CIM5 Bubbler: Effect of Sparge Rate and Duration on Homogeneity to Am/Cm Glass

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DOE Contract No. DE-AC09-96SR18500

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WSRC-TR-99-0462TL

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CIM5 BUBBLER: EFFECT OF SPARGE RATE
AND DURATION ON HOMOGENEITY OF AM/CM GLASS

The attached document describes the results of the evaluation of the rate of argon sparging and sparge duration on the homogeneity of the final glass product. This work was in response to Task 1.07 of TTR 99-MNSS/SE-006. Please refer any questions you may have regarding the contents of this document to M. E. Stone (Ext. 7-7751)

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STI 703-43A (4)

WSRC-TR-99-00462, Revision 0

CIM5 BUBBLER: EFFECT OF SPARGE RATE AND DURATION ON HOMOGENEITY OF Am/Cm GLASS (U)

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WSRC-TR-99-00462, Rev.0

ITS Tracking Number:
ITS-99-0100

Keywords: Americium,
Curium,
Precipitation,
Vitrification,
Sparge,
Bubbler,
Am/Cm

Retention: Permanent

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Publication Date: December 2, 1999

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SUMMARY

The current flowsheet for the Am/Cm program requires that the glass pool be sparged with argon during the soaking period immediately prior to draining the melter. The effect of varying sparge rate and duration on the homogeneity of the final glass product was evaluated using the full scale 5" Cylindrical Induction Melter (CIM5) pilot facility. The tests showed that the homogeneity of the glass product is maintained provided the sparge rate is at least 1.5 scfh and the sparge duration is at least 45 minutes or the flowrate is at least 1.0 scfh and the sparge duration is 60 minutes. SRTC recommends that the melt pool be sparged for 75 minutes with an argon flowrate of 1.5 scfh and a sparge dip tube located 1" from the melter bottom. In addition, pour flowrate was found to be a reliable indication of glass homogeneity.

BACKGROUND

The Am/Cm program will vitrify the americium and curium currently stored in F-canyon. The current flowsheet results in a large variation in lanthanide loading from the bottom to the top of the melt pool unless the glass pool is mixed. The highly loaded glass at the bottom of the melter is susceptible to devitrification at the operating temperature of the drain tube while the lightly loaded glass at the top of the melter has a high viscosity resulting in a glass heel in the melter after pouring. An argon sparge to mix the glass pool was shown to greatly improve homogeneity of the glass during base process development tests (WSRC-TR-99-00434); therefore tests were conducted to determine optimal sparge settings. The argon is bubbled into the melter using a ¼" diameter bubbler assembly as shown in Appendix B.

EVALUATION

Nine test runs were conducted to determine the optimal conditions for sparge rate and duration. The final glass product for all tests was 49 wt% lanthanide content glass produced from 25SrABS cullet and surrogate feed oxalate produced in Coupled Precipitator One. The same heatup sequence was used for all runs. The sparge tube was inserted at the beginning of the soak period and the pour sequence was initiated when the desired sparge duration was completed. Argon flow was started prior to insertion of the sparge tube (bubbler) and flow continued until the pour sequence was completed.

All tests were successfully completed without excessive volume expansion, drain tube pluggage, or other process difficulties noted. All pour sequences began cleanly within 30 seconds of pour initiation, all pours terminated cleanly with no strings, and no residual heels were noted after any pour. 30 grams of 49SrABS cullet was used to seal the drain tube at the conclusion of each pour. The glass poured during each run showed no signs of swirling or devitrification and was generally free of bubbles.

During the pouring process, timed samples were taken at approximately 30 second intervals to determine the pour flowrate. These samples were crushed and ground at TNX, then analyzed for elemental composition by the ITS Mobile Laboratory. Graphs for each run showing pour flowrates and lanthanide content of the glass versus pour time are attached in Appendix A. The parameters used for each run and the results are shown in Table 1.

Table 1. Run Parameters and Results

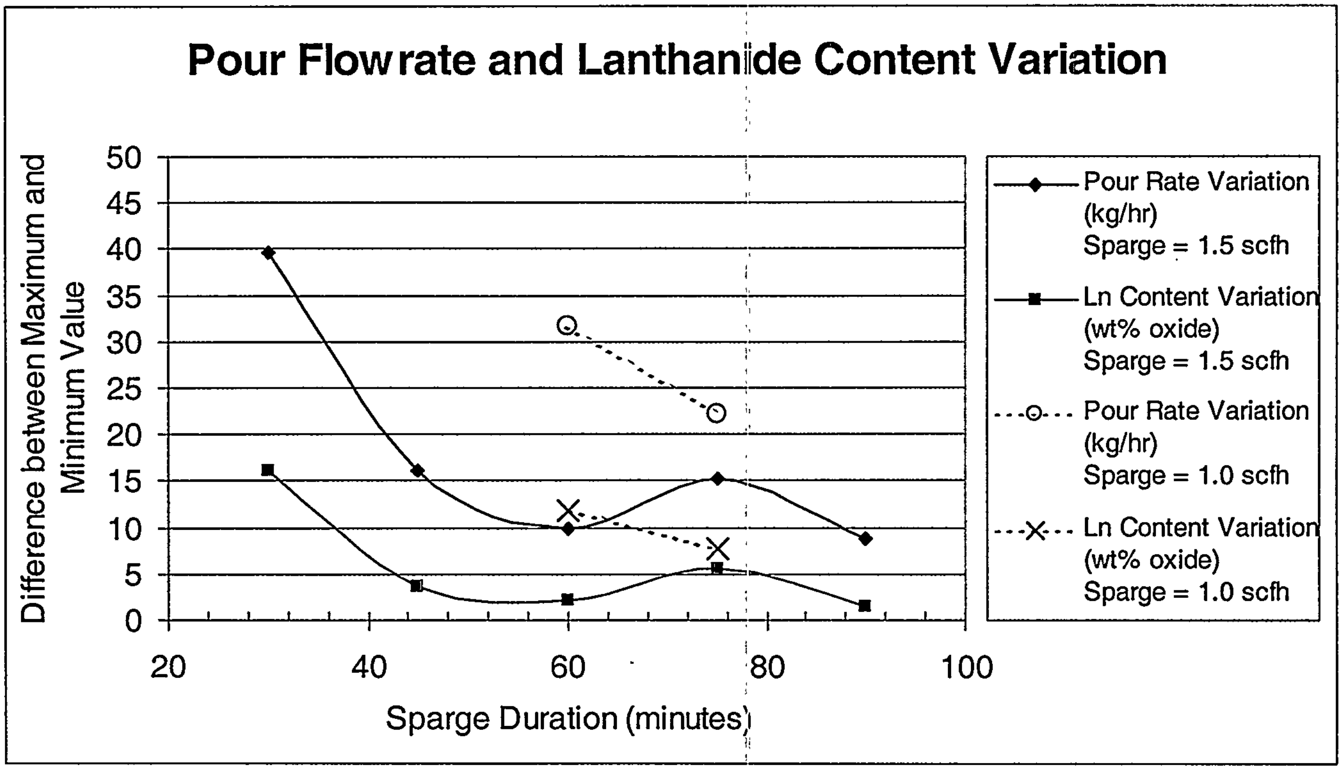
Run #	Argon Flowrate	Sparge Duration	Sparge Tube Height	Pour Flowrate		Pour Flowrate Difference	Ln Content of Glass		Ln Content Difference
	Scfh	Minutes	Inches from bottom	Kg/hr		Kg/hr	Wt% oxide		Wt% oxide
				Min	Max		Min	Max	
1	1.5	90	1.0	22.1	31.0	8.9	47.1	48.6	1.5
2	1.5	60	1.0	21.3	31.2	9.9	47.8	49.9	2.1
3	1.5	45	1.0	21.2	37.3	16.1	46.7	50.4	3.7
4	1.5	30	1.0	10.8	50.4	39.6	35.2	51.4	16.2
5	1.0	60	1.0	12.9	44.5	31.6	37.9	49.8	11.9
6	1.0	75	1.0	23.2	47.2	22.1	46.2	53.9	7.7
7	1.5	75	1.0	24.2	39.4	15.2	46.1	51.8	5.7
8	2.0	45	1.0	23.5	47.2	23.7	45.3	48.3	3.0
9	1.5	75	1.75	24.4	41.6	17.2	44.5	48.1	3.6

The general trends indicated by the data matched expections: higher sparge flowrates and longer sparge durations resulted in more uniform glass. These trends were followed by all runs except #7, which had a sparge rate of 1.5 scfh and a sparge duration of 75 minutes. A review of the laboratory notebook and sample results did not indicate any condition which would cause the deviation from the general trend. The test runs were not duplicated to determine the amount of variance, therefore it is not known if the deviation shown by Run #7 is within the expected variance of the process.

The difference in lanthanide content from the sample with the highest loading to the sample with the lowest loading was utilized to determine the amount of uniformity during each run. All runs except for Runs 4 and 5 showed acceptable uniformity (difference < 10 wt% oxide). At a sparge flowrate of 1.0 scfh, 60 minutes was determined to be the minimum sparge duration that produced uniform glass while increasing the flow to 1.5 scfh decreased the minimum sparge duration to 45 minutes. In order to allow for instrument error and other margins for error, SRTC recommends that the melter be sparged at 1.5 scfh of argon for 75 minutes.

The difference in maximum and minimum pour flowrates for each run was plotted in Figure 1 along with the difference in lanthanide content to determine if pour flowrate measurements could be used to predict homogeneity of the glass. As shown by the chart, pour flowrate difference follows the same trends as lanthanide content difference and can used to reliably predict whether or not the glass is uniform.

Figure 1. Difference in Pour Flowrate and Ln Content Versus Sparge Duration



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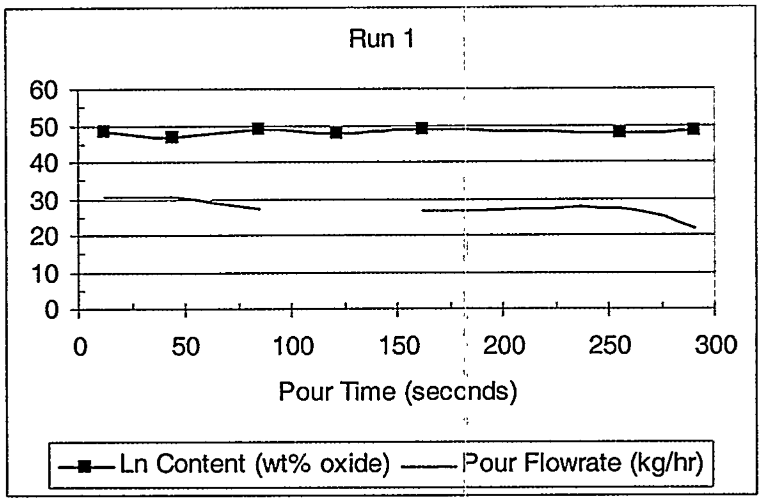
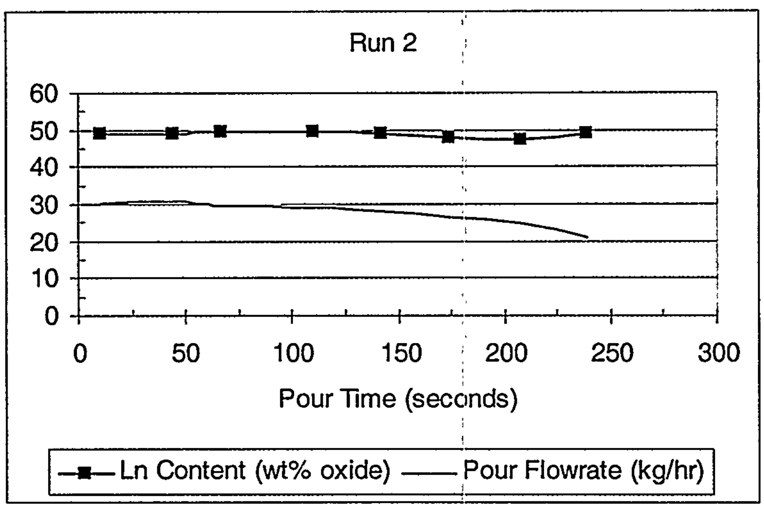
Appendix A. Pour Flowrate and Lanthanide Content versus Pour Time Charts

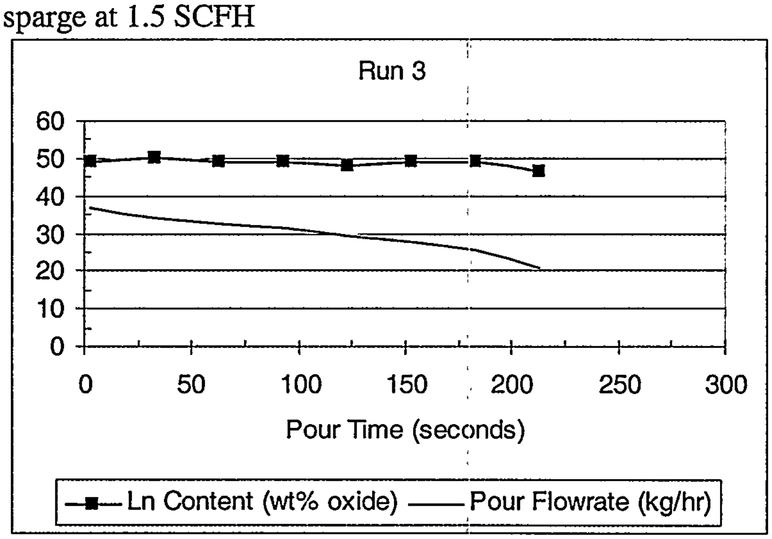
Run 1: 90 minute sparge at 1.5 SCFH: Line is discontinuous due to missing data point.



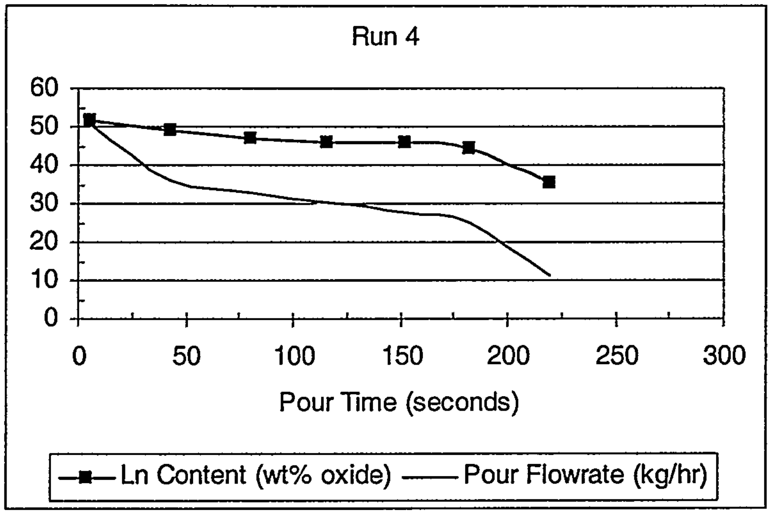
Run 2: 60 minute sparge at 1.5 SCFH



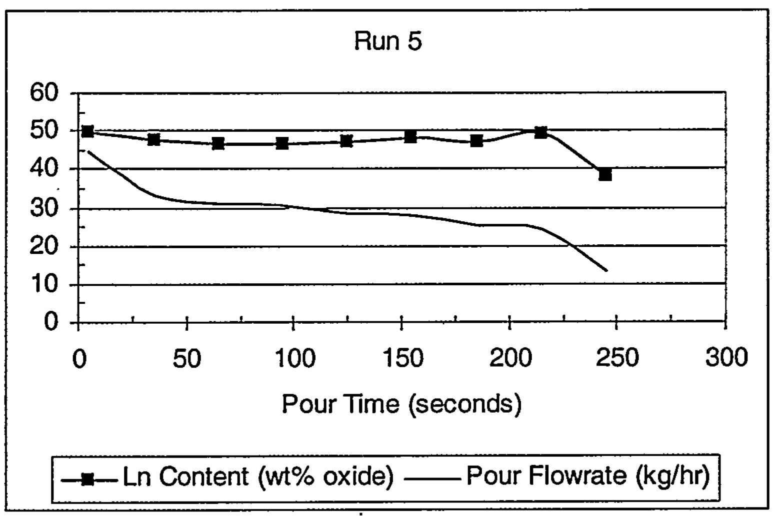
Run 3: 45 minute sparge at 1.5 SCFH



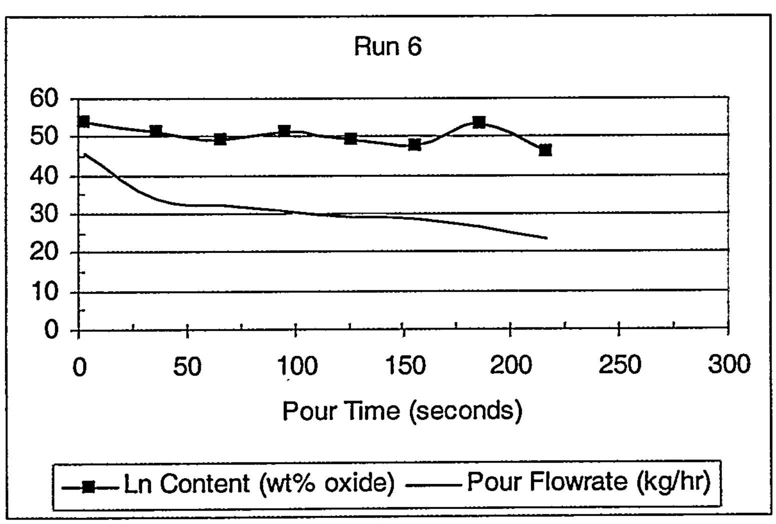
Run 4: 30 minute sparge at 1.5 SCFH



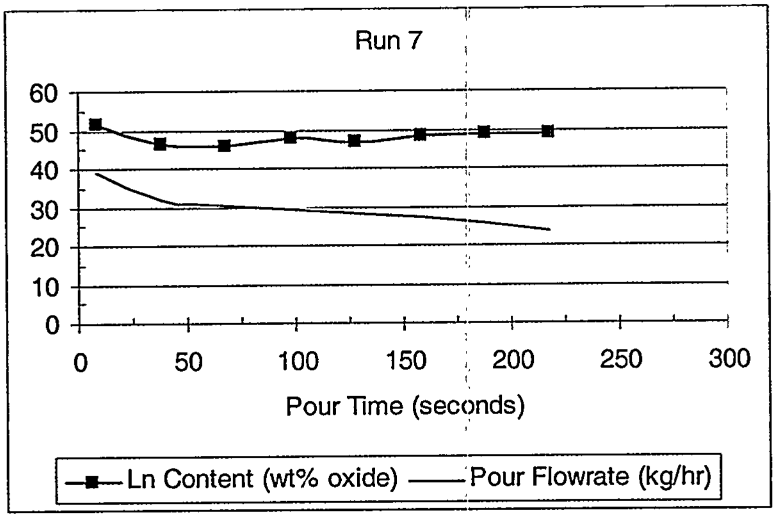
Run 5: 45 minute sparge at 1.0 SCFH



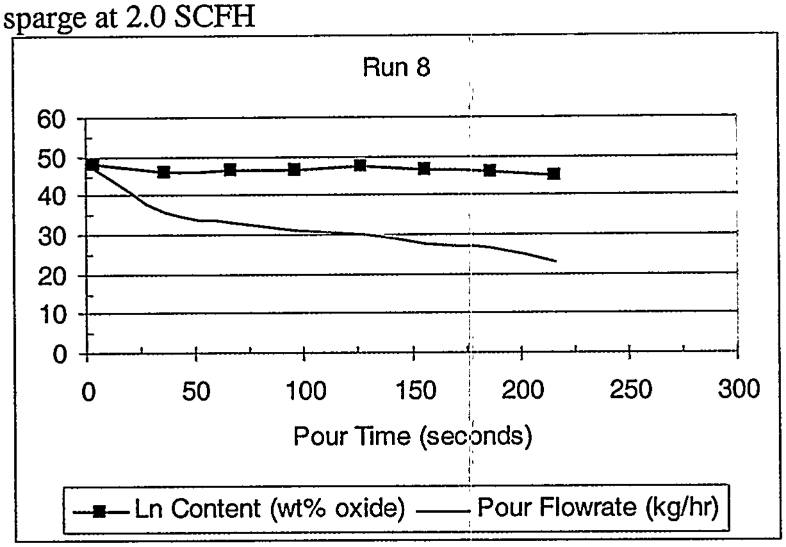
Run 6: 60 minute sparge at 1.0 SCFH



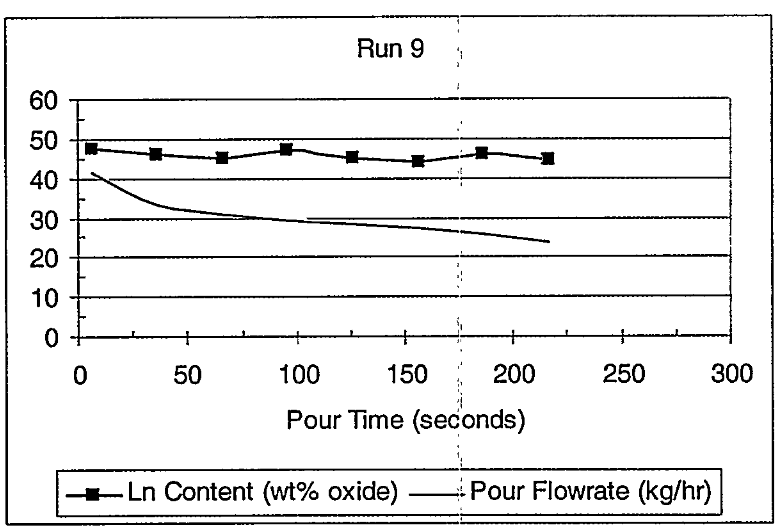
Run 7: 75 minute sparge at 1.5 SCFH



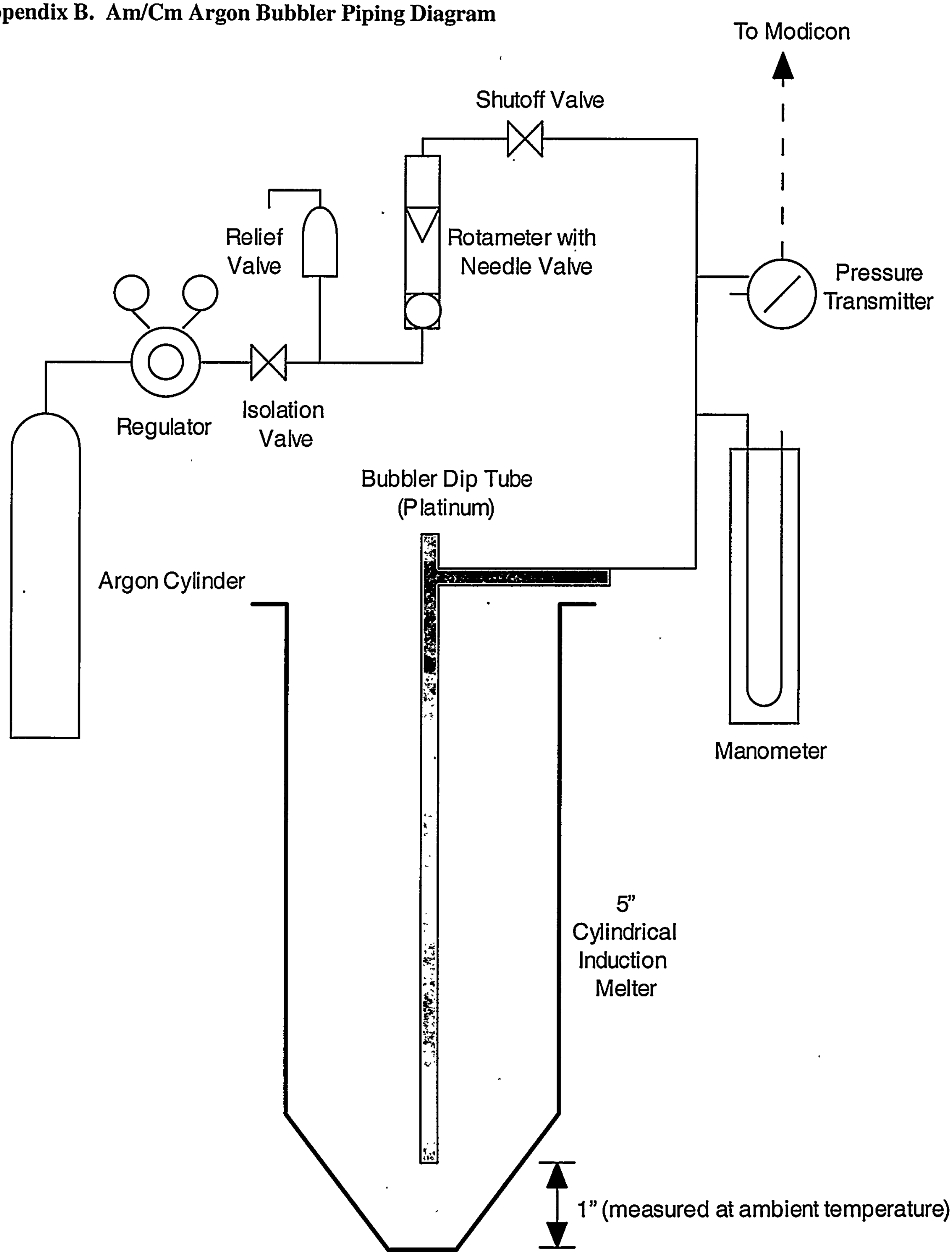
Run 8: 45 minute sparge at 2.0 SCFH



Run 9: 75 minute sparge at 1.5 SCFH with sparge dip tube raised to 1.75”



Appendix B. Am/Cm Argon Bubbler Piping Diagram



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