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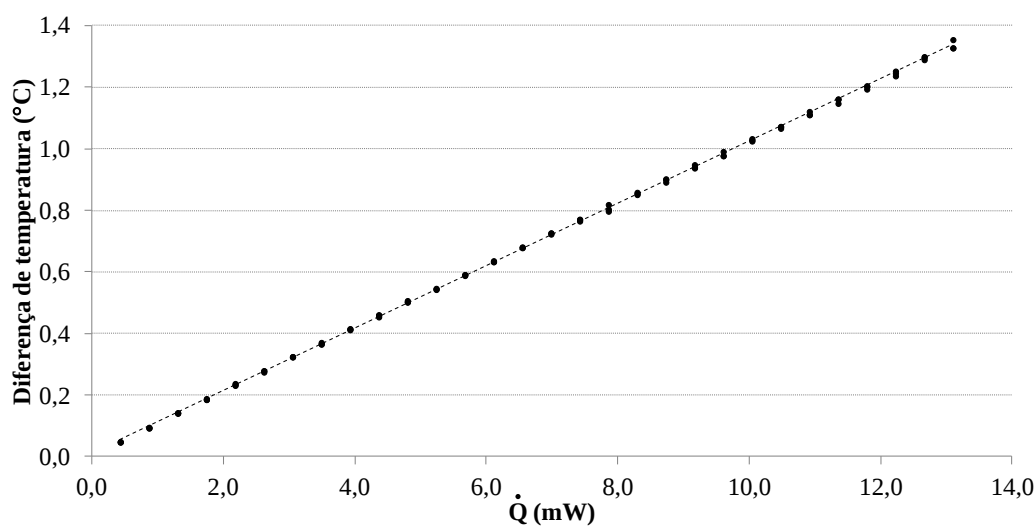
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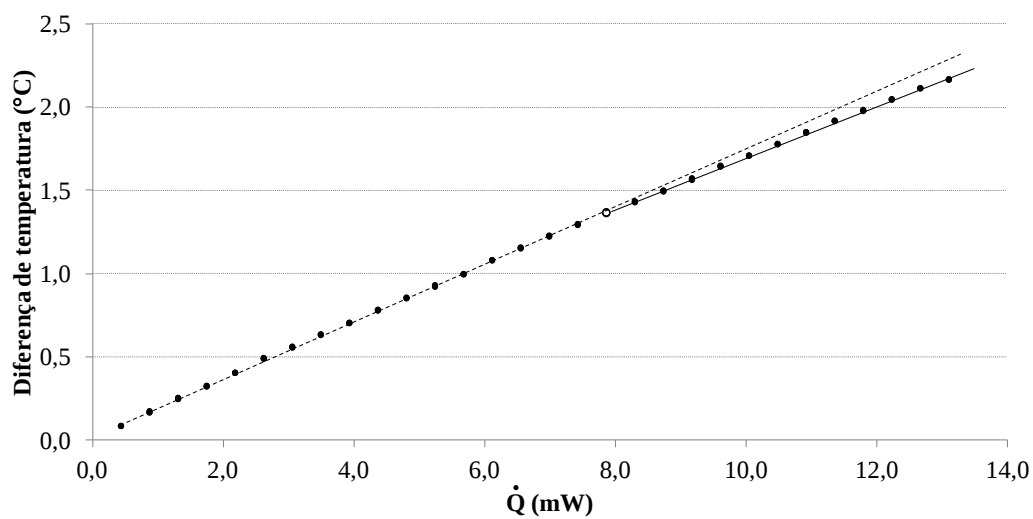
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APÊNDICE A

ΔT em função de $\dot{Q}$ para o item 01 em água destilada

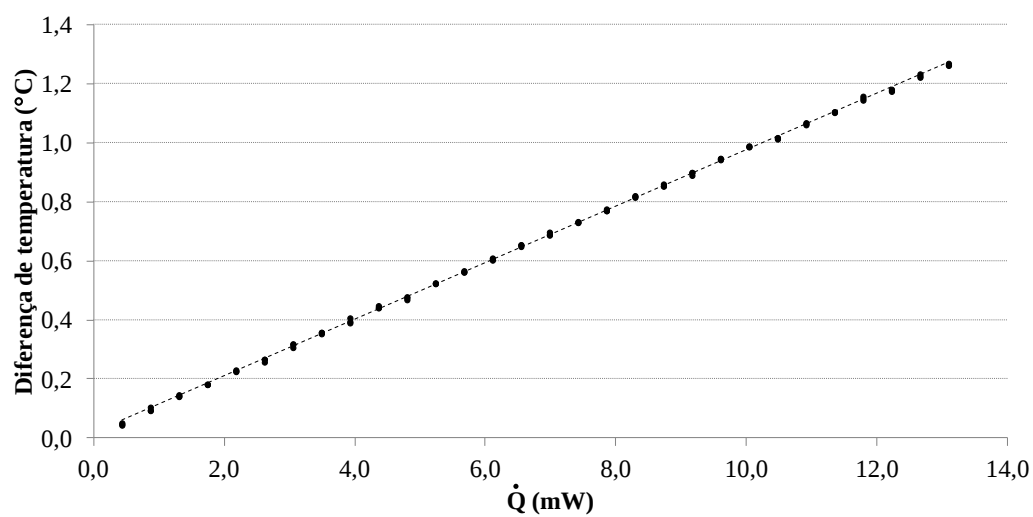


ΔT em função de $\dot{Q}$ para o item 01 em etanol

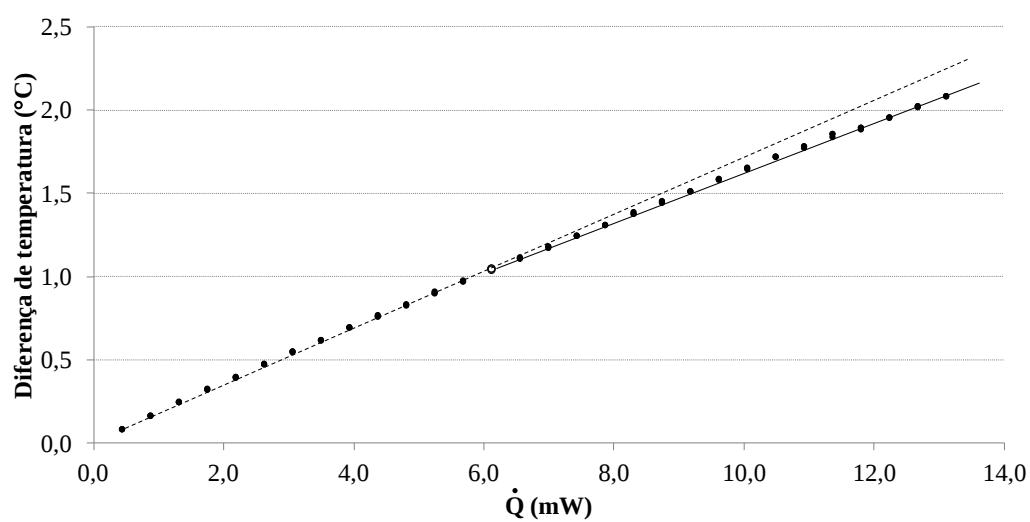


Continuação do APÊNDICE A

ΔT em função de $\dot{Q}$ para o item 02 em água destilada



ΔT em função de $\dot{Q}$ para o item 02 em etanol



APÊNDICE B

Fatores de abrangência para vários graus de liberdade em diversos níveis de confiança – GUM 2008 (Inmetro, 2012b)

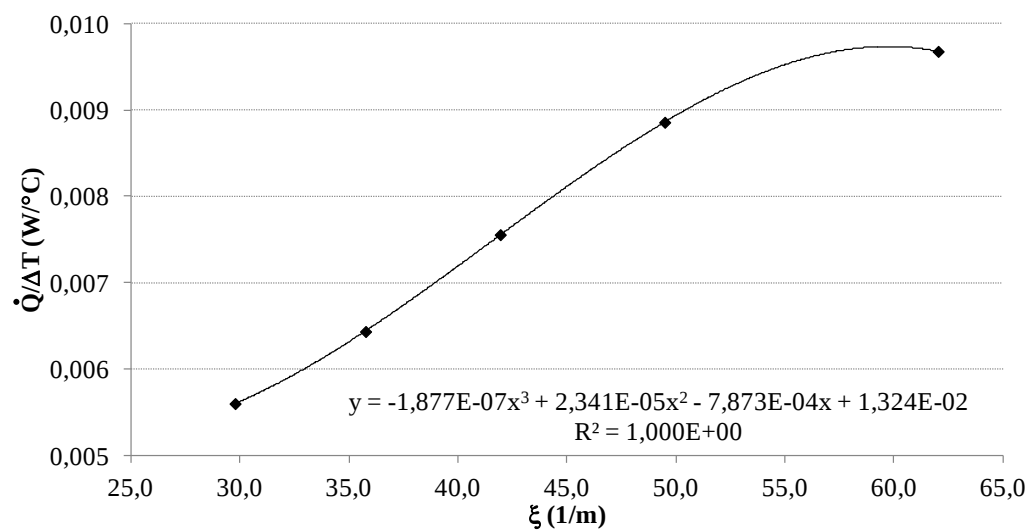
Tabela G 2 — Valor de $t_p(v)$ da distribuição- t para v graus de liberdade que define um intervalo $-t_p(v)$ a $+t_p(v)$ que abrange a fração p da distribuição

Graus de liberdade v	Fração p em porcentagem					
	68,27 ^{a)}	90	95	95,45 ^{a)}	99	99,73 ^{a)}
1	1,84	6,31	12,71	13,97	63,66	235,78
2	1,32	2,92	4,30	4,53	9,92	19,21
3	1,20	2,35	3,18	3,31	5,84	9,22
4	1,14	2,13	2,78	2,87	4,60	6,62
5	1,11	2,02	2,57	2,65	4,03	5,51
6	1,09	1,94	2,45	2,52	3,71	4,90
7	1,08	1,89	2,36	2,43	3,50	4,53
8	1,07	1,86	2,31	2,37	3,36	4,28
9	1,06	1,83	2,26	2,32	3,25	4,09
10	1,05	1,81	2,23	2,28	3,17	3,96
11	1,05	1,80	2,20	2,25	3,11	3,85
12	1,04	1,78	2,18	2,23	3,05	3,76
13	1,04	1,77	2,16	2,21	3,01	3,69
14	1,04	1,76	2,14	2,20	2,98	3,64
15	1,03	1,75	2,13	2,18	2,95	3,59
16	1,03	1,75	2,12	2,17	2,92	3,54
17	1,03	1,74	2,11	2,16	2,90	3,51
18	1,03	1,73	2,10	2,15	2,88	3,48
19	1,03	1,73	2,09	2,14	2,86	3,45
20	1,03	1,72	2,09	2,13	2,85	3,42
25	1,02	1,71	2,06	2,11	2,79	3,33
30	1,02	1,70	2,04	2,09	2,75	3,27
35	1,01	1,69	2,03	2,07	2,72	3,23
40	1,01	1,68	2,02	2,06	2,70	3,20
45	1,01	1,68	2,01	2,06	2,69	3,18
50	1,01	1,68	2,01	2,05	2,68	3,16
100	1,005	1,660	1,984	2,025	2,626	3,077
∞	1,000	1,645	1,960	2,000	2,576	3,000

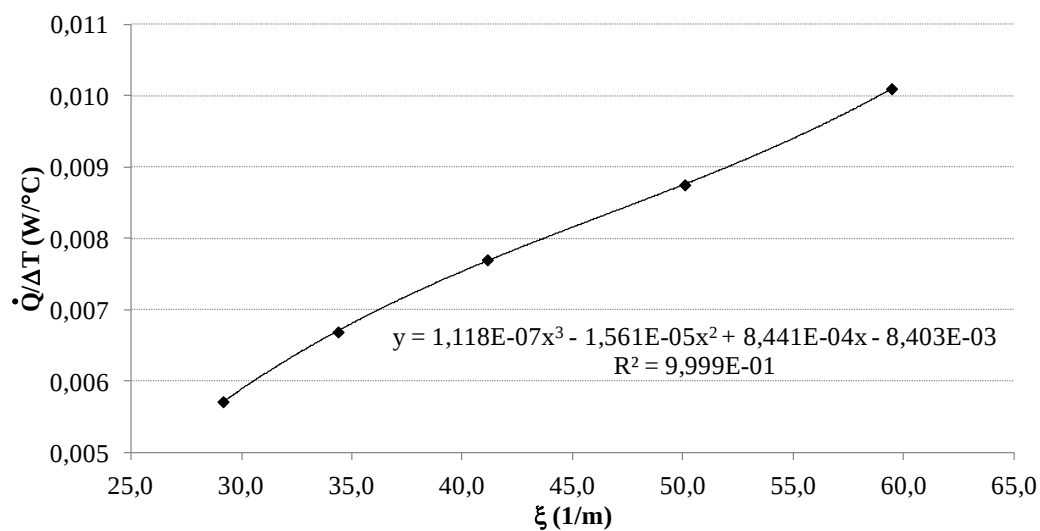
a) Para uma grandeza z descrita por uma distribuição normal, com esperança μ_z e desvio-padrão σ , o intervalo $\mu_z \pm k\sigma$ abrange $p = 68,27, 95,45$ e $99,73$ por cento da distribuição para $k = 1, 2$ e 3 , respectivamente.

APÊNDICE C

Ajuste da curva de regressão de $\dot{Q}/\Delta T \times \xi$ - Item 01



Ajuste da curva de regressão de $\dot{Q}/\Delta T \times \xi$ - Item 02



APÊNDICE D

Coeficiente de sensibilidade de k em relação à razão experimental $\dot{Q}/\Delta T$

Função $\lambda = \dot{Q}/\Delta T$ das variáveis independentes k e ξ

$$\lambda = \frac{\dot{Q}}{\Delta T} \quad \xi = \frac{k}{\lambda}$$

Ajuste das curvas de regressão dos itens 01 e 02

$$\lambda = a\xi^3 + b\xi^2 + c\xi + d$$

Considerando a função $f(k, \lambda)$ das variáveis independentes k e λ

$$f = a\xi^3 + b\xi^2 + c\xi + d - \lambda$$

Pela regra da cadeia,

$$df = \frac{\partial f}{\partial k} dk + \frac{\partial f}{\partial \lambda} d\lambda$$

Derivada parcial em relação a k , mantendo λ constante

$$\frac{\partial f}{\partial k} = \frac{\partial f}{\partial \xi} \frac{\partial \xi}{\partial k} = (3a\xi^2 + 2b\xi + c)\lambda^{-1}$$

Derivada parcial em relação a λ , mantendo k constante

$$\frac{\partial f}{\partial \lambda} = \frac{\partial(a\xi^3 + b\xi^2 + c\xi + d)}{\partial \xi} \frac{\partial \xi}{\partial \lambda} - 1 = (3a\xi^2 + 2b\xi + c)\left(\frac{-k}{\lambda^2}\right) - 1 = \dots$$

$$\dots = -\left[(3a\xi^2 + 2b\xi + c)\left(\frac{\xi}{\lambda}\right) + 1\right]$$

Assim,

$$df = (3a\xi^2 + 2b\xi + c)\frac{1}{\lambda} dk - \left[(3a\xi^2 + 2b\xi + c)\left(\frac{\xi}{\lambda}\right) + 1\right] d\lambda$$

Porém, $f = 0$ e $df = 0$. Assim, substituindo:

$$\frac{dk}{d\lambda} = \xi + \frac{\lambda}{(3a\xi^2 + 2b\xi + c)}$$

APÊNDICE E

Estimativa da incerteza de medição de k para o item 01

Água destilada

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
$\dot{Q} / \Delta T$	0,00021	W/°C	Normal	2	-132,447	-0,0138	∞
k_L	0,0019	W/m. °C	Normal	1	1	0,0019	15384
Resolução	0,001	W/m. °C	Retangular	3,46	1	0,0003	∞
Ajuste	0,000008	W/°C	Normal	1	-132,447	-0,0011	∞
Incerteza combinada u_C						0,0139	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						0,028	

75% Água + 25% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
$\dot{Q} / \Delta T$	0,00016	W/°C	Normal	2	108,269	0,0087	∞
k_L	0,0037	W/m. °C	Normal	1	1	0,0037	171
Resolução	0,001	W/m. °C	Retangular	3,46	1	0,0003	∞
Ajuste	0,000008	W/°C	Normal	1	108,269	0,0009	∞
Incerteza combinada u_C						0,0095	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						0,019	

50% Água + 50% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
$\dot{Q} / \Delta T$	0,00018	W/°C	Normal	2	82,593	0,0074	∞
k_L	0,0025	W/m. °C	Normal	1	1	0,0025	392
Resolução	0,001	W/m. °C	Retangular	3,46	1	0,0003	∞
Ajuste	0,000008	W/°C	Normal	1	82,593	0,0007	∞
Incerteza combinada u_C						0,0079	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						0,016	

25% Água + 75% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
$\dot{Q} / \Delta T$	0,00014	W/°C	Normal	2	74,313	0,0053	∞
k_L	0,0015	W/m. °C	Normal	1	1	0,0015	594
Resolução	0,001	W/m. °C	Retangular	3,46	1	0,0003	∞
Ajuste	0,000008	W/°C	Normal	1	74,313	0,0006	∞
Incerteza combinada u_C						0,0056	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						0,011	

Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
$\dot{Q} / \Delta T$	0,00008	W/°C	Normal	2	81,890	0,0032	∞
k_L	0,0013	W/m. °C	Normal	1	1	0,0013	273
Resolução	0,001	W/m. °C	Retangular	3,46	1	0,0003	∞
Ajuste	0,000008	W/°C	Normal	1	81,890	0,0007	∞
Incerteza combinada u_C						0,0035	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						0,007	

Continuação do APÊNDICE E

Estimativa da incerteza de medição de k para o item 02

Água destilada

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
$\dot{Q} / \Delta T$	0,00030	W/°C	Normal	2	117,649	0,0178	∞
k_L	0,0019	W/m. °C	Normal	1	1	0,0019	43756
Resolução	0,001	W/m. °C	Retangular	3,46	1	0,0003	∞
Ajuste	0,000025	W/°C	Normal	1	117,649	0,0029	∞
Incerteza combinada u_C						0,0181	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						0,036	

75% Água + 25% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
$\dot{Q} / \Delta T$	0,00022	W/°C	Normal	2	121,913	0,0132	∞
k_L	0,0037	W/m. °C	Normal	1	1	0,0037	824
Resolução	0,001	W/m. °C	Retangular	3,46	1	0,0003	∞
Ajuste	0,000025	W/°C	Normal	1	121,913	0,0030	∞
Incerteza combinada u_C						0,0140	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						0,028	

50% Água + 50% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
$\dot{Q} / \Delta T$	0,00017	W/°C	Normal	2	101,574	0,0088	∞
k_L	0,0025	W/m. °C	Normal	1	1	0,0025	827
Resolução	0,001	W/m. °C	Retangular	3,46	1	0,0003	∞
Ajuste	0,000025	W/°C	Normal	1	101,574	0,0025	∞
Incerteza combinada u_C						0,0095	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						0,019	

25% Água + 75% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
$\dot{Q} / \Delta T$	0,00015	W/°C	Normal	2	74,373	0,0055	∞
k_L	0,0015	W/m. °C	Normal	1	1	0,0015	777
Resolução	0,001	W/m. °C	Retangular	3,46	1	0,0003	∞
Ajuste	0,000025	W/°C	Normal	1	74,373	0,0019	∞
Incerteza combinada u_C						0,0060	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						0,012	

Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
$\dot{Q} / \Delta T$	0,00017	W/°C	Normal	2	55,254	0,0047	∞
k_L	0,0013	W/m. °C	Normal	1	1	0,0013	1146
Resolução	0,001	W/m. °C	Retangular	3,46	1	0,0003	∞
Ajuste	0,000025	W/°C	Normal	1	55,254	0,0014	∞
Incerteza combinada u_C						0,0050	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						0,010	

APÊNDICE F

Estimativa da incerteza de medição do teor de água para o item 01

75% Água + 25% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
k	0,019	W/m. °C	Normal	2	168	1,586	∞
Resolução	0,1	%	Retangular	3,46	1	0,029	∞
Ajuste	0,39	%	Normal	1	1	0,390	∞
Incerteza combinada u_C						1,63	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						3,3	

50% Água + 50% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
k	0,016	W/m. °C	Normal	2	248	1,980	∞
Resolução	0,1	%	Retangular	3,46	1	0,029	∞
Ajuste	0,39	%	Normal	1	1	0,390	∞
Incerteza combinada u_C						2,02	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						4,0	

25% Água + 75% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
k	0,011	W/m. °C	Normal	2	345	1,891	∞
Resolução	0,1	%	Retangular	3,46	1	0,029	∞
Ajuste	0,39	%	Normal	1	1	0,390	∞
Incerteza combinada u_C						1,93	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						3,9	

5% Água + 95% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
k	0,008	W/m. °C	Normal	2	406	1,583	∞
Resolução	0,1	%	Retangular	3,46	1	0,029	∞
Ajuste	0,39	%	Normal	1	1	0,390	∞
Incerteza combinada u_C						1,63	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						3,3	

Continuação do APÊNDICE F

Estimativa da incerteza de medição do teor de água para o item 02

75% Água + 25% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
k	0,028	W/m. °C	Normal	2	178	2,493	∞
Resolução	0,1	%	Retangular	3,46	1	0,029	∞
Ajuste	0,39	%	Normal	1	1	0,390	∞
Incerteza combinada u_C						2,52	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						5,0	

50% Água + 50% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
k	0,019	W/m. °C	Normal	2	244	2,315	∞
Resolução	0,1	%	Retangular	3,46	1	0,029	∞
Ajuste	0,39	%	Normal	1	1	0,390	∞
Incerteza combinada u_C						2,35	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						4,7	

25% Água + 75% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
k	0,012	W/m. °C	Normal	2	339	2,029	∞
Resolução	0,1	%	Retangular	3,46	1	0,029	∞
Ajuste	0,39	%	Normal	1	1	0,390	∞
Incerteza combinada u_C						2,07	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						4,1	

5% Água + 95% Etanol

Grandeza	Valor	Unidade	Distribuição	Divisor	c_i	u	v_{eff}
k	0,011	W/m. °C	Normal	2	423	2,324	∞
Resolução	0,1	%	Retangular	3,46	1	0,029	∞
Ajuste	0,39	%	Normal	1	1	0,390	∞
Incerteza combinada u_C						2,36	
Fator de abrangência κ (95,45%)						2,0	
Incerteza expandida U						4,7	