Results of the Calculation of φ for the Spherical Case

1) Metal ; density = 18 ; R = 4 cms

$\varphi = 0.6110$ (arithmetic mean)

HR = 1.7091

a) primitive formula

$\varphi_m = 0.633$

$V = 20,000\ cm^3$

$A\bar{Y} = 16.9$ cms (radius of cell)

b) cellular formula

$\varphi_m = 0.665$

$V = 22,000\ cm^3$

$A\bar{Y} = 17.5$ cms

$\left(\frac{Q^{th}}{Q_{exp}}\right)_m = 0.833$

$V = 40,000\ cm^3$ $\varphi = 0.599$ ($\frac{Q^{th}}{Q_{exp}}$ 10% higher) (10% decrease)

$V = 13,000\ cm^3$ $\varphi = 0.628$ ($\frac{Q^{th}}{Q_{exp}}$ 15% lower) (5% decrease)

$V = 10,000\ cm^3$ $\varphi = 0.507$ (25% decrease) ($\frac{Q^{th}}{Q_{exp}}$ 25% lower)

$\frac{wt(V)}{wt(C)} = 0.135$

2) Metal ; density = 18 ; R = 8 cms

~~$\varphi = 0.6664$~~ $\varphi = 0.7232$

~~HR = 2.3496~~ HR = 3.0728

a) primitive formula

$\varphi_m = 0.621$

$V = 53,100\ cm^3$

$A\bar{Y} = 23.6$ cms

b) cellular formula

$\varphi_m = 0.675$

$V = 57,000$

$A\bar{Y} = 24.2$ cms

$\left(\frac{Q^{th}}{Q_{exp}}\right)_m = 0.823$

$\frac{Q^{th}}{Q_{exp}}$ 20% lower

$V = 30,000\ cm^3$ $\varphi = 0.631$ (5% decrease)

$V = 100,000\ cm^3$ $\varphi = 0.641$ (5% decrease)

$\frac{Q^{th}}{Q_{exp}}$ 10% higher

$\frac{wt(V)}{wt(C)} = 0.416$

3) Metal; density = 18 ; R = 8 cms

constants changed:

$\left\{ \begin{array}{l} \nabla_{abs}(V) = \frac{5.5}{\sqrt{2}} \\ A = 45.4\sqrt{2} \end{array} \right.$ $\varphi = 0.6893$ HR = 2.4945

a) primitive formula :

$\varphi_m = 0.7030$

$V = 67,800\ cm^3$

$A\bar{Y} = 25.6$ cms

b) cellular formula

$\varphi_m = 0.743$

$V = 74,000\ cm^3$

$A\bar{Y} = 26.2$ cms

$\left(\frac{Q^{th}}{Q_{exp}}\right)_m = 0.859$

$V = 30,000\ cm^3$, φ is 15% lower , $\frac{Q^{th}}{Q_{exp}}$ is 20% lower

$V = 42,500\ cm^3$, φ is 5% lower , $\frac{Q^{th}}{Q_{exp}}$ is 10% lower

$V = 135,000\ cm^3$, φ is 5% lower , $\frac{Q^{th}}{Q_{exp}}$ is 8% higher

4) Oxide ; density = 6 ; R = 8 cms (old constants)

$\varphi = 0.5532$

HR = 1.4560

$\frac{wt(V)}{wt(C)} = 0.321$

a) primitive formula :

$\varphi_m = 0.583$

$V = 48,300\ cm^3$

$A\bar{Y} = 23$ cms

b) cellular formula

$\varphi_m = 0.626$

$V = 50,000\ cm^3$

$A\bar{Y} = 23$ cms

$\left(\frac{Q^{th}}{Q_{exp}}\right)_m = 0.794$

$\frac{Q^{th}}{Q_{exp}}$ 20% lower, $V = 27,000\ cm^3$; $\varphi = 0.561$ (10% decrease)

$\frac{Q^{th}}{Q_{exp}}$ 10% lower, $V = 37,000\ cm^3$, $\varphi = 0.607$ (5% decrease)

" 10% higher, $V = 80,000\ cm^3$; $\varphi = 0.597$ (5% decrease)

" 15% higher, $V = 100,000\ cm^3$; $\varphi = 0.570$ (10% decrease)

5) Oxide; density = 6; R = 12 cms :

$\varphi = 0.6845$

HR = 2.7420

a) primitive formula :

$\varphi_m = 0.590$

$V = 93,600\ cm^3$

$A\bar{Y} = 28.9$ cms

b) cellular formula :

$\varphi_m = 0.652$

$V = 100,000\ cm^3$

$A\bar{Y} = 29.5$ cms

$\left(\frac{Q^{th}}{Q_{exp}}\right)_m = 0.809$

$\frac{Q^{th}}{Q_{exp}}$ 25% lower; $V = 50,000$; $\varphi = 0.560$ (15% decrease)

" 12% lower; $V = 66,000$; $\varphi = 0.619$ (5% decrease)

" 09% higher; $V = 160,000$; $\varphi = 0.623$ (5% decrease)

" 11% higher; $V = 190,000$; $\varphi = 0.548$ (10% decrease)

Results (continued)

6) Oxide - density = 4 ; R = 10 cms

$\varphi = 0.5669$

$HR = 1,5970$

a) primitive formula :

$q_m = 0.572$

$V = 66,900 \text{ cm}^3$

$A\bar{Y} = 25.7 \text{ cms}$

b) Cellular formula :

$q_m = 0.622$

$V = 70,000 \text{ cm}^3$

$A\bar{Y} \simeq 26 \text{ cms}$

$\left(\frac{Q^{th}}{Q_{res}}\right)_m = 0.794$

V = 40,000	q = 0.562 (10% decrease)	$\frac{Q^{th}}{Q_{res}}$	20% lower
V = 54,000	q = 0.608 (5% decrease)	"	8% lower
V = 110,000	q = 0.595 (5% decrease)	"	10% higher
V = 133,000	q = 0.567 (10% decrease)	"	13% higher

7) Oxide ; density = 4 ; R = 16 cms

$\varphi = 0.7231$

$HR = 3.416$

a) primitive formula :

$q_m = 0.578$

$V = 147,000 \text{ cm}^3$

$A\bar{Y} = 34 \text{ cms}$

b) Cellular formula :

$q_m = 0.651$

$V = 162,400 \text{ cm}^3$

$A\bar{Y} = 35 \text{ cms}$

$\left(\frac{Q^{th}}{Q_{res}}\right)_m = 0.809$

V = 85,000	q = 0.572 (12% decrease)	$\frac{Q^{th}}{Q_{res}}$	22% lower
V = 108,000	q = 0.621 (5% decrease)	"	12% lower
V = 251,000	q = 0.622 (5% decrease)	"	8% higher
V = 340,000	q = 0.572 (12% decrease)	"	12% higher

8) Metal ; density = 18 ; R = 6 cms

$\varphi = 0.65089$

$HR = 2.1109$

a) primitive formula :

$q_m = 0.623$

$V = 35,000 \text{ cm}^3$

$A\bar{Y} = 20.4 \text{ cms}$

b) Cellular formula :

$q_m = 0.665$

$V = 37,900 \text{ cm}^3$

$A\bar{Y} = 21 \text{ cms}$

$\left(\frac{Q^{th}}{Q_{res}}\right)_m = 0.828$

V = 13,200 cm³	q = 0.472 (30% decrease)	$\frac{Q^{th}}{Q_{res}}$	40% lower
V = 19,700 cm³	q = 0.598 (10% decrease)	"	20% lower
V = 64,500 cm³	q = 0.623 (6.5% decrease)	"	8.5% higher
V = 81,500 cm³	q = 0.584 (12% decrease)	"	11% higher

$\frac{wt(v)}{wt(o)} = 0.264$

9) Oxide ; density = 4 ; R = 13 cms

$\varphi = 0.6587$

$HR = 2.4817$

a) primitive formula :

$q_m = 0.579$

$\bar{V} = 104,000 \text{ cm}^3$

$A\bar{Y} = 30 \text{ cms}$

b) Cellular formula :

$q_m = 0.641$

$V = 113,000 \text{ cm}^3$

$A\bar{Y} = 30.8 \text{ cms}$

$\left(\frac{Q^{th}}{Q_{res}}\right)_m = 0.805$

V = 56,000 cm³	q = 0.533 (17% decrease)	$\frac{Q^{th}}{Q_{res}}$	24% lower
V = 73,000 cm³	q = 0.607 (5.3% decrease)	"	13% lower
V = 186,000 cm³	q = 0.604 (5.8% decrease)	"	9.6% higher
V = 221,000 cm³	q = 0.577 (10% decrease)	"	12% higher

10) Metal ; density = 18 ; R = 5 cms

$\varphi = 0.59572$

$HR = 1.6358$

a) primitive formula

$q_m = 0.619$

$V = 26,800 \text{ cm}^3$

$A\bar{Y} = 18.6 \text{ cms}$

b) Cellular formula :

$q_m = 0.655$

$V = 28,200 \text{ cm}^3$

$A\bar{Y} = 19 \text{ cms}$

$\left(\frac{Q^{th}}{Q_{res}}\right)_m = 0.822$

V = 13,600 cm³	q = 0.567 (13% decrease)	$\frac{Q^{th}}{Q_{res}}$	23% lower
V = 20,000 cm³	q = 0.638 (2.6% decrease)	"	8.8% lower
V = 50,000 cm³	q = 0.607 (7.3% decrease)	"	9.6% higher
V = 65,000 cm³	q = 0.564 (14% decrease)	"	12% higher

$\frac{wt(o)}{wt(v)} = 0.205$

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Results of Calculations

I - Spherical Case - H and Φ:

R	H	Φ (diffusion)	Φ (optical)
2			0.4718
3	0.2451	0.4082	0.6090
4	0.2929	0.5185	0.7035
5	0.3272	0.5957	
6	0.3518	0.6509	
7	0.3702	0.6918	
8	0.3841	0.7232	

high temperature constants

R	H	Φ (diff.)	Φ (opt.)
4	0.2262	0.4599	0.5874
8	0.3118	0.6893	

II Cylindrical Case - H and Φ:

R	H	Φ (diffusion)	Φ (optical)
2	0.2512	0.6177	0.7077
3	0.3230	0.7341	0.9135
4	0.3665	0.7905	1.0553
5	0.3931	0.8233	
6	0.4100	0.8440	

III - Calculation of q_m:

Case	R	Φ	Primitive Formula q_m	V	AY	Wt(v)/Wt(c)	Cellular Formula q_m	V	AY	Wt(v)/Wt(c)
1) Spherical	3	0.5086 (mean)	0.617	13,000 m²	14.7 cms	0.0966				
$A = A_0\sqrt{10}$ *	4	0.6110 (mean)	0.633	20,000	16.9	0.148	0.665	22,000 m²	17.5 cms	0.135
	5	0.5957	0.619	26,400	18.6	0.220	0.655	28,200	19.0	0.205
	6	0.6509	0.623	34,700	20.4	0.288	0.665	37,900	21.0	0.264
	8	0.7232	0.621	53,100	23.6	0.446	0.675	57,000	24.2	0.416
2) Spherical - high temperature constants: $T_c = 1200°K$, $T_v = 600°K$	4	0.5237 (mean)	0.701	24,600	18.1	0.121				
	8	0.6893	0.703	67,800	25.6	0.350	0.743	74,000	26.3	0.321
3) Cylindrical -	2	0.6627 (mean)	0.589	931	17.3	0.149	.787 0.638	1005	18.0	0.138
	3	0.7699 (weighted mean)	0.596	1188	19.7	0.263	.815 0.664	1292	20.5	0.241
	4	0.7905	0.588	1394	21.4	0.398				
	5	0.8233	0.584	1602	23.1	0.541				
	6	0.8440	0.580	1800	24.7	0.694	0.823 0.680	2170	27.0	0.576
4) Volume effects										
a) Spherical	4	0.6110					0.701	19000	16.6	0.157
B' = 4.81 C = 0.2615	6	0.6509					0.671	35200	20.5	0.284
b) Cylindrical	2	0.6627					0.675	895	17.0	0.155
	3	0.7341					0.675	1228	20.0	0.254
	6	0.8440					0.624	2529	29	0.490
5) Large Sphere Correction:	4	0.6110					no effect			
	8	0.7232					0.673	57000	24.2	0.416
6) Large Cylinder Correction:	3	0.7341					0.663	1292	20.5	0.241
	6	0.8440					0.673	1930	25.5	0.648
7) $T_c = 3000°K$, $T_v = 300°K$ } Spherical:	4	0.6110	0.768	31,700	19.7	0.0938	0.793	33,242	20.0	0.0893
8) Spherical	4	0.5244	0.725	26,700	18.6	0.110	0.746	28,500	19.0	0.103
$T_c = 1800°K$				solution of diffusion eq.			0.740	28,500	19.0	0.103
$T_v = 600°K$	5	0.5663	0.725	36,500	20.7	0.159	0.750	38,300	21.0	0.151
				solution of diffusion eq.			0.747	38,300	21.0	0.151