.5478247	83.26
80K N2	3	5.715	0.01039241	0.00005928	0.6223	0.61976	0.39252498	0.73048899	78.50

$\Delta r = \text{"inches"} \quad 0.001$

11-8-88

Temperature	ΔP (atm)	ΔL (cm)	dens. (g/cm ³)	μ g/cm-s	r1 (cm)	r2 (cm)	M (g/s)	ft ³ /min	Watts to Vaporize
300K N2	1	5.715	0.0017077	0.00017962	0.6223	0.61468	0.42953964	0.79937327	85.91
300K Ar	1	5.715	0.002413	0.0002291	0.6223	0.61468	0.50661308	0.66670281	101.32
90K Ar	1	5.715	0.008273	0.0000758	0.6223	0.61468	1.13587415	1.49481039	227.17
80K N2	1	5.715	0.00670851	0.00005559	0.6223	0.61468	1.04644823	1.94744015	209.29
300K N2	2	5.715	0.00227705	0.0001797	0.6223	0.61468	0.74070183	1.37844611	148.14
300K Ar	2	5.715	0.003216	0.0002292	0.6223	0.61468	0.87338278	1.14937173	174.68
90K Ar	2	5.715	0.010774	0.0000784	0.6223	0.61468	1.92606813	2.53470566	385.21
80K N2	2	5.715	0.00876454	0.00005777	0.6223	0.61468	1.77665108	3.30634765	355.33
300K N2	3	5.715	0.0027326	0.00017977	0.6223	0.61468	1.02672715	1.91073922	205.35
300K Ar	3	5.715	0.003855	0.0002293	0.6223	0.61468	1.20987056	1.59218965	241.97
90K Ar	3	5.715	0.0122747	0.0000803	0.6223	0.61468	2.5870684	3.40458201	517.41
80K N2	3	5.715	0.01039241	0.00005928	0.6223	0.61468	2.43943639	4.53979112	487.89

$\Delta r = \text{"inches"} \quad 0.003$

11-8-88

Temperature	ΔP (atm)	ΔL (cm)	dens. (g/cm ³)	μ g/cm-s	r1 (cm)	r2 (cm)	M (g/s)	ft ³ /min	Watts to Vaporize
300K N2	1	5.715	0.0017077	0.00017962	0.6223	0.6096	1.00222202	1.86513519	200.44
300K Ar	1	5.715	0.002413	0.0002291	0.6223	0.6096	1.18205338	1.55558225	236.41
90K Ar	1	5.715	0.008273	0.0000758	0.6223	0.6096	2.65027482	3.48776167	530.05
80K N2	1	5.715	0.00670851	0.00005559	0.6223	0.6096	2.44162206	4.54385866	488.32
300K N2	2	5.715	0.00227705	0.0001797	0.6223	0.6096	1.72824024	3.21625509	345.65
300K Ar	2	5.715	0.003216	0.0002292	0.6223	0.6096	2.03781763	2.68176801	407.56
90K Ar	2	5.715	0.010774	0.0000784	0.6223	0.6096	4.49399246	5.91409407	898.80
80K N2	2	5.715	0.00876454	0.00005777	0.6223	0.6096	4.14536557	7.71452533	829.07
300K N2	3	5.715	0.0027326	0.00017977	0.6223	0.6096	2.39560792	4.45822633	479.12
300K Ar	3	5.715	0.003855	0.0002293	0.6223	0.6096	2.8229267	3.71497154	564.59
90K Ar	3	5.715	0.0122747	0.0000803	0.6223	0.6096	6.03626927	7.94373035	1207.25
80K N2	3	5.715	0.01039241	0.00005928	0.6223	0.6096	5.69180734	10.5924535	1138.36

$\Delta r = \text{"inches"} \quad 0.005$

11-8-88

Temperature	ΔP (atm)	ΔL (cm)	dens. (g/cm ³)	μ g/cm-s	r1 (cm)	r2 (cm)	M (g/s)	ft ³ /min	Watts to Vaporize
300K N2	1	5.715	0.0017077	0.00017962	0.6223	0.5969	3.14905395	5.86038939	629.81
300K Ar	1	5.715	0.002413	0.0002291	0.6223	0.5969	3.71409704	4.88775171	742.82
90K Ar	1	5.715	0.008273	0.0000758	0.6223	0.5969	8.3273548	10.9587989	1665.47
80K N2	1	5.715	0.00670851	0.00005559	0.6223	0.5969	7.67175277	14.2771319	1534.35
300K N2	2	5.715	0.00227705	0.0001797	0.6223	0.5969	5.43025559	10.1057056	1086.05
300K Ar	2	5.715	0.003216	0.0002292	0.6223	0.5969	6.40297011	8.42630866	1280.59
90K Ar	2	5.715	0.010774	0.0000784	0.6223	0.5969	14.1204487	18.5825105	2824.09
80K N2	2	5.715	0.00876454	0.00005777	0.6223	0.5969	13.0250379	24.2395955	2605.01
300K N2	3	5.715	0.0027326	0.00017977	0.6223	0.5969	7.527173	14.008069	1505.43
300K Ar	3	5.715	0.003855	0.0002293	0.6223	0.5969	8.86983946	11.6727087	1773.97
90K Ar	3	5.715	0.0122747	0.0000803	0.6223	0.5969	18.9663938	24.9597742	3793.28
80K N2	3	5.715	0.01039241	0.00005928	0.6223	0.5969	17.8840695	33.2822534	3576.81

$\Delta r =$ "inches" 0.01