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SAVANNAH RIVER LABORATORY

DPST-80-418-Errata

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TO: J. K. OKESON

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THEORETICAL PREDICTIONS OF MELTING RATE IN A DRY-FED CYLINDRICAL GLASS MELTER - ERRATA

INTRODUCTION AND SUMMARY

A mathematical error was discovered* in the original derivations and is corrected here. A numerical error in the computation of Figure 3 was found, and Fig. 3 is presented in corrected form. The effect of these errors is to shift the theoretical melt rate upward compared to experimentally measured melt rates. The difference between theoretical and observed rates is probably due predominantly to foaming. Previous conclusions regarding the effects of increased coverage of the melt surface by the feedpile and the use of lid heaters remain unchanged.

DISCUSSION

A mathematical error occurred in (1-3). The correct equation is:

$$\frac{g\pi R_f^3 \rho_f \tan\theta}{3go} = \frac{g\pi R_f^2 d_{fb}(\rho_g - \rho_f)}{3go} \qquad (1\text{-}3)$$

* *Thanks to P. D. d'Entremont for bringing this error to my attention.*

Other important equations affected are listed in correct form below.

$$d_t > d_{fb}\Big|_{max} = \frac{R_m \rho_f \tan\theta}{\rho_g - \rho_f} \qquad (1\text{-}7)$$

$$d_t > 0.842 R_m \qquad (1\text{-}8)$$

$$\frac{\pi \rho_f \rho_g R_f^2 \tan\theta}{(\rho_g - \rho_f)} \frac{dR_f}{dt} = w_i - w_o \qquad (1\text{-}14)$$

$$h_{fa}(t) = \left[\frac{3(\rho_g - \rho_f)(w_i - w_o) t \tan^2\theta}{\pi \rho_f \rho_g}\right]^{1/3} \qquad (1\text{-}19)$$

$$\phi = \frac{w_o}{\pi R_m^2} = \frac{k_g \left[1 + \frac{\rho_f^2 \tan^2\theta}{(\rho_g - \rho_f)^2}\right]^{\frac{1}{2}} \frac{(T_g - T_m)}{\delta_t} + \frac{\sigma\left[T_w^4 - T_i^4\right]}{\cos\theta}}{c_{po} T_m - c_{pi} T_i} \qquad (1\text{-}35)$$

Figure 3 has been replotted with wall emissivity values of $\varepsilon_w = 0.75, 1.0$. This should enable one to bracket the range of the mass flux ϕ at high temperatures more accurately.

Finally, Table 2 has been reproduced to facilitate the comparison of experimental data with the corrected theory.

KRR:dj

Att

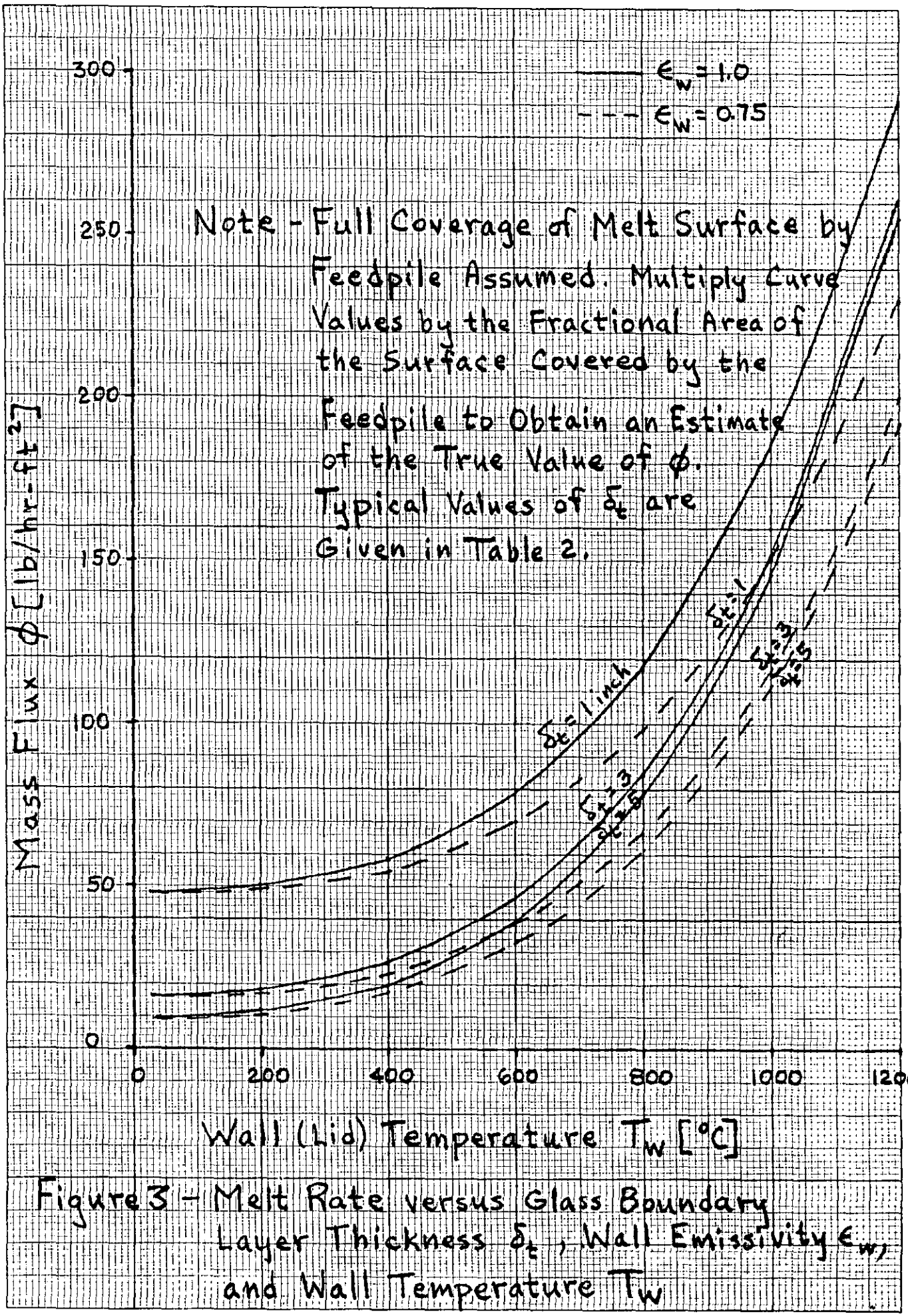

Figure 3 - Melt Rate versus Glass Boundary Layer Thickness δ_t, Wall Emissivity ϵ_w, and Wall Temperature T_w

TABLE 2 - COMPARISON OF THEORETICAL AND EXPERIMENTAL MELT RATES

Equipment	Reference	T_g (°C)	T_w (°C)	δ_t (inches)	Measured Nominal ϕ (lb/hr-ft^2)	Measured Max. ϕ (lb/hr-ft^2)	Surface Area (ft^2)	Glass	% of Surface Covered by Feedpile	Theoretical ϕ from Fig. 3 (lb/hr-ft^2)	Max. Theoretical ϕ from Fig. 3 (lb/hr-ft^2)
2D Computer Simulation of 675G Melter	1	1150	----	1-1.5	15-20*	----	12.6	Frit 21 + composite	100	----	----
3D Physical Model of 675G Melter	2	1150	----	3-4	>7.3*	----	3.14	Frit 21 + composite	100	----	----
CTD Melter at 773-A	3	1150	~700	1-2.5?	----	4.74	.167	Frit 21 + composite	25	14-24	55-96
	3	1150	~700	1-2.5?	----	7.90	.167	Frit 411 + Simulated Waste	25		
	4	1150	~700	1-2.5?	----	14.1	.167	Frit 211 + high Fe	25		
Small Rectangular Melter at TNX	5	1170	500+	~1.5	14.2	----	.901	Frit 411 + composite	33	13-17	40-50
	5	1170	500+	~1.5	15.0	----	.901	Frit 211 + TDS	<33		
Small Cylindrical Melter at TNX	6	1130-1180	1000-1050	4-5	----	13-17	1.28	Frit 211 + TDS	15-27	17-47	112-175
	6	1130-1180	600-800?	4-5	----	4.9-6.5	1.28	Frit 211 + TDS	15-27	5.0-22	33-82

TABLE 2 - COMPARISON OF THEORETICAL AND EXPERIMENTAL MELT RATES(Cont'd)

Equipment	Reference	T_g (°C)	T_w (°C)	δ_t (inches)	Measured Nominal ϕ (lb/hr-ft^2)	Measured Max. ϕ (lb/hr-ft^2)	Surface Area (ft^2)	Glass	% of Surface Covered by Feedpile	Theoretical ϕ from Fig. 3 (lb/hr-ft^2)	Max. Theoretical ϕ from Fig. 3 (lb/hr-ft^2)
CFCM Melter at PNL											
- CFCM5	7-9	1100-1250	650-750	3-5	10.3-11.1	12.9	8.56	Frit 411 + composite			
- CFCM6	10,11	1150-1230	650-700?	3-5?	16.7	20.6	8.56	Frit 411 + TDS, Frit 211 + TDS	~37	14-27	38-74
- CFCM7	11,12	1260-1340	650-700?	3-5?	14.6	18.0	8.56	Frit 211 + TDS			
- Sodium Silicate	13	1050-1070	650-700?	3-5?	12.8-15.4	----	8.56	Frit 211-SS + TDS			
DLF Melter at PNL	14	1290	300	4.3	12.7-20.0	20.0	11.33	Frit + Hanford Waste	~100	16-20	16-20
	15	1179	500-700?	----	8.09	9.93	11.33	Batch 411 + composite			
	15	1213	500-700?	----	----	17.7	11.33	Frit 411 + composite			
	16	1210	500-700?	9?	7.65	10.3	11.33	Frit 211 + TDS	~49	13-29	27-60
	17	1190	500-700?	4	----	17.7	11.33	Frit 211 + TDS			

* *Calculated values*