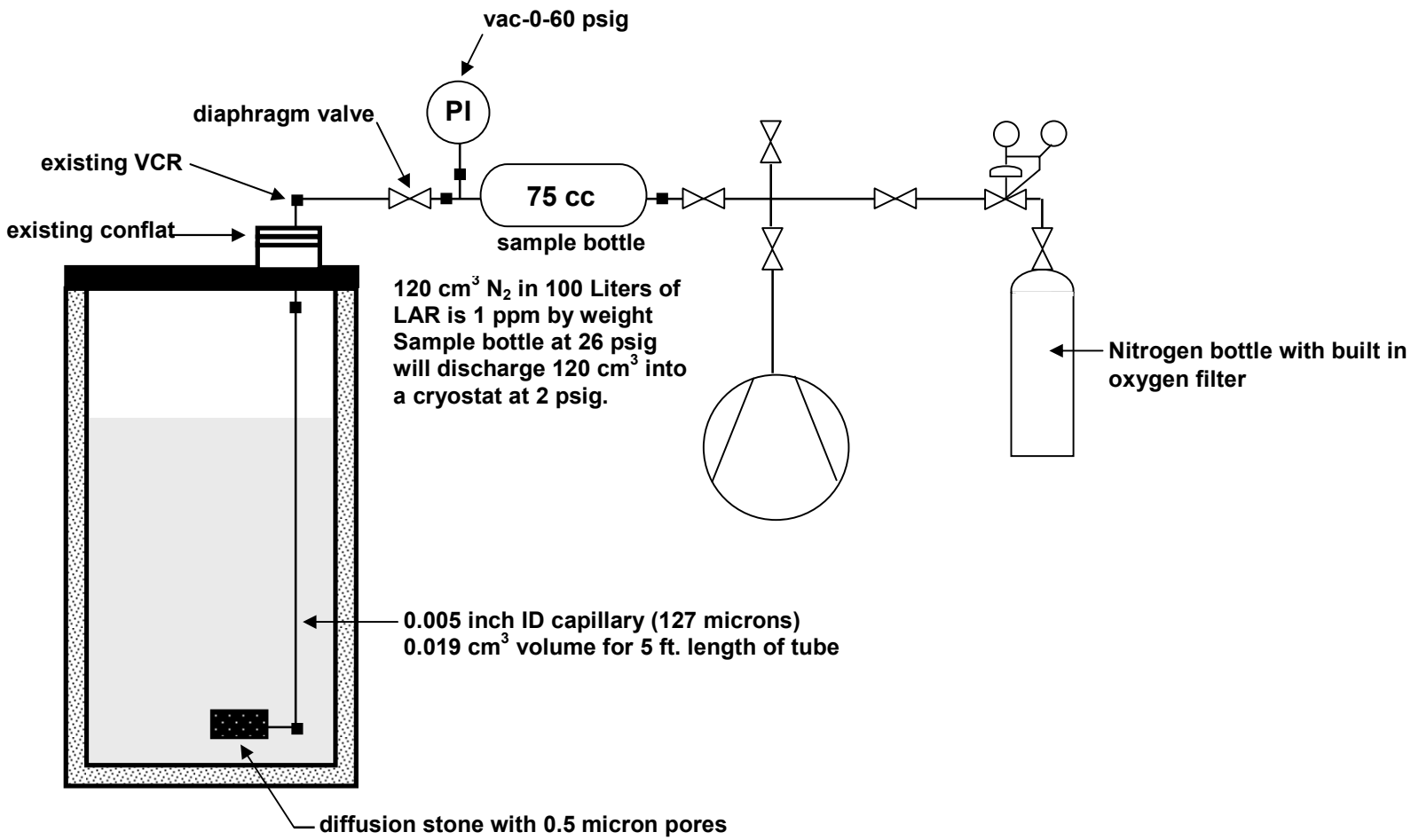
Terry Tope
3/10/06



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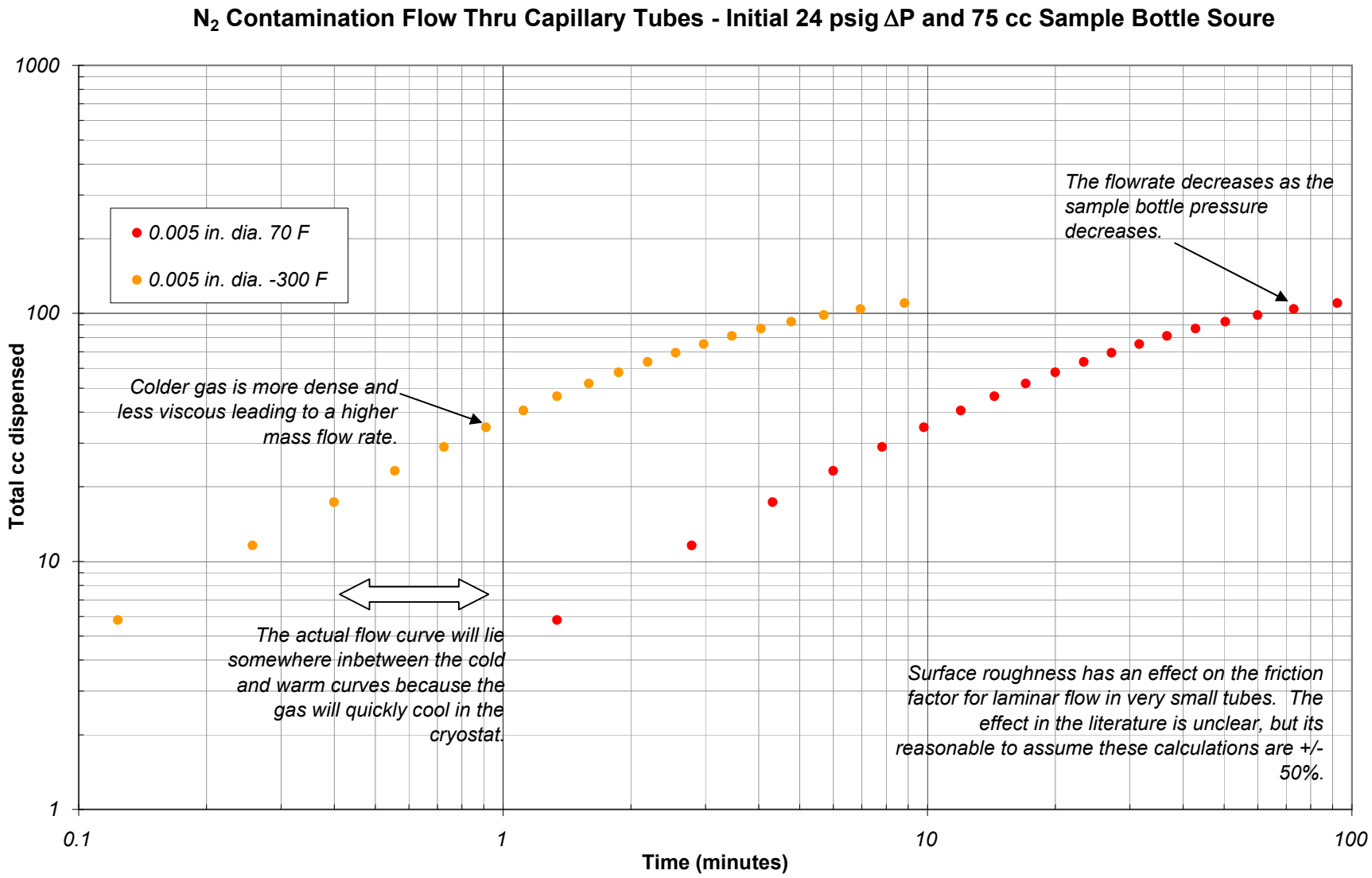

N_2 = 0.001161 g/cm^3
100 liters of Lar = 139253 grams

Equations solved simultaneously at each pressure increment

$$w^2 = \left[\frac{144 g A^2}{\overline{V}_1\left(\frac{fL}{D} + 2\ln\frac{P_1'}{P_2'}\right)}\right]\left[\frac{(P_1')^2 - (P_2')^2}{P_1'}\right]$$

$$f = \frac{64}{\mathrm{Re}} \text{ for laminar}$$

$$\mathrm{Re} = 6.31\frac{W}{d\mu}$$

For 5 ft. of 0.01 inch ID tube, 0.078 cm^3 total volume, WARM GAS, F=64/Re

N2 flow cc/sec	inlet pressure psia	inlet pressure psig	Reynolds Number	Laminar friction coefficient	Pressure difference psi	total cc dispensed cc	mass N2 g	ppm for 100 L LAr	total time seconds	total time mintues
1.192	40	25	391.6	0.1634	24					
1.111	38.84	23.84	365.1	0.1753	22.84	5.8	0.0067338	0.0483566	5.036908	0.083948
1.033	37.68	22.68	339.3	0.1886	21.68	11.6	0.0134676	0.0967133	10.44736	0.174123
0.9567	36.53	21.53	314.3	0.2036	20.53	17.35	0.0201434	0.144653	16.22712	0.270452
0.8829	35.37	20.37	290.1	0.2206	19.37	23.15	0.0268772	0.1930097	22.53284	0.375547
0.8115	34.21	19.21	266.6	0.24	18.21	28.95	0.033611	0.2413663	29.37892	0.489649
0.7425	33.05	18.05	244	0.2623	17.05	34.75	0.0403448	0.289723	36.84353	0.614059
0.6758	31.89	16.89	222.1	0.2882	15.89	40.55	0.0470786	0.3380796	45.02233	0.750372
0.6115	30.74	15.74	200.9	0.3185	14.74	46.3	0.0537543	0.3860194	53.95576	0.899263
0.5495	29.58	14.58	180.6	0.3544	13.58	52.1	0.0604881	0.434376	63.94715	1.065786
0.49	28.42	13.42	161	0.3976	12.42	57.9	0.0672219	0.4827326	75.10636	1.251773
0.4327	27.26	12.26	142.2	0.4501	11.26	63.7	0.0739557	0.5310893	87.67816	1.461303
0.3779	26.11	11.11	124.2	0.5155	10.11	69.45	0.0806315	0.579029	101.8652	1.697753
0.3254	24.95	9.947	106.9	0.5986	8.947	75.265	0.0873827	0.6275107	118.4015	1.973359
0.2753	23.79	8.789	90.45	0.7076	7.789	81.055	0.0941049	0.675784	137.679	2.29465
0.2276	22.63	7.632	74.77	0.856	6.632	86.84	0.1008212	0.7240156	160.6856	2.678093
0.1822	21.47	6.474	59.87	1.069	5.474	92.63	0.1075434	0.7722888	188.9433	3.149054
0.1392	20.32	5.316	45.74	1.399	4.316	98.42	0.1142656	0.8205621	224.9731	3.749552
0.09862	19.16	4.158	32.4	1.975	3.158	104.21	0.1209878	0.8688354	273.6654	4.56109
0.0604	18	3	19.85	3.225	2	110	0.12771	0.9171086	346.4865	5.774774

For 5 ft. of 0.005 inch ID tube, 0.019 cm^3 total volume, WARM GAS, F=64/RE

N2 flow cc/sec	inlet pressure psia	inlet pressure psig	Reynolds Number	Laminar friction coefficient	Pressure difference psi	total cc dispensed cc	mass N2 g	ppm for 100 L LAr	total time seconds	total time mintues
0.07463	40	25	49.04	1.305	24					
0.06956	38.84	23.84	45.71	1.4	22.84	5.8	0.0067338	0.0483566	80.44941	1.340823
0.06464	37.68	22.68	42.48	1.507	21.68	11.6	0.0134676	0.0967133	166.8876	2.781459
0.05987	36.53	21.53	39.34	1.627	20.53	17.35	0.0201434	0.144653	259.2496	4.320827
0.05525	35.37	20.37	36.3	1.763	19.37	23.15	0.0268772	0.1930097	360.014	6.000234
0.05077	34.21	19.21	33.36	1.918	18.21	28.95	0.033611	0.2413663	469.4274	7.823789
0.04645	33.05	18.05	30.52	2.097	17.05	34.75	0.0403448	0.289723	588.7444	9.812406
0.04227	31.89	16.89	27.78	2.304	15.89	40.55	0.0470786	0.3380796	719.4928	11.99155
0.03824	30.74	15.74	25.13	2.547	14.74	46.3	0.0537543	0.3860194	862.3322	14.3722
0.03437	29.58	14.58	22.58	2.834	13.58	52.1	0.0604881	0.434376	1022.09	17.03483
0.03064	28.42	13.42	20.13	3.179	12.42	57.9	0.0672219	0.4827326	1200.524	20.00873
0.02706	27.26	12.26	17.78	3.6	11.26	63.7	0.0739557	0.5310893	1401.564	23.3594
0.02362	26.11	11.11	15.52	4.122	10.11	69.45	0.0806315	0.579029	1628.478	27.1413
0.02034	24.95	9.947	13.37	4.788	8.947	75.265	0.0873827	0.6275107	1893.036	31.55061
0.01721	23.79	8.789	11.31	5.659	7.789	81.055	0.0941049	0.675784	2201.425	36.69042
0.01422	22.63	7.632	9.347	6.847	6.632	86.84	0.1008212	0.7240156	2569.545	42.82575
0.01139	21.47	6.474	7.484	8.552	5.474	92.63	0.1075434	0.7722888	3021.712	50.36187
0.008702	20.32	5.316	5.718	11.19	4.316	98.42	0.1142656	0.8205621	3598.061	59.96768
0.006164	19.16	4.158	4.051	15.8	3.158	104.21	0.1209878	0.8688354	4377.019	72.95032
0.003775	18	3	2.481	25.8	2	110	0.12771	0.9171086	5542.127	92.36878

For 5 ft. of 0.005 inch ID tube, 0.019 cm^3 total volume, COLD GAS f=64/Re

N2 flow cc/sec	inlet pressure psia	inlet pressure psig	Reynolds Number	Laminar friction coefficient	Pressure difference psi	total cc dispensed cc	mass N2 g	ppm for 100 L LAr	total time seconds	total time mintues
0.8104	40	25	1565	0.04089	24					
0.7531	38.84	23.84	1454	0.044	22.84	5.8	0.0067338	0.0483566	7.419252	0.123654
0.6978	37.68	22.68	1348	0.04749	21.68	11.6	0.0134676	0.0967133	15.41429	0.256905
0.6444	36.53	21.53	1245	0.05142	20.53	17.35	0.0201434	0.144653	23.98231	0.399705
0.5929	35.37	20.37	1145	0.05588	19.37	23.15	0.0268772	0.1930097	33.35756	0.555959
0.5434	34.21	19.21	1050	0.06098	18.21	28.95	0.033611	0.2413663	43.56614	0.726102
0.4957	33.05	18.05	957.5	0.06684	17.05	34.75	0.0403448	0.289723	54.72964	0.912161
0.4499	31.89	16.89	869.1	0.07364	15.89	40.55	0.0470786	0.3380796	66.99699	1.116616
0.4059	30.74	15.74	784.1	0.08162	14.74	46.3	0.0537543	0.3860194	80.43471	1.340578
0.3638	29.58	14.58	702.7	0.09107	13.58	52.1	0.0604881	0.434376	95.50551	1.591759
0.3234	28.42	13.42	624.8	0.1024	12.42	57.9	0.0672219	0.4827326	112.3856	1.873093
0.2849	27.26	12.26	550.3	0.1163	11.26	63.7	0.0739557	0.5310893	131.4551	2.190919
0.2481	26.11	11.11	479.3	0.1335	10.11	69.45	0.0806315	0.579029	153.0311	2.550519
0.2131	24.95	9.947	411.6	0.1555	8.947	75.265	0.0873827	0.6275107	178.248	2.970799
0.1798	23.79	8.789	347.3	0.1843	7.789	81.055	0.0941049	0.675784	207.7211	3.462018
0.1482	22.63	7.632	286.3	0.2235	6.632	86.84	0.1008212	0.7240156	242.9955	4.049925
0.1184	21.47	6.474	228.7	0.2799	5.474	92.63	0.1075434	0.7722888	286.4314	4.773856
0.0902	20.32	5.316	174.3	0.3672	4.316	98.42	0.1142656	0.8205621	341.9443	5.699072
0.06374	19.16	4.158	123.2	0.5197	3.158	104.21	0.1209878	0.8688354	417.1684	6.952807
0.03894	18	3	75.24	0.8506	2	110	0.12771	0.9171086	529.946	8.832433