Constants

$T_{base} = 120$ [C]

$T_{air} = 20$ [C]

$\theta_b = T_{base} - T_{air}$

$k = 70$ [W/(m·*·C)]

$W = 0.1$ [m]

Design Variable

D = 0.0075$_m$

a = 0.005$_m$

Calculated Values

$L = 10 \cdot a$

$h_{coeff} = 40$ [W/(m^{2}·*·C)]

$$\bar{h} = h_{coeff} \cdot \left[\frac{a}{0.005 \text{ [m]}}\right]^{0.4} \cdot \left[\frac{D}{0.01 \text{ [m]}}\right]^{-0.3}$$

Fin parameters

$$A_c = \pi \cdot \frac{D^2}{4}$$

$P = \pi \cdot D$

$$n_{fins} = \mathbf{FLOOR}^{2}\left[\frac{W}{a + D}\right]$$

$A_{base} = W^2 - n_{fins} \cdot A_c$

$$m = \sqrt{\bar{h} \cdot \frac{P}{k \cdot A_c}}$$

$cap_m = \sqrt{\bar{h} \cdot P \cdot k \cdot A_c} \cdot \theta_b$

$$q_{fin} = cap_m \cdot \left[\frac{\mathbf{sinh}\,(m \cdot L) + \frac{\bar{h}}{m \cdot k} \cdot \mathbf{cosh}\,(m \cdot L)}{\mathbf{cosh}\,(m \cdot L) + \frac{\bar{h}}{m \cdot k} \cdot \mathbf{sinh}\,(m \cdot L)}\right]$$

Total Heat Transfer

$q_{total} = q_{fin} \cdot n_{fins} + \bar{h} \cdot A_{base} \cdot \theta_b$

SOLUTION

Unit Settings: SI C kPa kJ mass deg

Maximization of q_total(a,D) = 357 120 iterations: Variable Metric method

d) model optimization results with D_min = a_min = 1mm

a = 0.001439 [m]
A_c = 7.854E-07 [m^2]
D = 0.001 [m]
h_{coeff} = 40 [$W/(m^2 \cdot * \cdot C)$]
L = 0.01439 [m]
n_{fins} = 1681
q_{fin} = 0.1873 [W]
θ_b = 100 [C]
T_{base} = 120 [C]
A_{base} = 0.00868 [m^2]
cap_m = 0.2894 [W]
$\bar{h}$ = 48.49 [$W/(m^2 * C)$]
k = 70 [$W/(m \cdot * \cdot C)$]
m = 52.64 [1/m]
P = 0.003142 [m]
q_{total} = 357 [W]
T_{air} = 20 [C]
W = 0.1 [m]

No unit problems were detected.

Parametric Table: Table 1

	a [m]	L [m]	n_{fins}	cap_m [W]	$\bar{h}$ [W/(m² * C)]	m [1/m]	q_{fin} [W]	q_{total} [W]
Run 1	0.001	0.01	121	4.085	22.91	13.21	0.6357	87.58
Run 2	0.00125	0.0125	121	4.272	25.04	13.81	0.8373	113
Run 3	0.0015	0.015	121	4.431	26.94	14.33	1.051	139.7
Run 4	0.00175	0.0175	100	4.569	28.65	14.78	1.273	143.3
Run 5	0.002	0.02	100	4.693	30.22	15.18	1.503	167.2
Run 6	0.00225	0.0225	100	4.805	31.68	15.54	1.737	191.4
Run 7	0.0025	0.025	100	4.907	33.05	15.87	1.974	215.9
Run 8	0.00275	0.0275	81	5.002	34.33	16.17	2.212	201.2
Run 9	0.003	0.03	81	5.089	35.55	16.46	2.449	221.2
Run 10	0.00325	0.0325	81	5.171	36.7	16.72	2.684	240.9
Run 11	0.0035	0.035	81	5.249	37.81	16.97	2.914	260.3
Run 12	0.00375	0.0375	64	5.322	38.87	17.21	3.139	228.8
Run 13	0.004	0.04	64	5.391	39.88	17.43	3.359	243.6
Run 14	0.00425	0.0425	64	5.457	40.86	17.64	3.571	257.8
Run 15	0.0045	0.045	64	5.519	41.81	17.85	3.775	271.6
Run 16	0.00475	0.0475	64	5.579	42.72	18.04	3.971	284.8
Run 17	0.005	0.05	49	5.637	43.61	18.23	4.159	237.9
Run 18	0.00525	0.0525	49	5.692	44.46	18.41	4.337	247.4
Run 19	0.0055	0.055	49	5.745	45.3	18.58	4.506	256.3
Run 20	0.00575	0.0575	49	5.797	46.11	18.74	4.667	264.8
Run 21	0.006	0.06	49	5.846	46.9	18.9	4.818	272.8
Run 22	0.00625	0.0625	49	5.894	47.68	19.06	4.961	280.4
Run 23	0.0065	0.065	49	5.94	48.43	19.21	5.095	287.6
Run 24	0.00675	0.0675	49	5.985	49.17	19.35	5.221	294.4
Run 25	0.007	0.07	36	6.029	49.89	19.5	5.34	234.2
Run 26	0.00725	0.0725	36	6.072	50.59	19.63	5.451	238.8
Run 27	0.0075	0.075	36	6.113	51.28	19.77	5.554	243.1
Run 28	0.00775	0.0775	36	6.153	51.96	19.9	5.652	247.2
Run 29	0.008	0.08	36	6.192	52.62	20.02	5.743	251
Run 30	0.00825	0.0825	36	6.231	53.28	20.15	5.828	254.6
Run 31	0.0085	0.085	36	6.268	53.92	20.27	5.908	258
Run 32	0.00875	0.0875	36	6.304	54.55	20.39	5.983	261.3
Run 33	0.009	0.09	36	6.34	55.16	20.5	6.053	264.3
Run 34	0.00925	0.0925	25	6.375	55.77	20.61	6.12	202.6
Run 35	0.0095	0.095	25	6.409	56.37	20.72	6.182	204.7

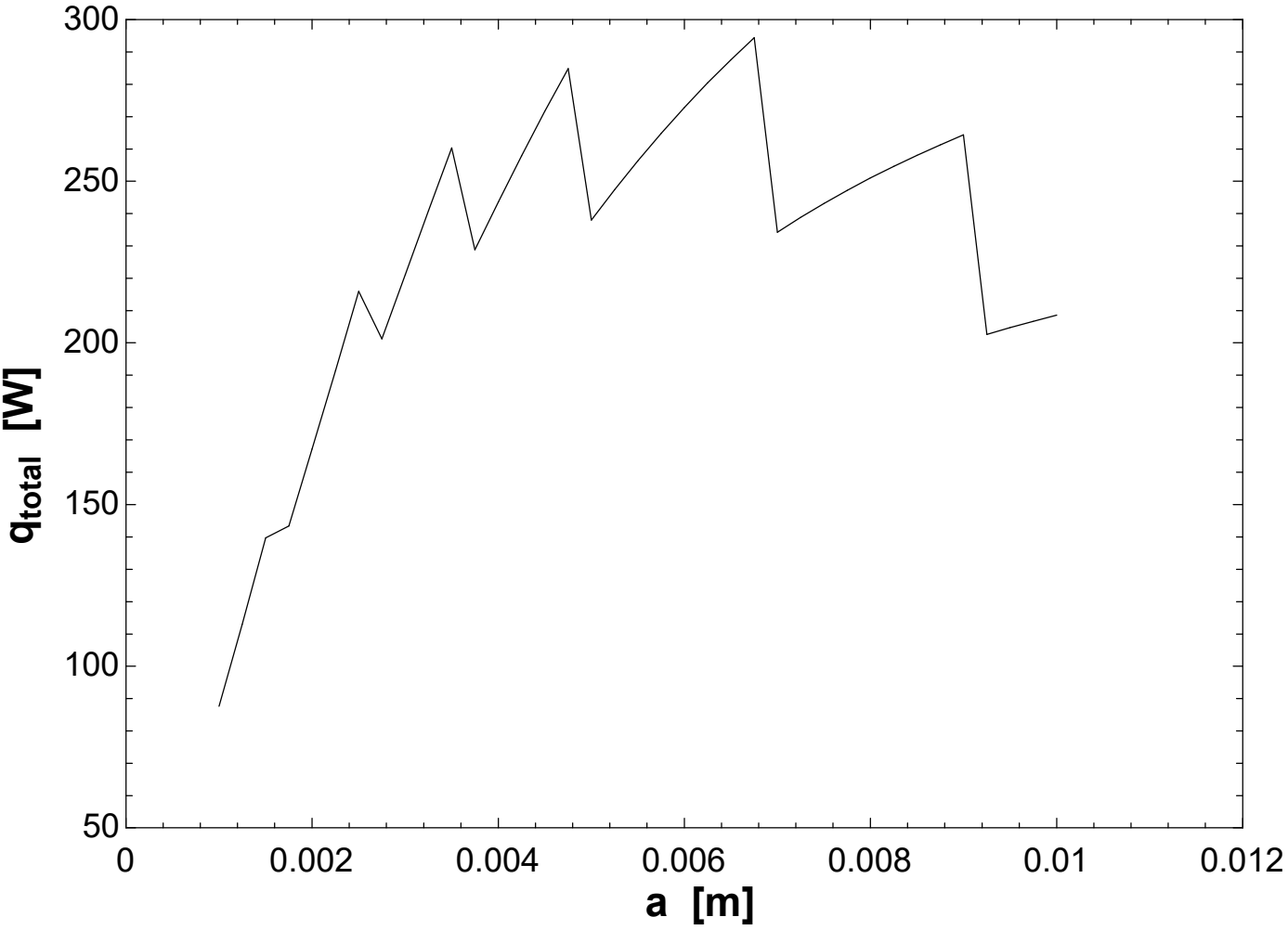
a) q_total for a=0.5cm, D=0.75cm

Parametric Table: Table 1

	a [m]	L [m]	n_{fins}	cap_m [W]	$\bar{h}$ [W/(m² * C)]	m [1/m]	q_{fin} [W]	q_{total} [W]
Run 36	0.00975	0.0975	25	6.442	56.96	20.83	6.24	206.7
Run 37	0.01	0.1	25	6.475	57.54	20.94	6.296	208.6

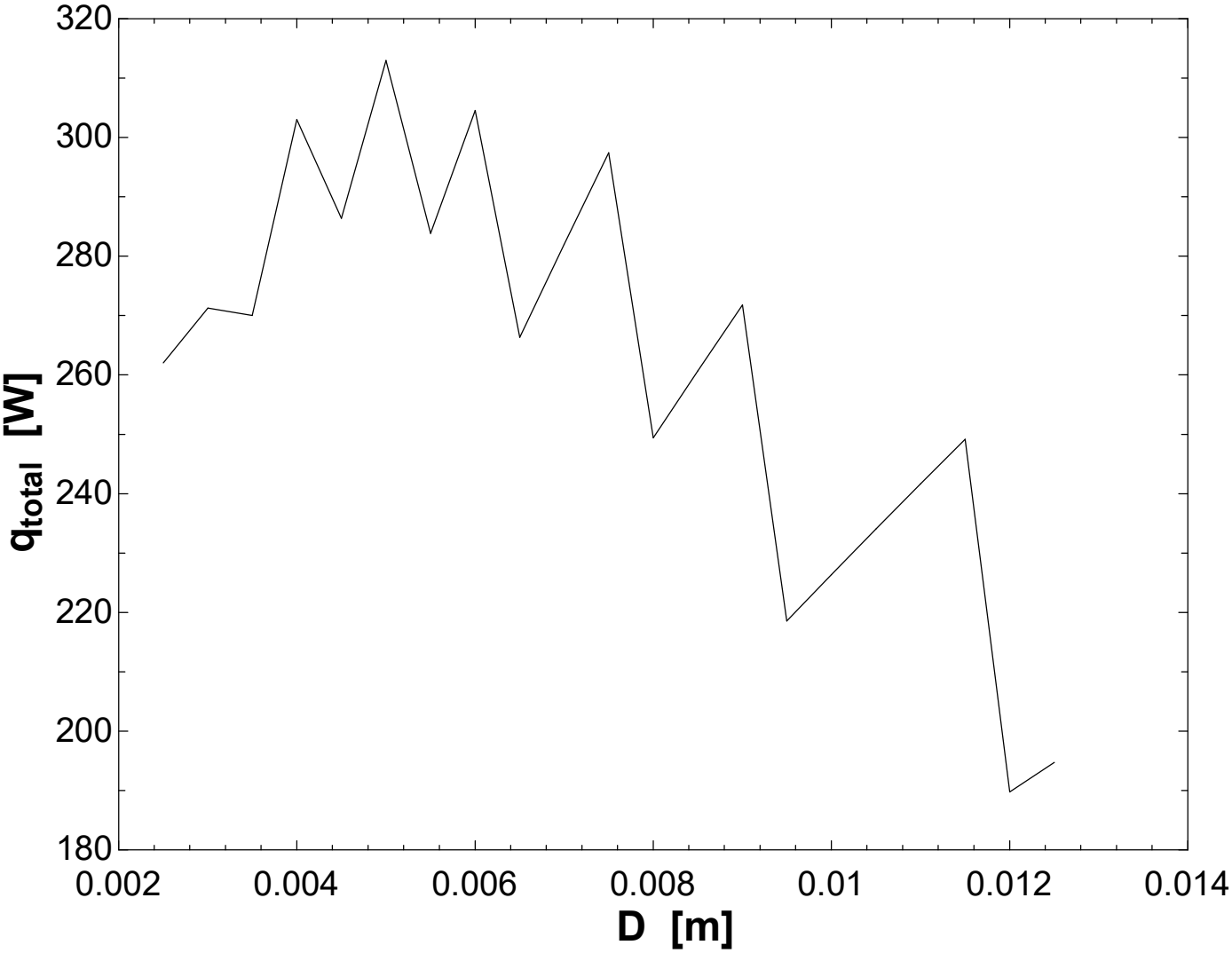
Parametric Table: Table 2

	D [m]	n_{fins}	$\bar{h}$ [W/(m² * C)]	m [1/m]	cap_m [W]	q_{fin} [W]	q_{total} [W]
Run 1	0.0025	169	60.63	37.23	1.279	1.221	262
Run 2	0.003	144	57.4	33.07	1.636	1.526	271.3
Run 3	0.0035	121	54.81	29.91	2.015	1.831	270
Run 4	0.004	121	52.66	27.43	2.413	2.135	303
Run 5	0.0045	100	50.83	25.41	2.828	2.436	286.4
Run 6	0.005	100	49.25	23.72	3.261	2.734	313
Run 7	0.0055	81	47.86	22.3	3.708	3.027	283.8
Run 8	0.006	81	46.62	21.07	4.171	3.316	304.6
Run 9	0.0065	64	45.52	20	4.647	3.601	266.3
Run 10	0.007	64	44.52	19.06	5.135	3.882	282
Run 11	0.0075	64	43.61	18.23	5.637	4.159	297.4
Run 12	0.008	49	42.77	17.48	6.15	4.432	249.4
Run 13	0.0085	49	42	16.8	6.674	4.701	260.7
Run 14	0.009	49	41.28	16.19	7.21	4.967	271.8
Run 15	0.0095	36	40.62	15.63	7.756	5.23	218.5
Run 16	0.01	36	40	15.12	8.312	5.49	226.3
Run 17	0.0105	36	39.42	14.65	8.878	5.747	234
Run 18	0.011	36	38.87	14.21	9.453	6.002	241.6
Run 19	0.0115	36	38.36	13.81	10.04	6.254	249.2
Run 20	0.012	25	37.87	13.43	10.63	6.504	189.8
Run 21	0.0125	25	37.41	13.08	11.23	6.752	194.7



b) plot of q_total vs a for a fixed value of D=0.75cm, using L=10a

Spikes in plots are due to the number of fins being forced rounded down to an integer.



c) plot of q_total vs D for a fixed value of a=0.5cm