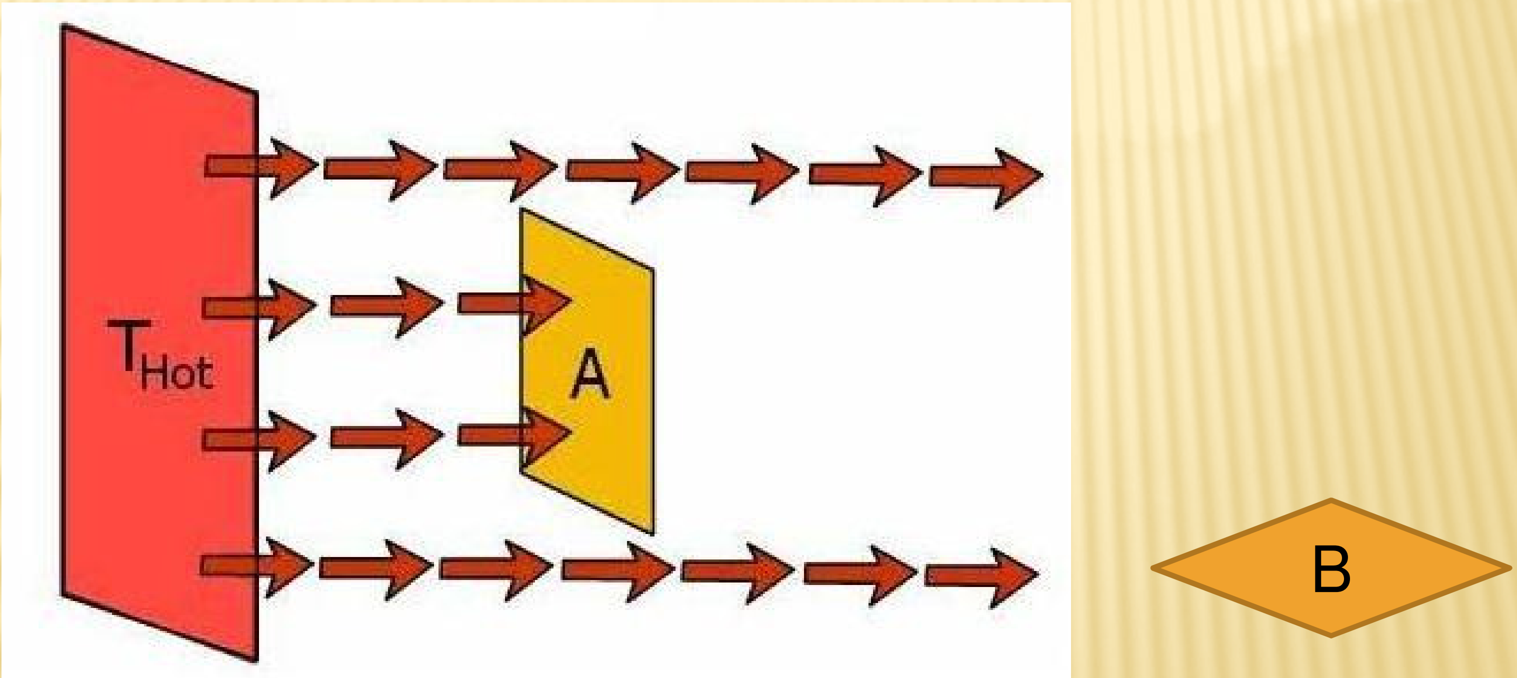
Radiação Atingindo um Alvo



Mesma radiação emitida, mas a quantidade recebida pelos alvos A e B é diferente!

Configuration Factor

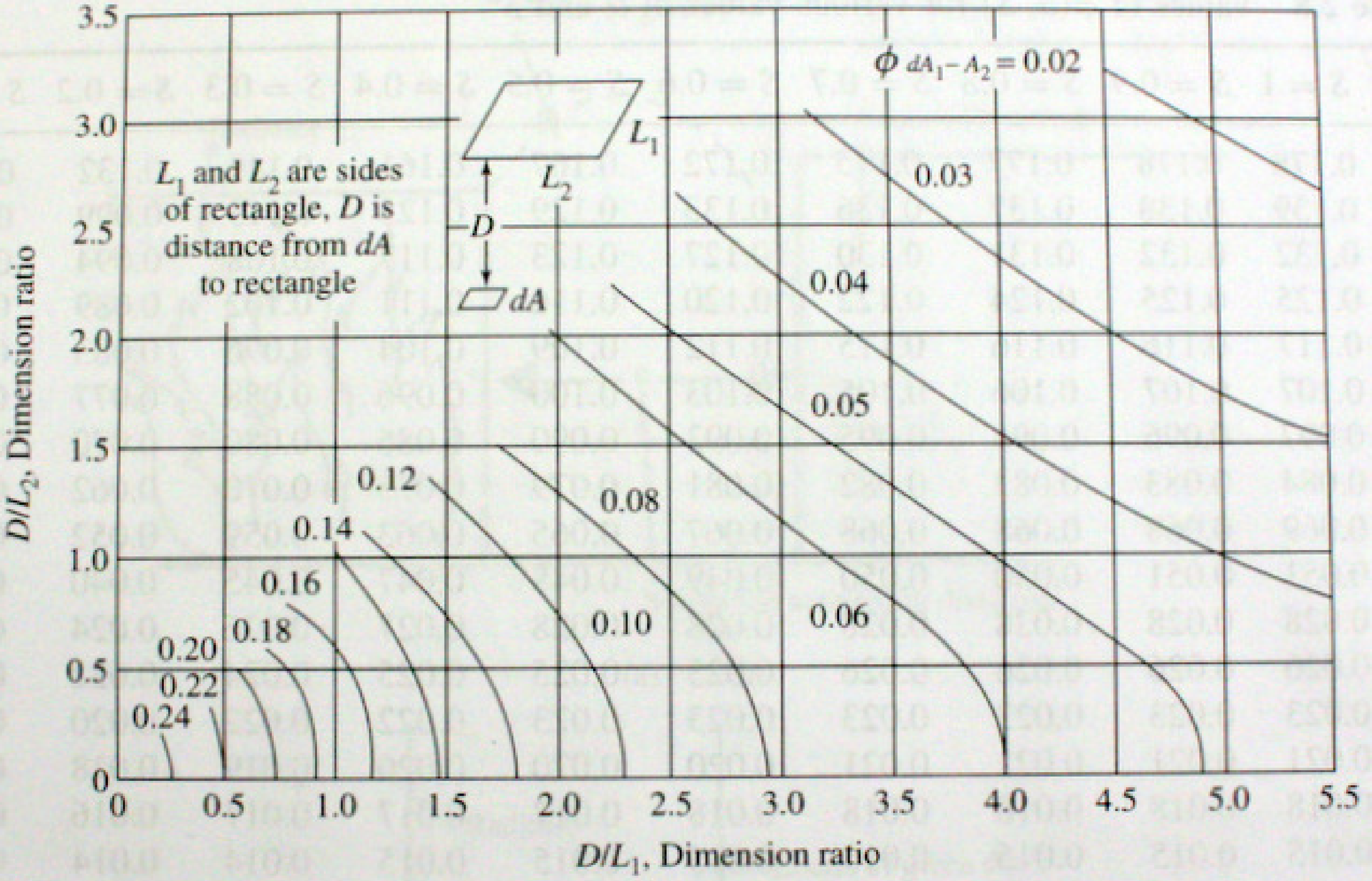
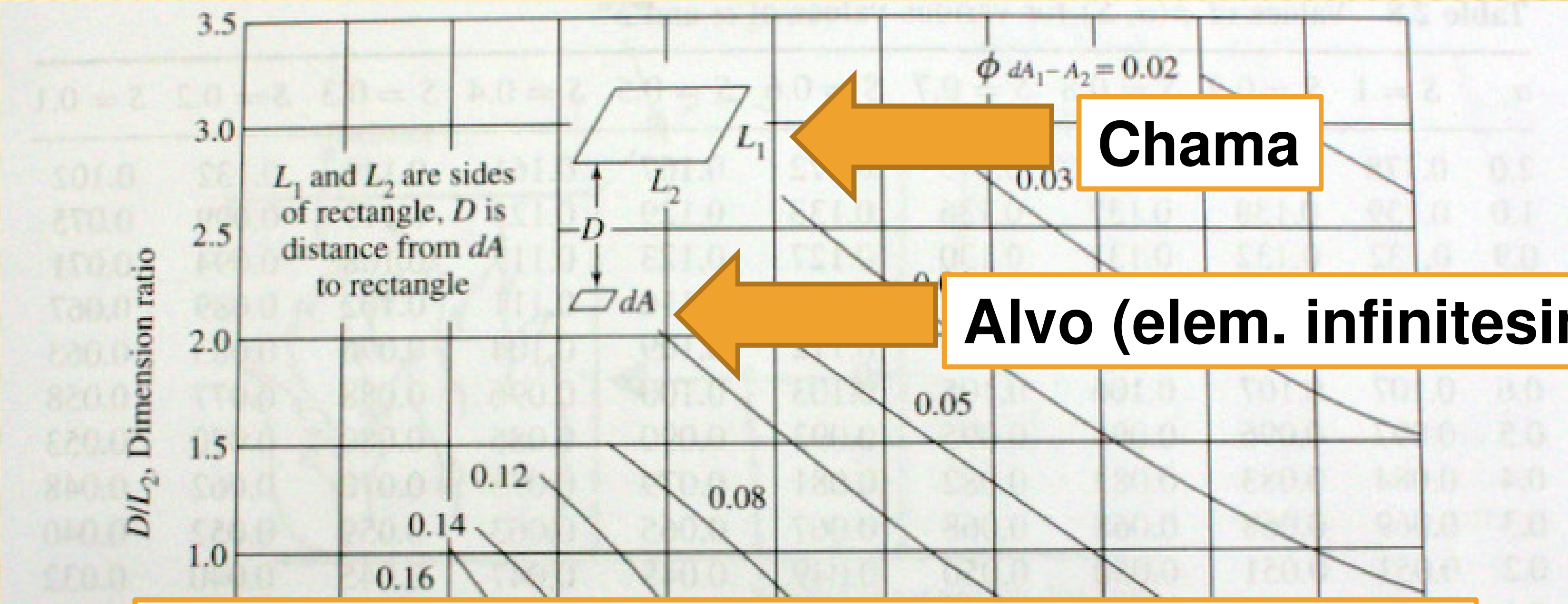


Figure 2.22 Configuration factor ϕ for direct radiation from a rectangle to a parallel small element of surface dA lying on a perpendicular to a corner of the radiator (Figure 2.23(a)) (Hottel, 1930). Reproduced by permission of John Wiley & Sons, Inc

Configuration Factor



Note que, embora o alvo real seja muito grande, considero a projeção em relação a uma parte infinitesimal do alvo.

Isso ocorre pois desejo saber se essa parte infinitesimal recebe radiação suficiente para sofrer ignição (pilotada ou não).

Figure 2.22 Configuration factor ϕ for direct radiation from a rectangle to a parallel small element of surface dA lying on a perpendicular to a corner of the radiator (Figure 2.23(a)) (Hottel, 1930). Reproduced by permission of John Wiley & Sons, Inc

Configuration Factor

Mesmo que o alvo tenha dimensões próximas ou maiores que a chama, o Configuration Factor pode ser calculado como alvo infinitesimal.

Não importa o fluxo sobre todo o alvo, é relevante apenas o que atinge um ponto infinitesimal. Caso esse ponto infinitesimal receba um fluxo de calor suficiente, irá sofrer ignição e propagar as chamas pelo restante do alvo.

Configuration Factor

A CATALOG OF RADIATION HEAT TRANSFER CONFIGURATION FACTORS

John R. Howell
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http://www.me.utexas.edu/~Howell/tablecon.html

SECTION B
Differential Area to Finite Area

I. Differential element to....

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1. Differential element of any length to semi-infinite plane. Plane containing element and receiving semi-infinite plane intersect at angle τ at edge of semiinfinite plane.

2. Differential planar element touching any convex one-, two-, or three-dimensional surface at tangent angle λ.

3. Differential planar element to finite parallel rectangle. Normal to element passes through corner of rectangle.

3a-d. Differential planar element to finite parallel rectangle. Normal to element passes through center of rectangle. Rectangle is partially shaded by rectangle in parallel plane.

3e-3h. Differential planar element to finite parallel rectangle. Normal to element passes through center of rectangle. Rectangle is partially shaded by circular disk in parallel plane.

4. Differential planar element to rectangle in plane 90° to plane of element and perpendicular to corner of plane.

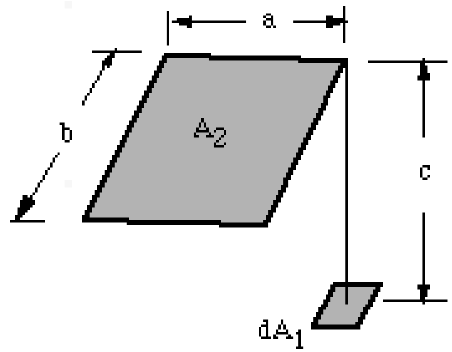
5. From differential element tilted at arbitrary angle to a finite rectangle.

6. Planar element to rectangle with right triangle added. Vertex of added triangle at end of rectangle nearest element.

Configuration Factor

SECTION B
Factors From Differential Elements to Finite Areas

B-3: Differential planar element to finite parallel rectangle. Normal to element passes through corner of rectangle.



Alvo perpendicular ao solo

Definitions: A=a/c; B=b/c

Governing equation:

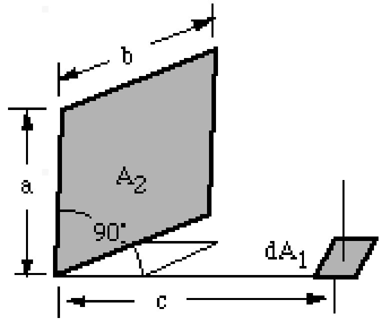
$$F_{d1-2} = \frac{1}{2\pi}\left\{\frac{A}{\left(1+A^2\right)^{1/2}}\tan^{-1}\left[\frac{B}{\left(1+A^2\right)^{1/2}}\right] + \frac{B}{\left(1+B^2\right)^{1/2}}\tan^{-1}\left[\frac{A}{\left(1+B^2\right)^{1/2}}\right]\right\}$$

Configuration Factor

SECTION B

Factors From Differential Elements to Finite Areas

B-4: Differential planar element to rectangle in plane 90° to plane of element and perpendicular to corner of plane.



Alvo horizontal, no solo.

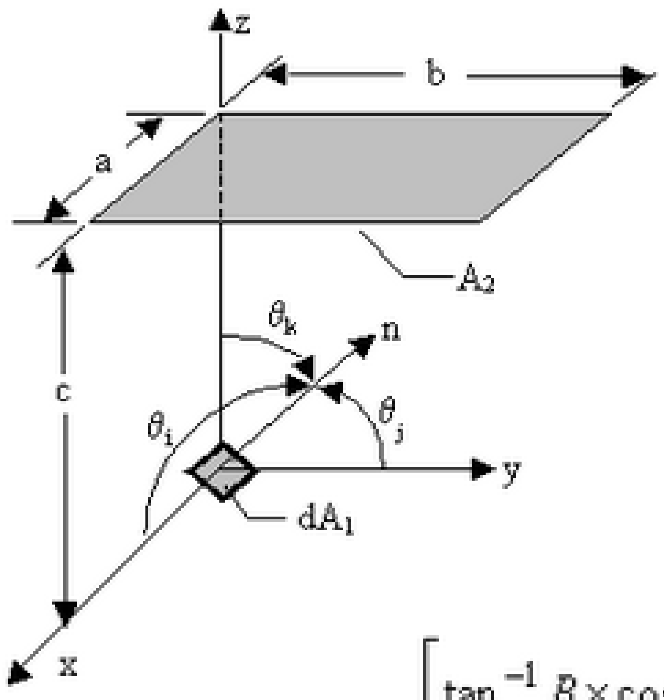
Definitions: A=a/b; C=c/b; Y=$(A^2+C^2)^{1/2}$

Governing equation:

$$F_{d1-2} = \frac{1}{2\pi}\left[\tan^{-1}\left(\frac{1}{C}\right) - \frac{C}{Y}\tan^{-1}\left(\frac{1}{Y}\right)\right]$$

SECTION B
Factors From Differential Elements to Finite Areas

B-5: From differential element tilted at arbitrary angle to a finite rectangle. (A_2 must not pass through plane of dA_1)



Alvo inclinado em relação ao solo

Definitions: A=a/c; B=b/c

$$F_{d1-2} = \frac{1}{2\pi}\left[\tan^{-1} B \times \cos\theta_i + \tan^{-1} A \times \cos\theta_j + \frac{A\cos\theta_k - \cos\theta_i}{\left(1+A^2\right)^{1/2}} \tan^{-1} \frac{B}{\left(1+A^2\right)^{1/2}} + \frac{B\cos\theta_k - \cos\theta_j}{\left(1+B^2\right)^{1/2}} \tan^{-1} \frac{A}{\left(1+B^2\right)^{1/2}}\right]$$

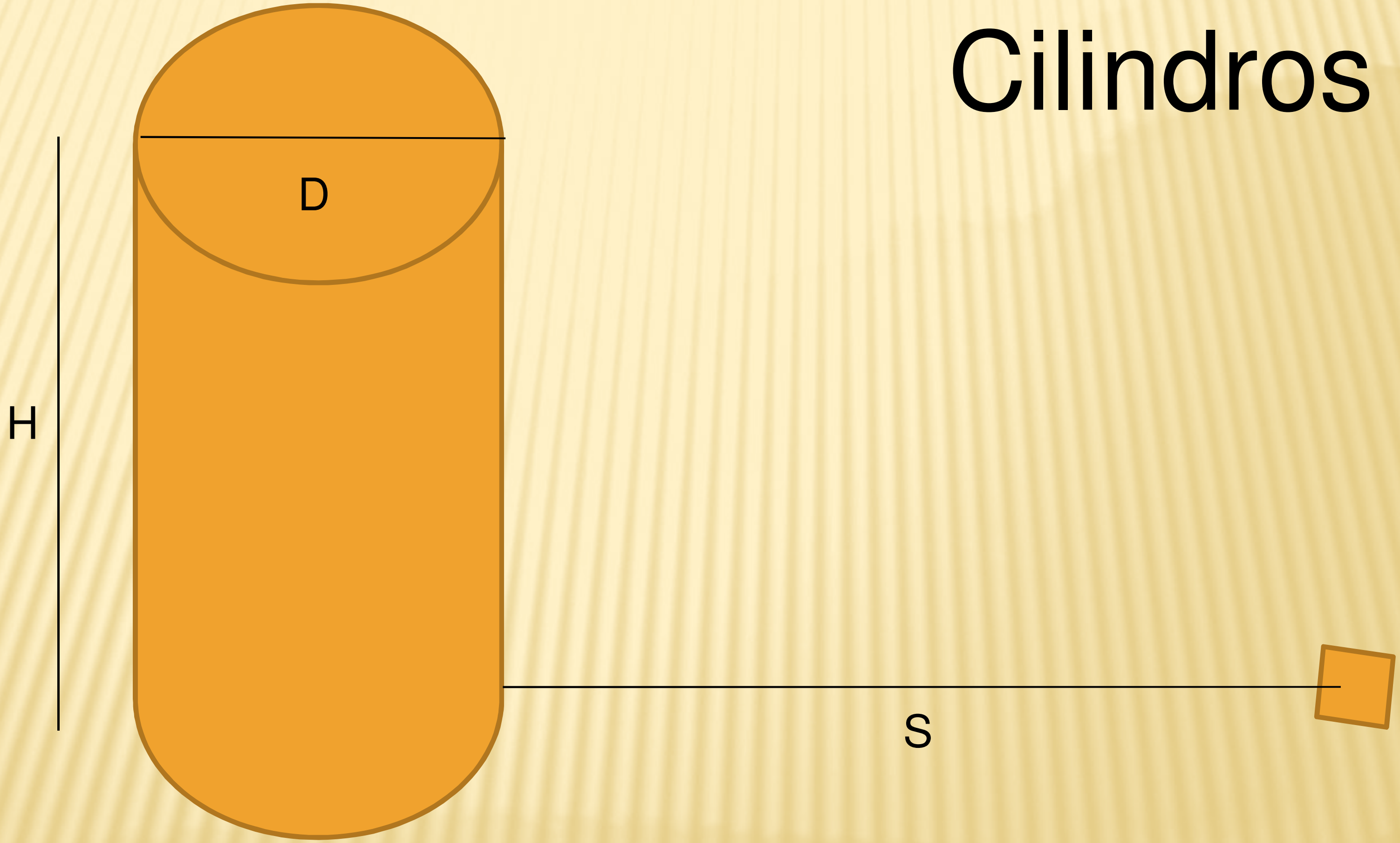
Configuration Factor

Atenção:

- Nas equações anteriores usar RADIANOS (e não graus)
- Tan-1 significa tangente inversa - “atan” no MATLAB

Table 3: View Factors from a Cylinder to an Element Receiving Maximum Radiation [4]. Note that H is the height of the cylinder, D is the diameter of the cylinder, and S is the distance from the leading edge of the fire to the element. The element is assumed to be at the same elevation as the base of the cylinder. See Fig. 12 for a schematic diagram.

Cilindros



S é medido em relação a <u>borda</u> da chama, não ao centro.

Cilindros

S/D	H/D									
	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.1
0.1	0.044	0.087	0.128	0.166	0.201	0.233	0.262	0.288	0.311	0.331
0.2	0.019	0.039	0.058	0.077	0.095	0.113	0.130	0.146	0.162	0.177
0.3	0.012	0.023	0.035	0.046	0.057	0.068	0.079	0.090	0.101	0.111
0.4	0.008	0.016	0.024	0.031	0.039	0.047	0.054	0.062	0.069	0.076
0.5	0.006	0.011	0.017	0.023	0.029	0.034	0.040	0.045	0.051	0.056
0.6	0.004	0.009	0.013	0.017	0.022	0.026	0.030	0.035	0.039	0.043
0.7	0.003	0.007	0.010	0.014	0.017	0.021	0.024	0.028	0.031	0.034
0.8	0.003	0.006	0.008	0.011	0.014	0.017	0.020	0.022	0.025	0.028
0.9	0.002	0.005	0.007	0.009	0.012	0.014	0.016	0.019	0.021	0.023
1.0	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020
2.0	0.001	0.001	0.002	0.002	0.003	0.004	0.004	0.005	0.005	0.006
3.0	0.000	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.003
4.0	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002
5.0	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001
6.0	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001
7.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
8.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3: View Factors from a Cylinder to an Element Receiving Maximum Radiation [4]. Note that H is the height of the cylinder, D is the diameter of the cylinder, and S is the distance from the leading edge of the fire to the element. The element is assumed to be at the same elevation as the base of the cylinder. See Fig. 12 for a schematic diagram.

http://gisceu.net/pdf/u802.pdf

Cilindros

S/D	H/D 0.09	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
0.1	0.311	0.331	0.442	0.481	0.497	0.506	0.510	0.513	0.515	0.517	0.518
0.2	0.162	0.177	0.289	0.349	0.380	0.399	0.410	0.417	0.422	0.425	0.427
0.3	0.101	0.111	0.198	0.256	0.294	0.318	0.334	0.344	0.352	0.357	0.361
0.4	0.069	0.076	0.142	0.193	0.230	0.256	0.274	0.287	0.297	0.304	0.310
0.5	0.051	0.056	0.107	0.149	0.183	0.208	0.227	0.242	0.253	0.261	0.268
0.6	0.039	0.043	0.084	0.119	0.148	0.172	0.190	0.205	0.217	0.226	0.233
0.7	0.031	0.034	0.067	0.096	0.122	0.143	0.161	0.175	0.187	0.196	0.204
0.8	0.025	0.028	0.055	0.080	0.102	0.121	0.137	0.151	0.162	0.172	0.180
0.9	0.021	0.023	0.046	0.067	0.086	0.103	0.118	0.131	0.142	0.151	0.159
1.0	0.018	0.020	0.039	0.057	0.074	0.089	0.102	0.114	0.125	0.134	0.141
2.0	0.005	0.006	0.012	0.018	0.024	0.030	0.035	0.040	0.045	0.050	0.055
3.0	0.003	0.003	0.006	0.009	0.012	0.015	0.017	0.020	0.023	0.025	0.028
4.0	0.002	0.002	0.003	0.005	0.007	0.009	0.010	0.012	0.014	0.015	0.017
5.0	0.001	0.001	0.002	0.003	0.005	0.006	0.007	0.008	0.009	0.010	0.011
6.0	0.001	0.001	0.002	0.002	0.003	0.004	0.005	0.006	0.006	0.007	0.008
7.0	0.001	0.001	0.001	0.002	0.002	0.003	0.004	0.004	0.005	0.005	0.006
8.0	0.000	0.000	0.001	0.001	0.002	0.002	0.003	0.003	0.004	0.004	0.005
9.0	0.000	0.000	0.001	0.001	0.001	0.002	0.002	0.003	0.003	0.003	0.004
10.0	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.003	0.003

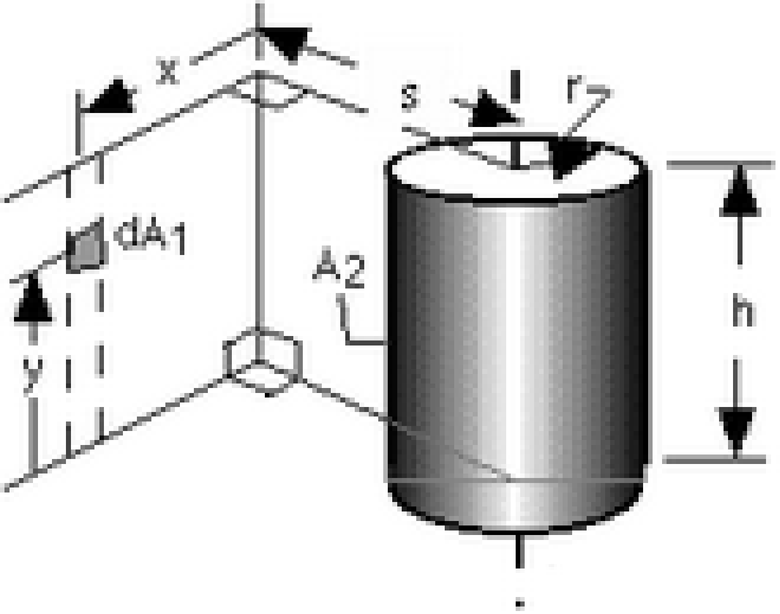
Table 3: View Factors from a Cylinder to an Element Receiving Maximum Radiation [4]. Note that H is the height of the cylinder, D is the diameter of the cylinder, and S is the distance from the leading edge of the fire to the element. The element is assumed to be at the same elevation as the base of the cylinder. See Fig. 12 for a schematic diagram.

NIST

http://gisceu.net/pdf/u802.pdf

B-32: Element on plane to exterior of right circular cylinder of finite length. Plane does not intersect cylinder.

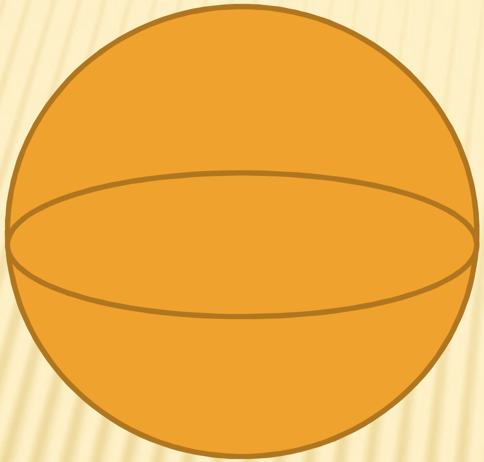
Definitions: $S = s/r$; $X = x/r$; $Y = y/r$; $H = h/r$; $A = X^2 + Y^2 + S^2$; $B = S^2 + X^2$; $C = (H - Y)^2$



$$F_{d1-2} = \frac{S}{B} - \frac{S}{2B\pi}\left\{ \begin{array}{l} \cos^{-1}\left(\frac{Y^2 - B + 1}{A - 1}\right) + \cos^{-1}\left(\frac{C - B + 1}{C + B - 1}\right) \\ -Y\left[\frac{A+1}{\sqrt{(A-1)^2 + 4Y^2}}\cos^{-1}\left(\frac{Y^2 - B + 1}{B^{1/2}(A-1)}\right)\right] \\ -C^{1/2}\frac{C + B + 1}{\sqrt{(C + B - 1)^2 + 4C}}\cos^{-1}\left(\frac{C - B + 1}{B^{1/2}(C + B - 1)}\right) \\ +H\cos^{-1}\left(\frac{1}{B^{1/2}}\right) \end{array} \right\}$$

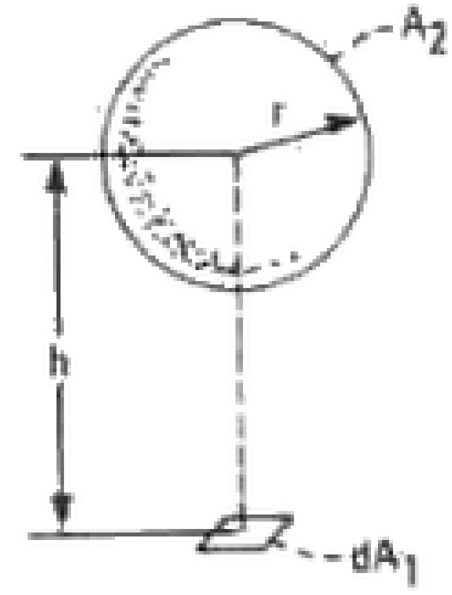
http://www.me.utexas.edu/~Howell/sectionb/B-32.html

Esferas

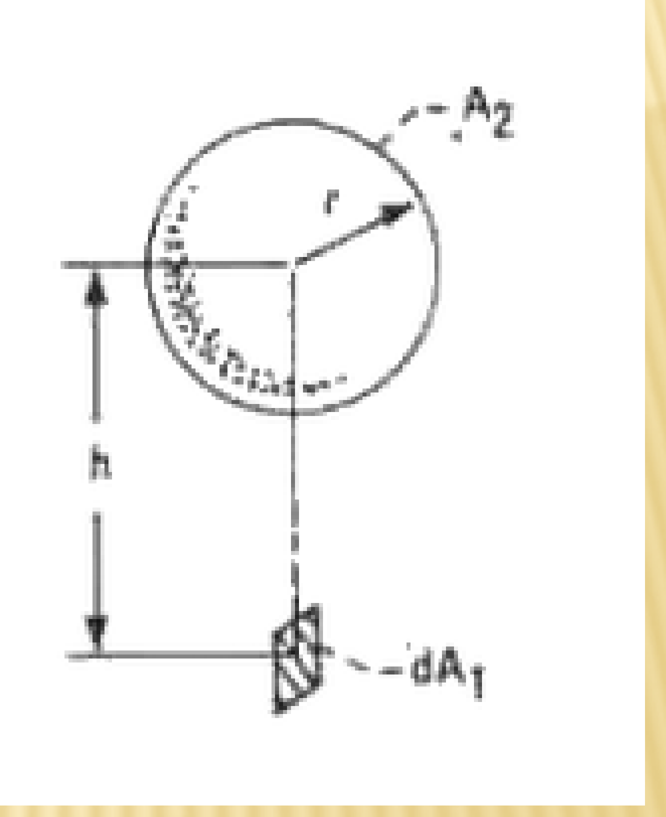


B-39: Plane element to sphere; normal to center of element passes through center of sphere.

$$F_{d1-2} = \left(\frac{r}{h}\right)^2$$



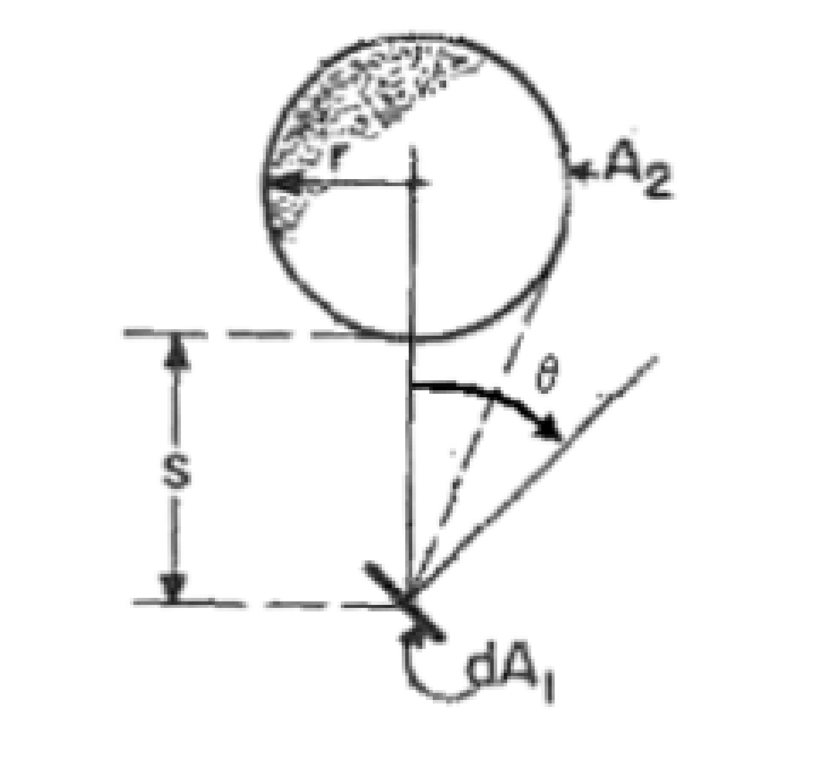
B-40: Plane element to sphere; tangent to element passes through center of sphere.



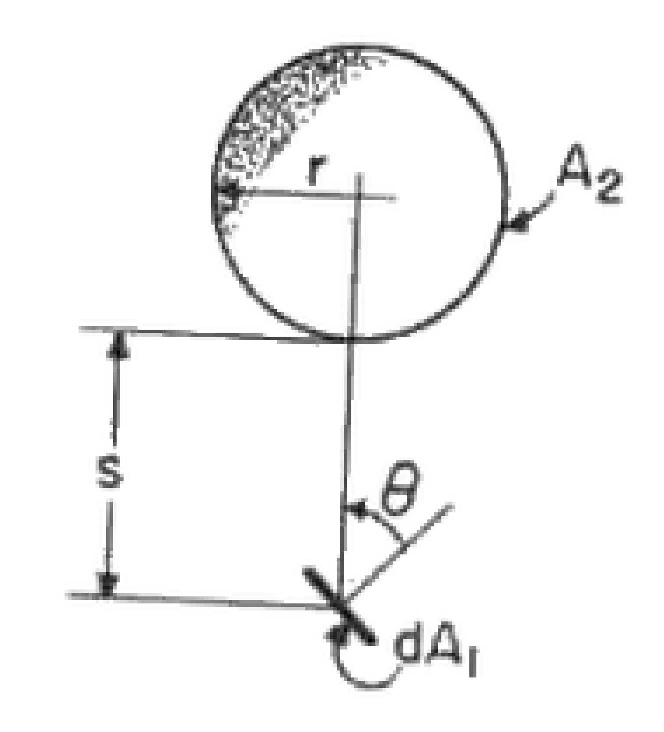
$$F_{d1-2} = \frac{1}{\pi}\left(\tan^{-1}\frac{1}{\sqrt{H^2-1}} - \frac{\sqrt{H^2-1}}{H^2}\right)$$

B-41: Differential planar element to sphere; element plane does not intersect sphere.

$$F_{d1-2} = \frac{1}{(1+S)^2}\cos\theta$$



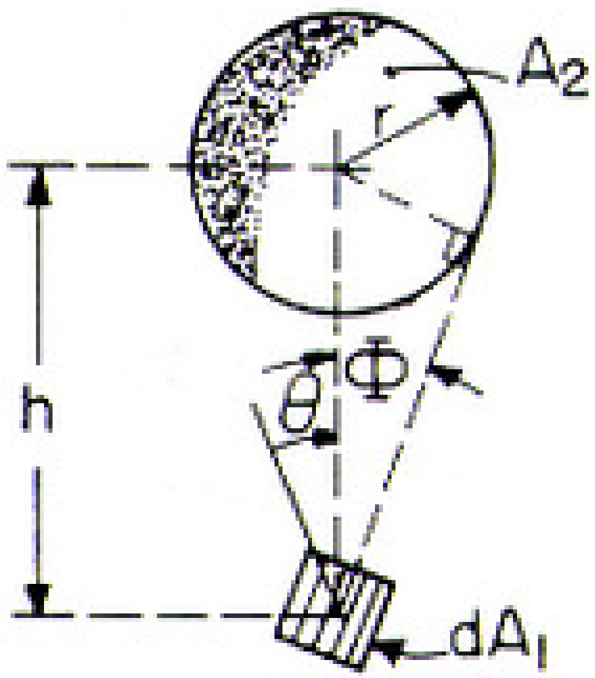
B-42: Differential planar element to sphere; element plane intersects sphere.



$$F_{d1-2} = \frac{\sqrt{S^2-1}\sin\theta}{\pi S^2}\left[1-\left(S^2-1\right)\cot^2\theta\right]^{1/2} + \frac{1}{\pi}\tan^{-1}\left[\frac{\sin\theta\sqrt{1-\left(S^2-1\right)\cot^2\theta}}{\sqrt{S^2-1}}\right]$$

$$+\frac{\cos\theta}{\pi S^2}\left[\pi - \cos^{-1}\left(\sqrt{S^2-1}\cot\theta\right)\right]$$

B-43: Arbitrarily oriented differential planar element to a sphere (see B-41, 38 for simpler form).



Definitions: H=h/r; $\phi=\sin^{-1}(1/H)$

For $\frac{\pi}{2}-\phi \le \theta \le \frac{\pi}{2}+\phi$:

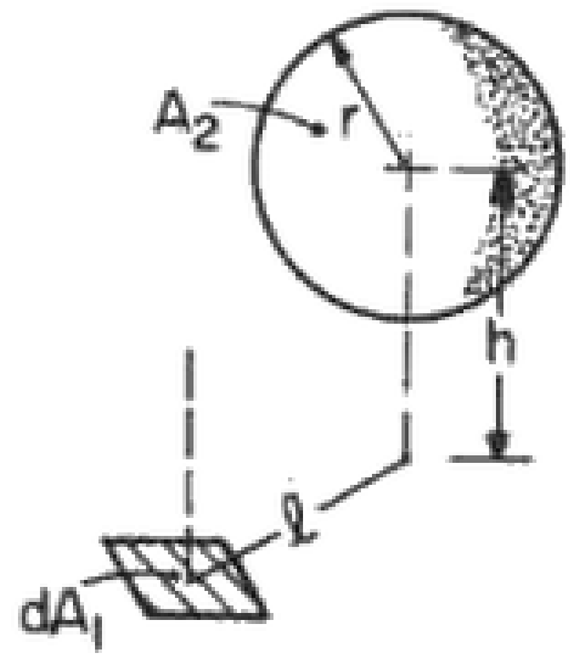
$$F_{d1-2}=\frac{1}{2}-\frac{1}{\pi}\sin^{-1}\left[\frac{\left(H^2-1\right)^{1/2}}{H\sin\theta}\right]+\frac{1}{\pi H^2}\left\{\begin{matrix}\cos\theta\cos^{-1}\left[-\left(H^2-1\right)^{1/2}\cot\theta\right] \\ -\left(H^2-1\right)^{1/2}\left[1-H^2\cos^2\theta\right]^{1/2}\end{matrix}\right\}$$

For $\theta<\frac{\pi}{2}-\phi$:

$$F_{d1-2}=\frac{\cos\theta}{H^2}$$

B-44: Area element to sphere; element lies in plane perpendicular to sphere axis.

Definitions: L=l/r; H=h/r



For $H \geq 1$:

$$F_{d1-2} = \frac{H}{\left(L^2 + H^2\right)^{3/2}}$$

For $-1 \leq H \leq 1$:

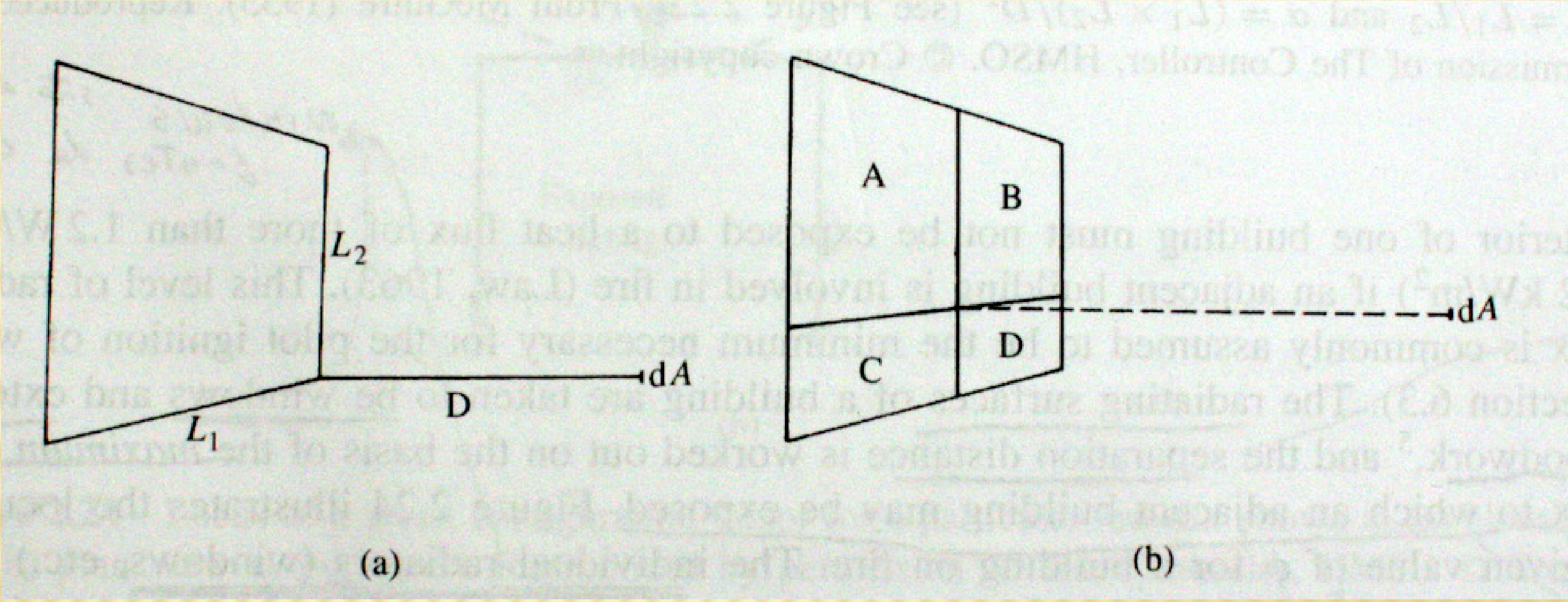
$$F_{d1-2} = \frac{1}{\pi}\left\{ \begin{array}{l} \dfrac{H}{\left(L^2+H^2\right)^{3/2}} \cos^{-1}\left[\dfrac{\left(-\dfrac{H}{L}\right)}{\left(L^2+H^2-1\right)^{1/2}}\right] - \dfrac{\left[\left(L^2+H^2-1\right)\left(1-H^2\right)\right]^{1/2}}{\left(L^2+H^2\right)} \\ -\sin^{-1}\left[\dfrac{\left(H^2+L^2-1\right)^{1/2}}{L^2}\right] + \dfrac{\pi}{2} \end{array} \right\}$$

Configuration Factor

Propriedade aditiva:

$$\varphi \text{ total} = \varphi 1 + \varphi 2 + \varphi 3 \ldots$$

Configuration Factor



φ A

φ total = φ A + φB + φC + φD

Configuration Factor

As vezes a propriedade aditiva simplifica muito o problema, inclusive permitindo não considerar o Fator de Forma.

Exemplo:

Example 1-2 You are inspecting an industrial plant so you can make firefight plans for the facility. They have an open tank of kerosene within 5 feet (1.52 m) of a wooden wall. You want to know if the wall would ignite from burning kerosene if the keronsene ignites. To avoid configuration factors you assume both the wall and flames are fairly large. The kerosene flames are 990° C (990 + 273 = 1,263°K). You assume the wall temperature is 21°C (294°K). To simplify calculations you assume the area is 1 m^2. If the minimum heat flux for the ignition of the wood is 10 kW/m^2, will the wall ignite?

Configuration Factor

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Calor para a madeira sofrer ignição

Configuration Factor

As vezes a propriedade aditiva simplifica muito o problema, inclusive permitindo não considerar o Fator de Forma.

Exemplo:

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Por que é possível desprezar o fator de forma neste exemplo?

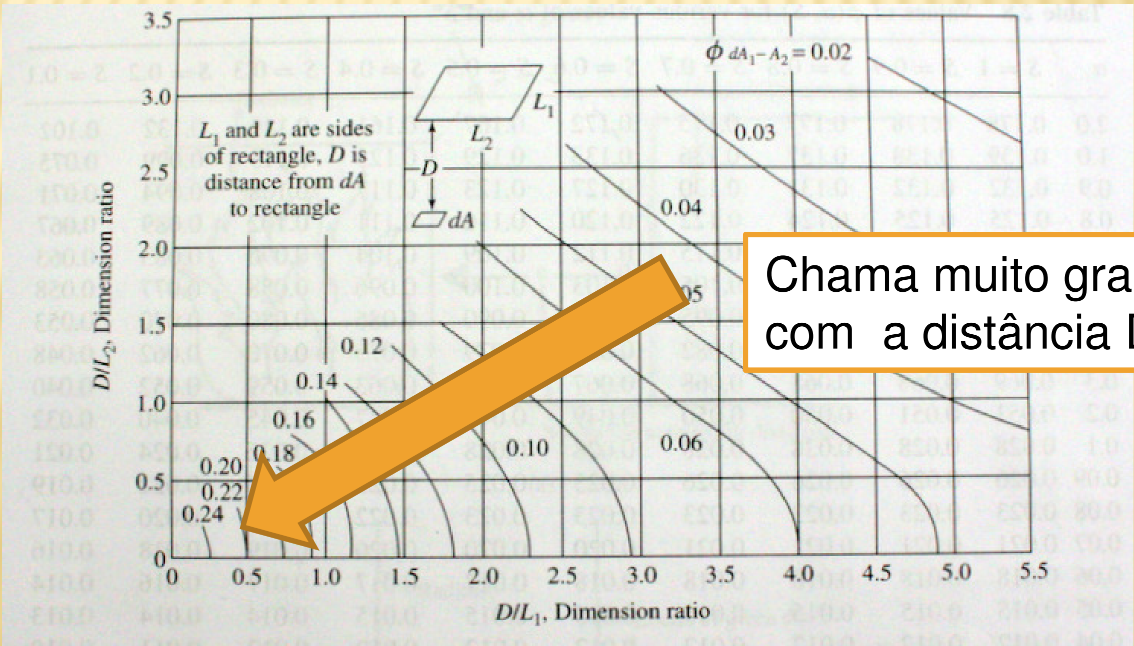
Torna a distância D pouco importânte.

on Factor

Chama muito grande (L1 e L2 grandes).

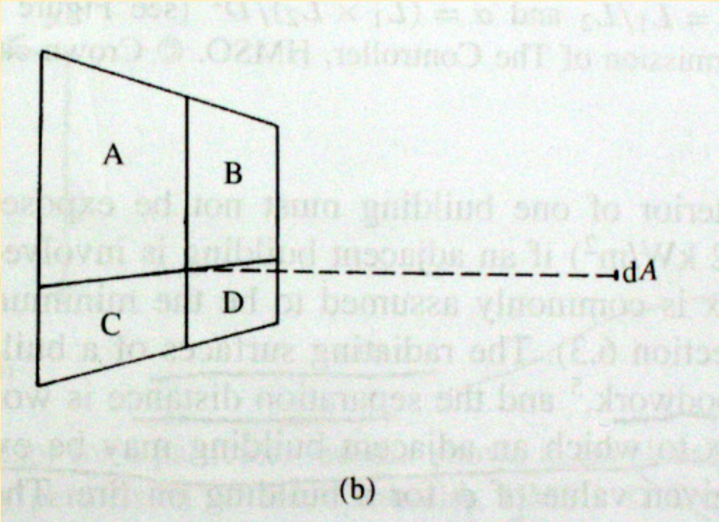
Exemplo:

Example 1-2 You are inspecting an industrial plant so you can make firefight plans for the facility. They have an open tank of kerosene within 5 feet (1.52 m) of a wooden wall. You want to know if the wall would ignite from burning kerosene if the keronsene ignites. To avoid configuration factors you assume both the wall and flames are fairly large. The kerosene flames are 990° C (990 + 273 = 1,263°K). You assume the wall temperature is 21°C (294°K). To simplify calculations you assume the area is 1 m^2. If the minimum heat flux for the ignition of the wood is 10 kW/m^2, will the wall ignite?

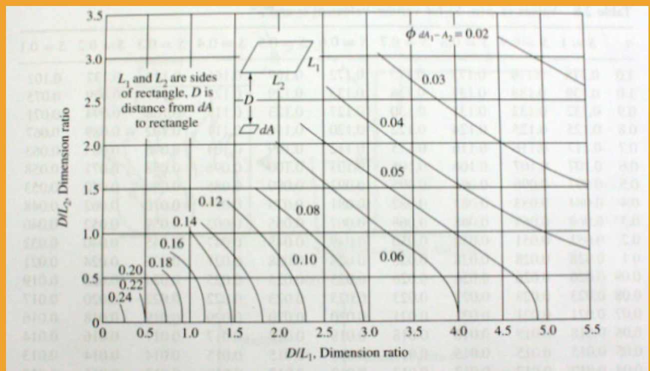


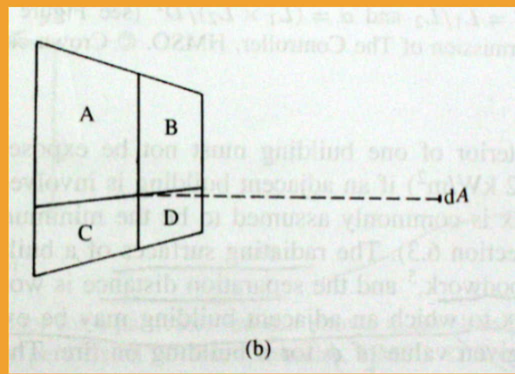
Chama muito grande comparada com a distância D

Configuration Factor



Propriedade aditiva

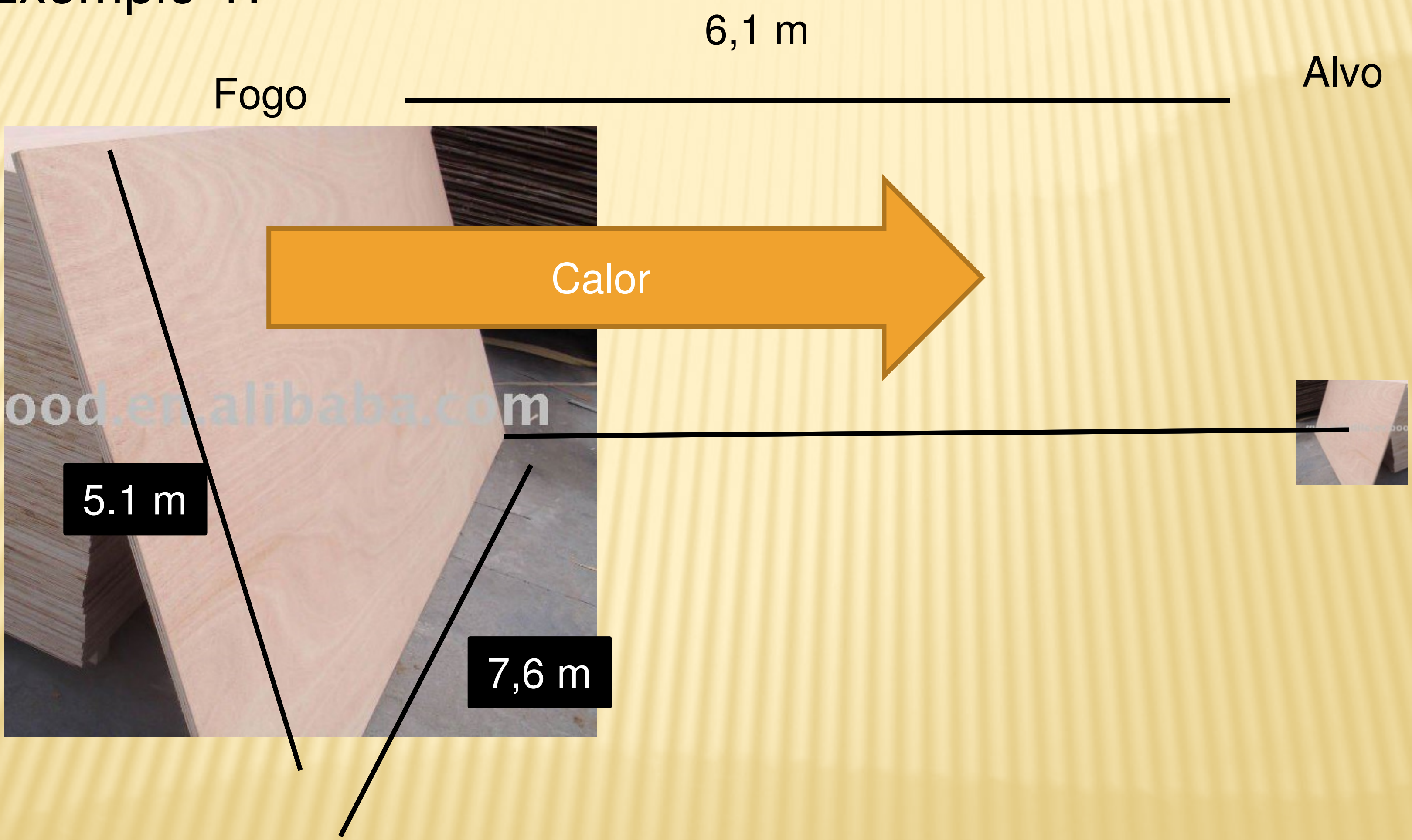




0.25 x 4 = 1

Configuration Factor

Exemplo 1:

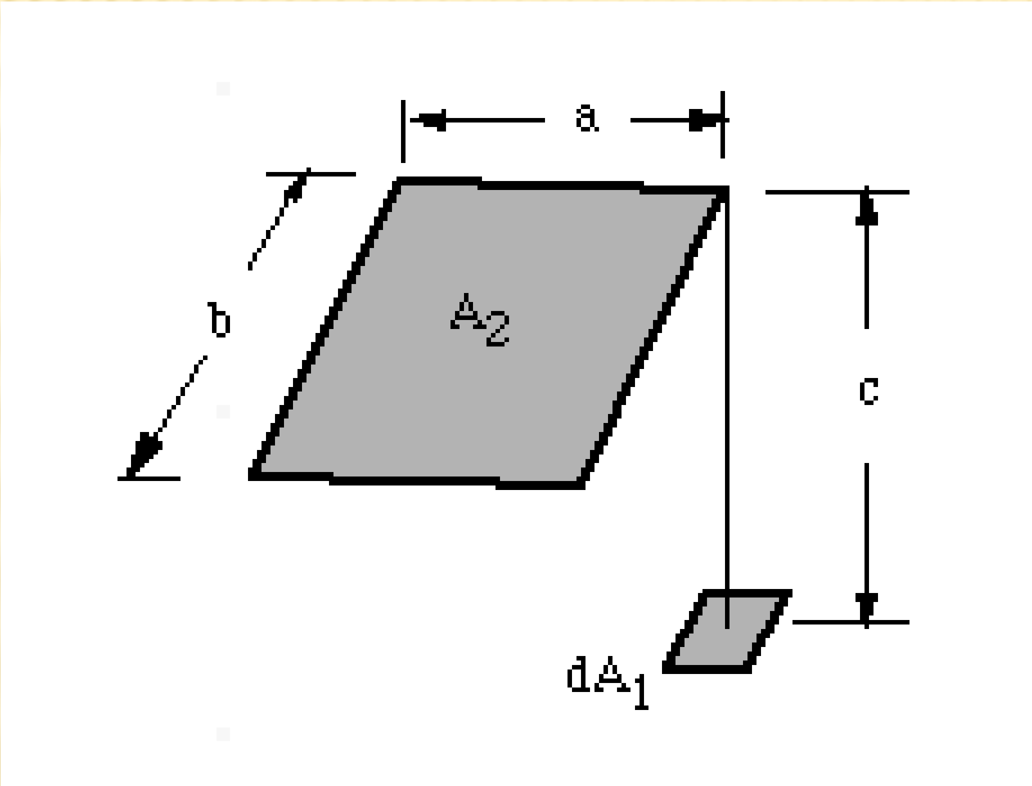


Qual o fluxo de calor radiante (radiant heat flux) sobre o alvo?

Configuration Factor

Exemplo 1:

Assumindo alvo de tamanho infinitesimal, paralelo a placa e posicionado em um dos cantos, temos:



$$F_{d1-2} = \frac{1}{2\pi}\left\{ \frac{A}{\left(1+A^2\right)^{1/2}} \tan^{-1}\left[\frac{B}{\left(1+A^2\right)^{1/2}}\right] + \frac{B}{\left(1+B^2\right)^{1/2}} \tan^{-1}\left[\frac{A}{\left(1+B^2\right)^{1/2}}\right] \right\}$$

Configuration Factor

Exemplo 1:

A = L1 / D = 7,6 / 6,1 = 1,24
B = L2 / D = 5,1 / 6,1 = 0,836

$$F_{d1-2} = \frac{1}{2\pi}\left\{ \frac{A}{\left(1+A^2\right)^{1/2}} \tan^{-1}\left[\frac{B}{\left(1+A^2\right)^{1/2}}\right] + \frac{B}{\left(1+B^2\right)^{1/2}} \tan^{-1}\left[\frac{A}{\left(1+B^2\right)^{1/2}}\right] \right\}$$

F12 = 0,159 [1,24 / (1 + 1,24^2)^0,5 * tan-1 (0,836 / (1 + 1,24^2)^0,5))
+ 0,836 / (1 + 0,836^2)^0,5 * tan-1 (1,24 / (1 + 0,836^2)^0,5))]

F12 = 0,159 [1,24/1,593 tan-1(0,836/1,593) + 0,836/1,303 tan-1(1,24/1,303)]

F12 = 0,159 [0,376 + 0,488] = 0,137

Radianos!

Tangente inversa ou atan

Configuration Factor

Em MATLAB:

A

B

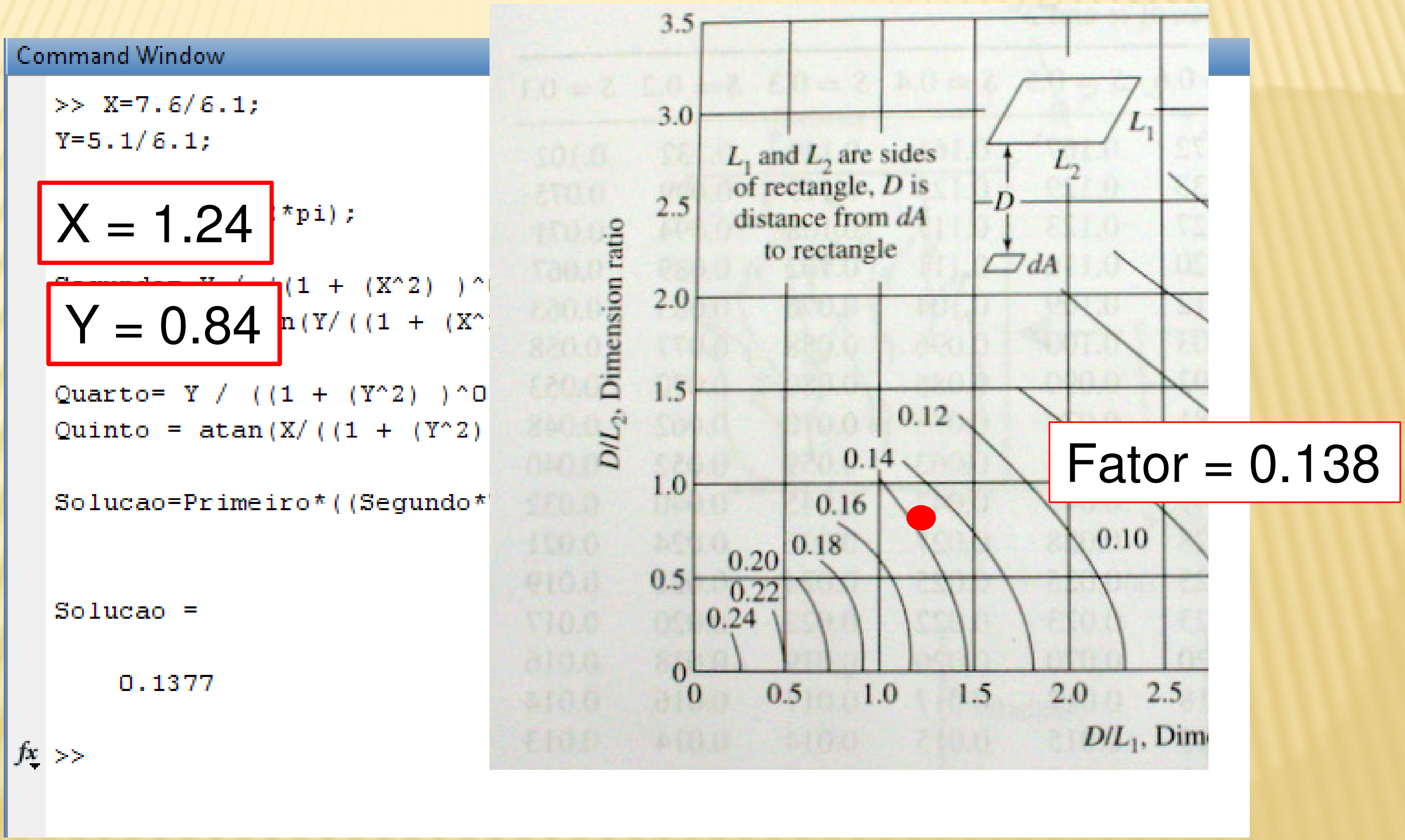
```
X=7.6/6.1;
Y=5.1/6.1;

Primeiro= 1/(2*pi);

Segundo= X / ((1 + (X^2) )^0.5 );
Terceiro = atan(Y/((1 + (X^2))^0.5) );

Quarto= Y / ((1 + (Y^2) )^0.5 );
Quinto = atan(X/((1 + (Y^2))^0.5) );

Solucao=Primeiro*((Segundo*Terceiro)+(Quarto*Quinto))
```

Configuration Factor

Command Window

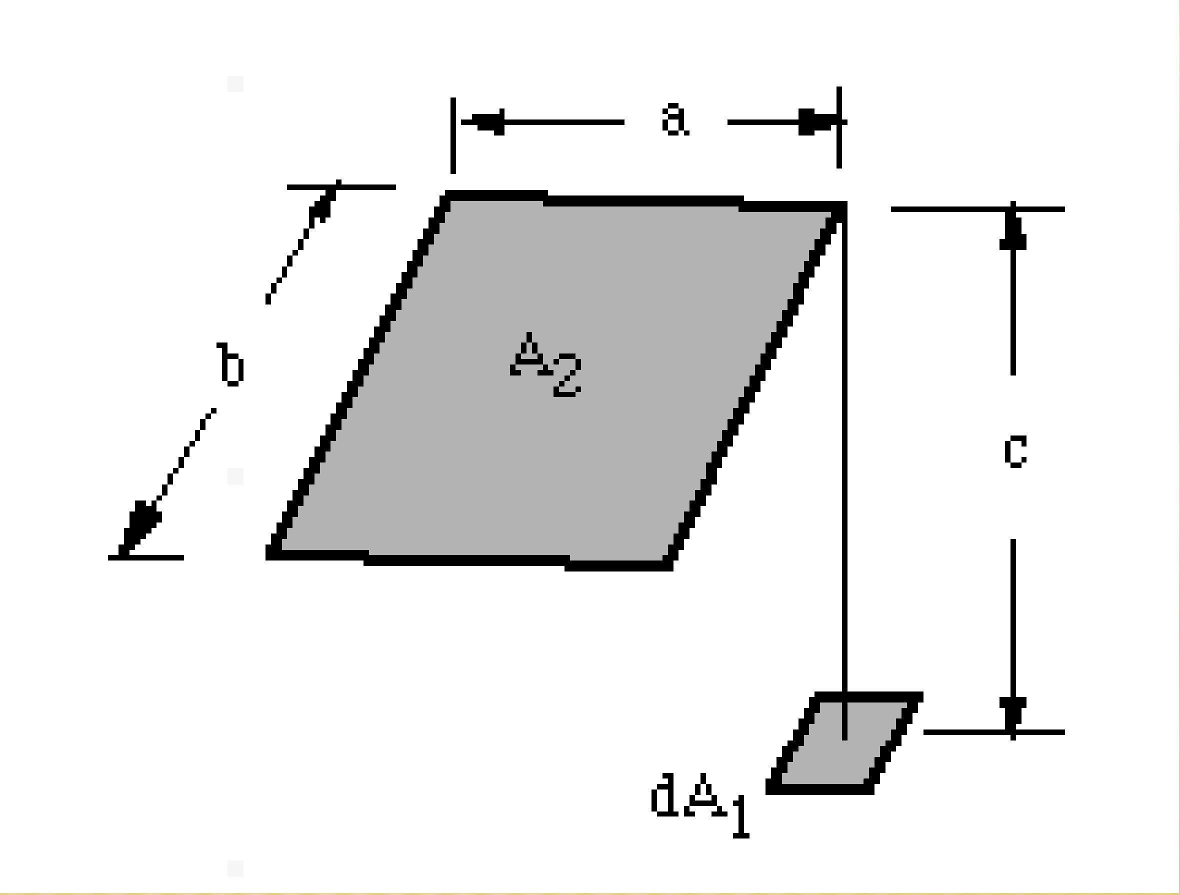
```
>> X=7.6/6.1;
Y=5.1/6.1;

Primeiro= 1/(2*pi);

Segundo= X / ((1 + (X^2) )^0.5 );
Terceiro = atan(Y/((1 + (X^2))^0.5) );

Quarto= Y / ((1 + (Y^2) )^0.5 );
Quinto = atan(X/((1 + (Y^2))^0.5) );

Solucao=Primeiro*((Segundo*Terceiro)+(Quarto*Quinto))


Solucao =

    0.1377

>>
```

Configuration Factor



Configuration Factor

Faz diferença quem é o ‘a’ e quem é o ‘b’?
Se inverter ‘a’ e ‘b’ o valor final muda?



C

```
>> X = 5.1/6.1;
Y=7.6/6.1;

Primeiro= 1/(2*pi);

Segundo= X / ((1 + (X^2)
Terceiro = atan(Y/((1 + (

Quarto= Y / ((1 + (Y^2) )
Quinto = atan(X/((1 + (Y^

Solucao=Primeiro*((Segundo*Terceiro)+(Quarto*Quinto))


Solucao =

    0.1377
```

```
>> X=7.6/6.1;
Y=5.1/6.1;

Primeiro= 1/(2*pi);

Segundo= X / ((1 + (X^2) )^0.5 );
Terceiro = atan(Y/((1 + (X^2))^0.5) );

Quarto= Y / ((1 + (Y^2) )^0.5 );
Quinto = atan(X/((1 + (Y^2))^0.5) );

Solucao=Primeiro*((Segundo*Terceiro)+(Quarto*Quinto))


Solucao =

    0.1377
```

O resultado é o mesmo!

Configuration Factor

No exemplo anterior foi adotada largura e altura do objeto em chamas
Porém, na prática pode ser indicado usar a **altura da chama.**
Exemplo empregando altura da chama será apresentado
posteriormente – quando soubermos calcular altura de chama...

Configuration Factor

Exemplo 2:

6,1 m

Fogo

Alvo

Calor

5.1 m

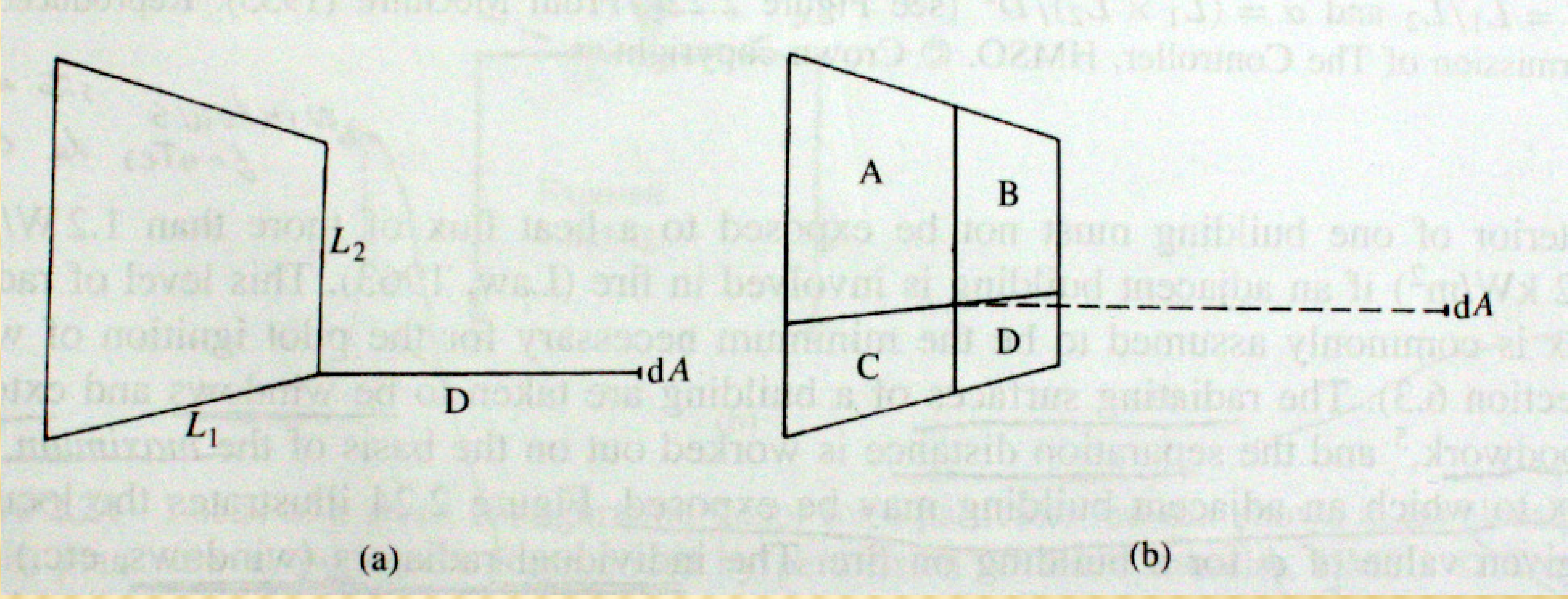
7,6 m

E se o alvo estiver alinhado com o centro?

Baseado no Exemplo da pag 28 do Zalosh

Configuration Factor

Exemplo 2:



φ A

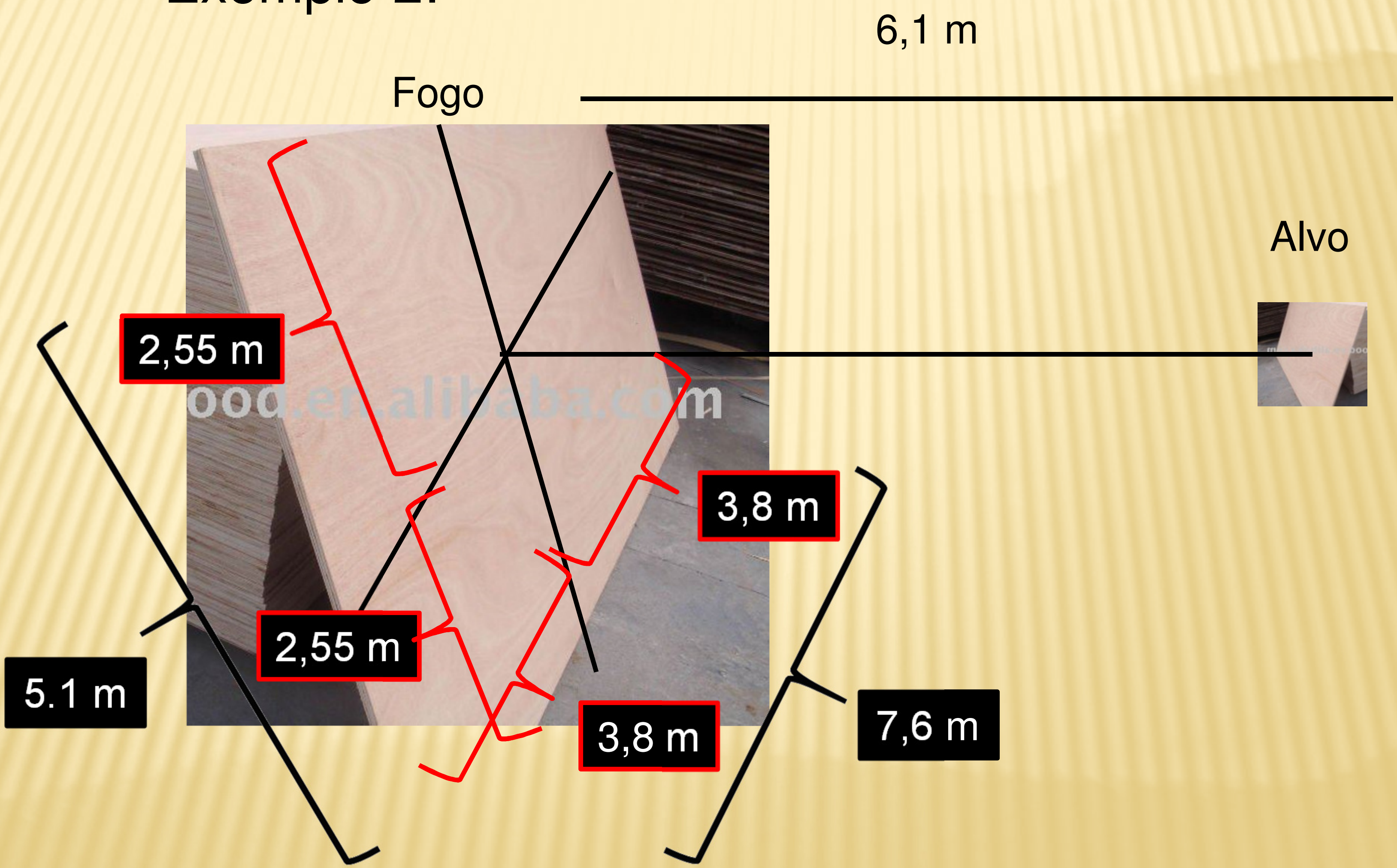
φ total = 4 . φ A

Cuidado: os lados L1 e L2 agora ficam divididos por 2!

Baseado no Exemplo da pag 28 do Zalosh

Configuration Factor

Exemplo 2:

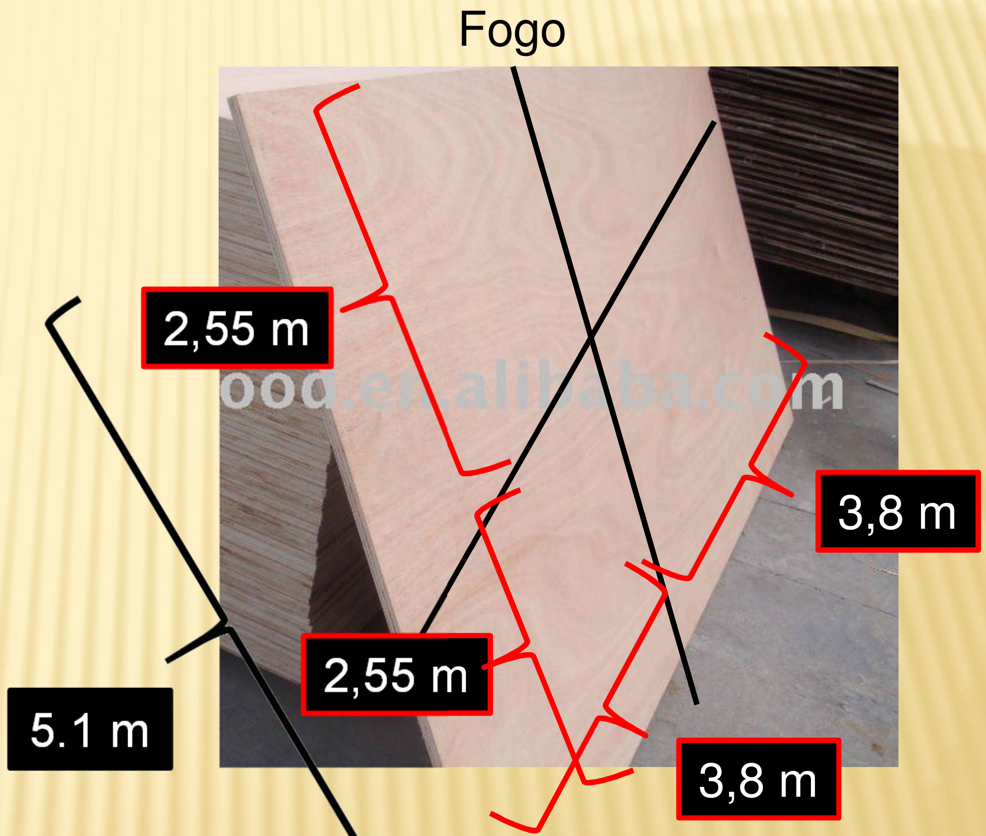


Baseado no Exemplo da pag 28 do Zalosh

Configuration Factor

Resolvendo em MATLAB:

```
X=(7.6/2)/6.1;
Y =(5.1/2)/6.1;

Primeiro= 1/(2*pi);

Segundo= X / ((1 + (X^2) )^0.5 );
Terceiro = atan(Y/((1 + (X^2))^0.5) );

Quarto= Y / ((1 + (Y^2) )^0.5 );
Quinto = atan(X/((1 + (Y^2))^0.5) );

Solucao=Primeiro*((Segundo*Terceiro)+(Quarto*Quinto))

Solucao=4*Solucao
```



Assim, Configuration Factor: 0.2429

Baseado no Exemplo da pag 28 do Zalosh

Configuration Factor

Aplicação Incêndios Estruturais

Na Inglaterra a separação mínima entre duas construções deve ser calculada considerando a exposição ao calor em caso de incêndio.

O fluxo de calor (heat flux) deve ser de no máximo 1,2W/cm2 (ou 12 kW/m2). Este valor é comumente admitido como sendo o mínimo necessário para promover a ignição (pilotada) de madeira.

Considero como fonte emissora de calor APENAS as janelas da edificação.

Considero que não ocorre queima na parte exterior as janelas, ou seja, não existe projeção das chamas. Caso as chamas se projetem, o fluxo de calor sobre a edificação vizinha será muito superior.

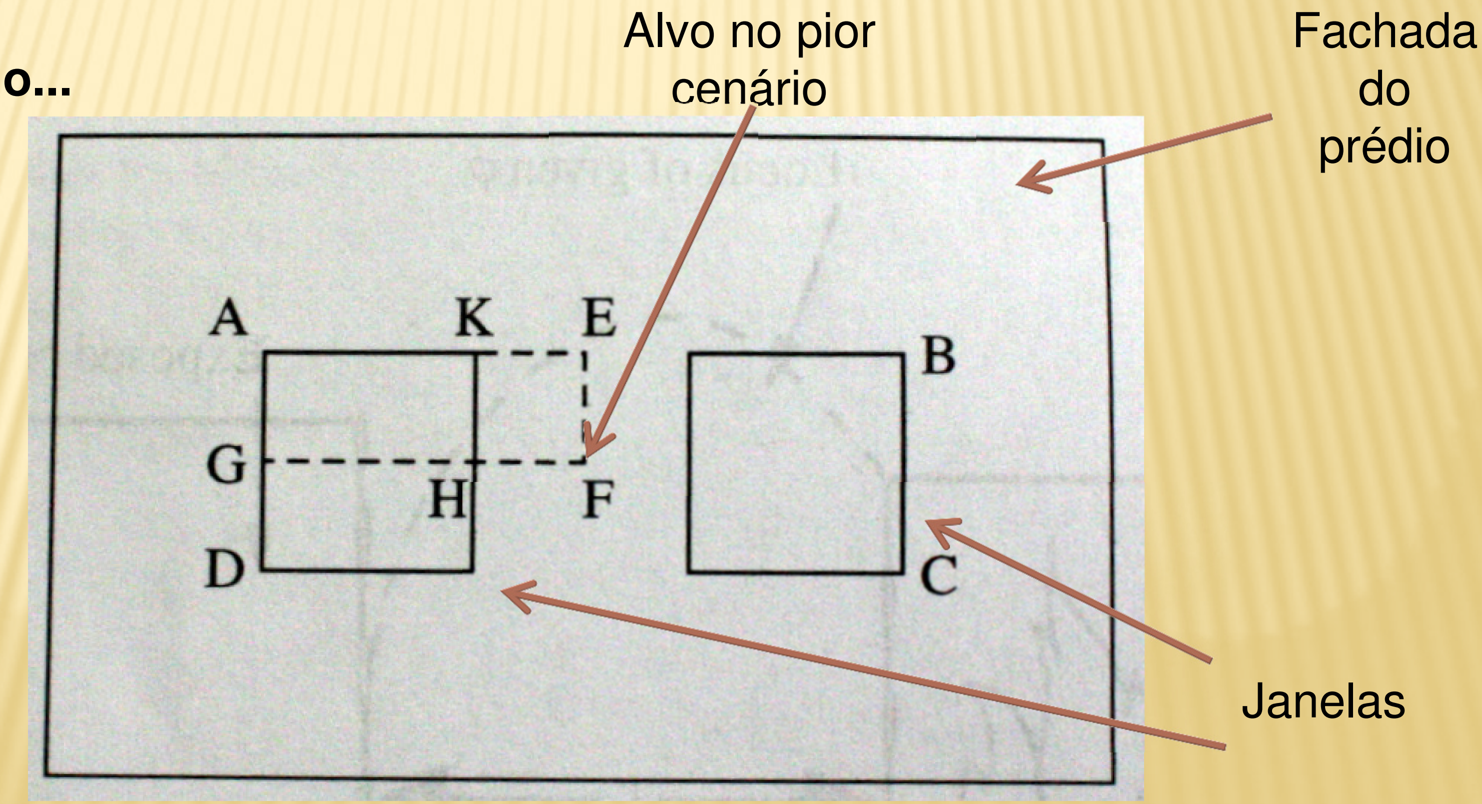
Configuration Factor

Aplicação Incêndios Estruturais

Exemplo:

Supondo prédio com 5 metros de largura e 3 metros de altura, com duas janelas de 1m por 1m. Calcular o fluxo máximo de calor que atingirá um objeto localizado a 5 metros da edificação.

Resolvendo...



Configuration Factor

Aplicação Incêndios Estruturais

Exemplo:

Configuration Factor

Aplicação Incêndios Estruturais

Exemplo:

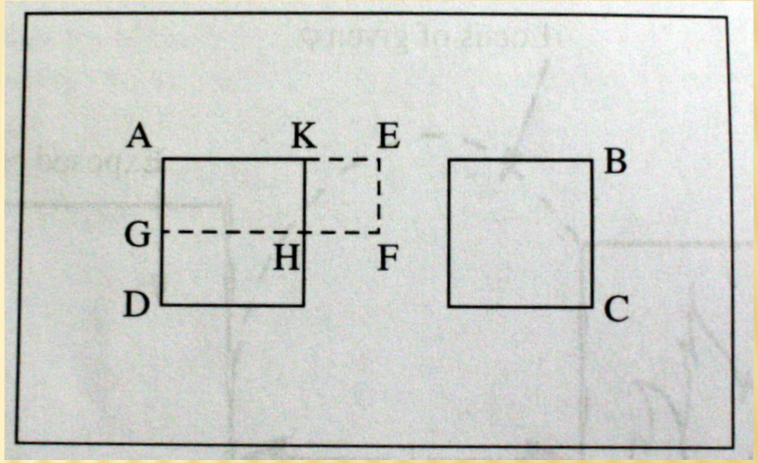
http://www.paraiba.com.br/static/images/noticias/normal/1339333155699-incendio-rio.jpg

Configuration Factor

Aplicação Incêndios Estruturais

Exemplo:

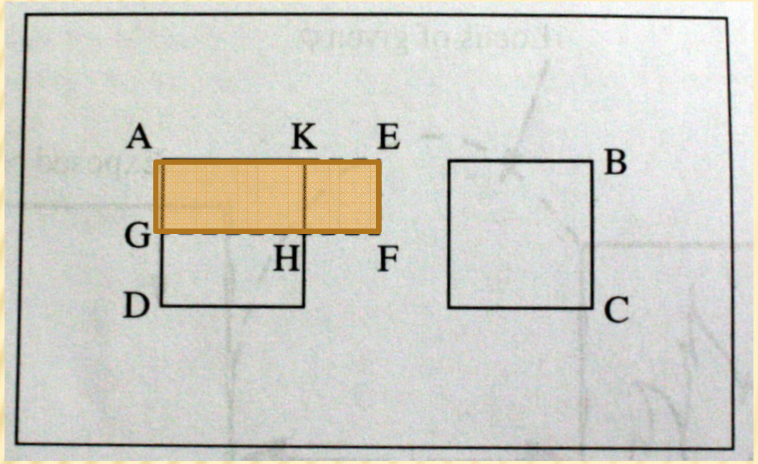
Trata-se de Configuration Factor do tipo placa paralela e elemento diferencial.



Para apresentar o máximo fluxo o elemento diferencial deve estar alinhado ao ponto F da figura (centro das duas janelas).

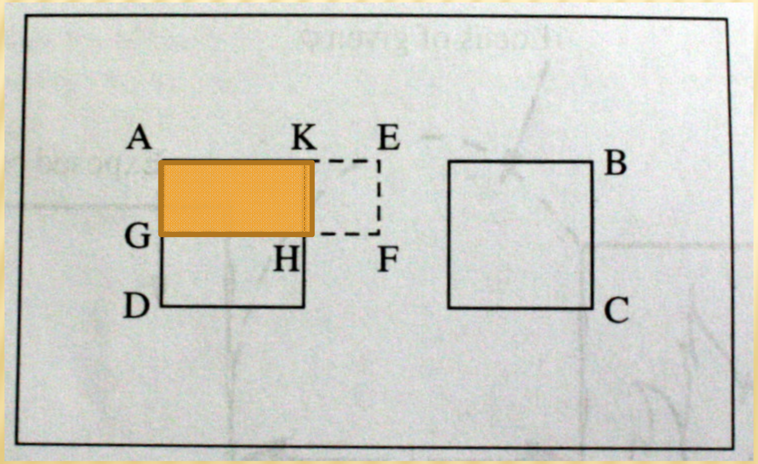
Configuration Factor

Exemplo:



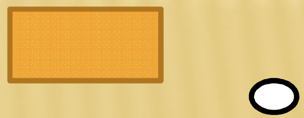
φ total = φ AEFG

Mas apenas as janelas emitem calor, logo o Config Factor ao lado está errado.



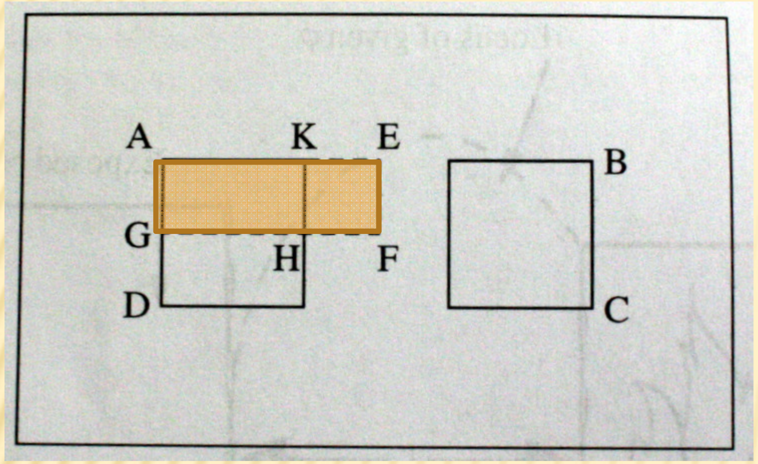
φ total = 4 φ AKHG

Mas não temos a equação para a configuração espacial resultante.

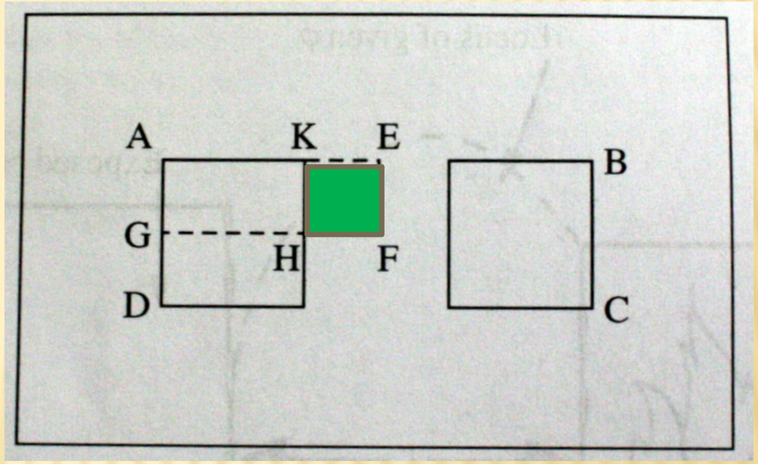


Configuration Factor

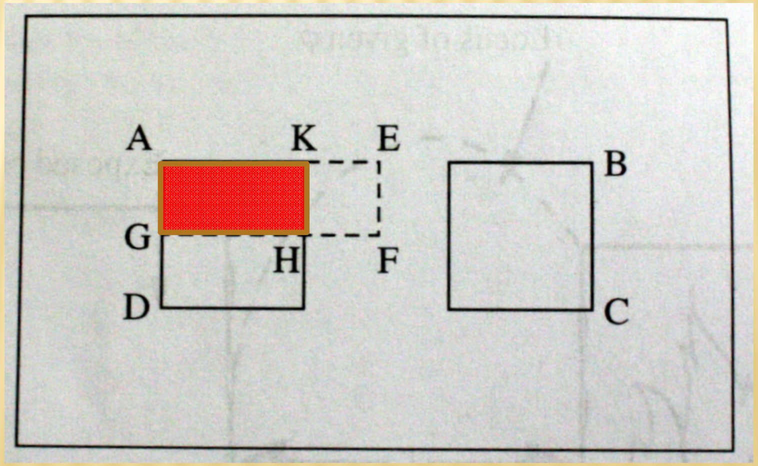
Exemplo:



-

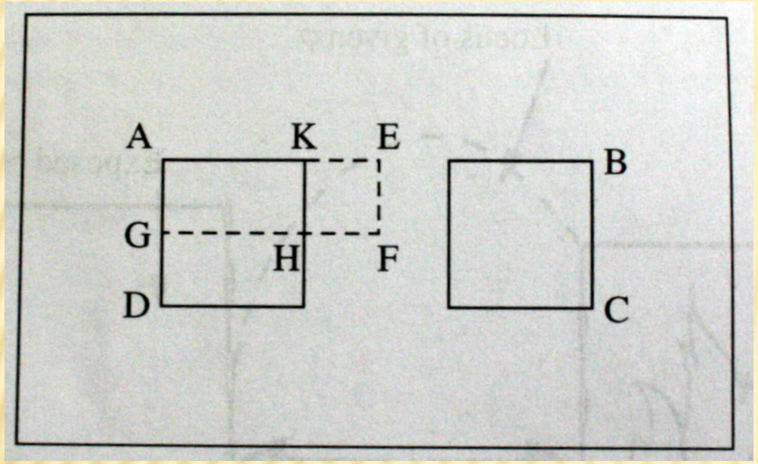


=

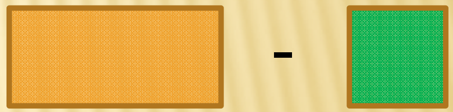


Configuration Factor

Exemplo:



φ total = 4 φ AKHG = 4 (φ AEFG - φ KEFH)



φ total = 4 (0.009 – 0.003)
φ total = 0.024

Configuration Factor

"Firemen spray water over a tanker on fire in Caracas on Dec. 29, 2011. At least 14 people were killed and 16 wounded Thursday when a truck carrying gasoline overturned and exploded on the Pan American highway connecting Caracas with the satellite city of Los Teques, authorities said".

http://photoblog.nbcnews.com/_news/2011/12/29/9814128-at-least-13-killed-in-venezuela-tanker-truck-fire?lite

http://msnbcmedia.msn.com/j/MSNBC/Components/Photo/_new/pb-111229-fire-3.photoblog900.jpg

Configuration Factor

Aplicação:

Limites de segurança da NIST:

31,5 kW/m2 para construções

1,4 kW/m2 para seres humanos

Entre 10 e 12 kW/m2 para ignição de madeira

O produto Emissive Power e Configuration factor para todas as categorias dá 12,6 kW/m2, o valor crítico para gerar ignição da madeira.

$$q'' = E \; \varphi \; \tau \; \varepsilon$$

Restrição NFPA:

Category	**Emissive Power** (kW/m2)	**Configuration factor**
Severe	358	0.035
Moderate	179	0.07
Light	90	0.14

Sabendo o Emissive Power e o valor máximo no alvo, defino o máximo Configuration Factor permitido, ou seja, regulo o tamanho da fonte emissora e, principalmente, a distância até o alvo.

Efeitos da Radiação

<u>Radiation Levels and Their Effects</u>:

Table 2.9 Effects of thermal radiation

Radiant heat flux (kW/m^2)	Observed effect
0.67	Summer sunshine in UK[a]
1	Maximum for indefinite skin exposure
6.4	Pain after 8 s skin exposure[b]
10.4	Pain after 3 s exposure[a]
12.5	Volatiles from wood may be ignited by pilot after prolonged exposure (see Section 6.3)
16	Blistering of skin after 5 s[b]
29	Wood ignites spontaneously after prolonged exposure[a] (see Section 6.4)
52	Fibreboard ignites spontaneously in 5 s[a]

[a] D.I. Lawson (1954).
[b] S.H. Tan (1967).
The data quoted for human exposure are essentially in agreement with information given by Purser (2008) and Beyler (2008).

Efeitos da Radiação

Radiation Levels and Their Effects:

Table 1-3[2] **Damage caused by Radiation** Damage Description	Heat Flux kW/m^2
Skin burns	5.0
Skin burns	4.7
Pain threshold	1.5
Pain at 1 minute	2.1
Plastic melts	12.0
Cable insulation degrades	18.0-20.0
Piloted ignition occurs:	
Wood	14.6
Wood with paint	16.7
Wood	25.0
No. 2 fuel oil	20.0 at 40 sec
No. 2 fuel oil	10.0 at 120 sec
Wood spontaneously ignites	33.5
Equipment damage	37.5