Formulário

atualizado em 23 de setembro

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Devolver no final da prova

$$Q_m = \rho \bar{u} A = A C_o \sqrt{2 \rho g_c P_g}.$$

$$Q_m = \rho \bar{u} A = \rho A C_o \sqrt{2\left(\frac{g_c P_g}{\rho} + g h_L\right)}.$$

$$h_L = h_L^o - \frac{C_o A}{A_t}\sqrt{\frac{2 g_c P_g}{\rho} + 2 g h_L^o}\, t + \frac{g}{2}\left(\frac{C_o A}{A_t} t\right)^2.$$

$$Q_m = \rho C_o A \sqrt{2\left(\frac{g_c P_g}{\rho} + g h_L^o\right)} - \frac{\rho g C_o^2 A^2}{A_t} t.$$

$$t_e = \frac{1}{C_o g}\left(\frac{A_t}{A}\right)\left[\sqrt{2\left(\frac{g_c P_g}{\rho} + g h_L^o\right)} - \sqrt{\frac{2 g_c P_g}{\rho}}\right].$$

$$Q_m = C_o A P_o \sqrt{\frac{2 g_c M}{R_g T_o} \frac{\gamma}{\gamma - 1}\left[\left(\frac{P}{P_o}\right)^{2/\gamma} - \left(\frac{P}{P_o}\right)^{(\gamma+1)/\gamma}\right]}.$$

$$\frac{P_{\text{choked}}}{P_o} = \left(\frac{2}{\gamma + 1}\right)^{\gamma/(\gamma-1)}.$$

$$(Q_m)_{\text{choked}} = C_o A P_o \sqrt{\frac{\gamma g_c M}{R_g T_o}\left(\frac{2}{\gamma+1}\right)^{(\gamma-1)/(\gamma-1)}},$$

$$Q_m = \frac{M K A P^{\text{sat}}}{R_g T_L},$$

$$K = K_o\left(\frac{M_o}{M}\right)^{1/3}.$$

$$Q_m = A C_o \sqrt{2 \rho_f g_c (P - P^{\text{sat}})},$$

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Estabilidade da atmosfera:

Table 5-1 Atmospheric Stability Classes for Use with the Pasquill-Gifford Dispersion Model[1,2]

Surface wind speed (m/s)	Daytime insolation[3]			Nighttime conditions[4]	
	Strong	Moderate	Slight	Thin overcast or >4/8 low cloud	≤3/8 cloudiness
<2	A	A–B	B	F[5]	F[5]
2–3	A–B	B	C	E	F
3–4	B	B–C	C	D[6]	E
4–6	C	C–D	D[6]	D[6]	D[6]
>6	C	D[6]	D[6]	D[6]	D[6]

Stability classes:
- A. extremely unstable
- B. moderately unstable
- C. slightly stable
- D. neutrally stable
- E. slightly stable
- F. moderately stable

[1] F. A. Gifford. "Use of Routine Meteorological Observations for Estimating Atmospheric Dispersion." *Nuclear Safety* (1961). 2(4): 47.

[2] F. A. Gifford. "Turbulent Diffusion-Typing Schemes: A Review." *Nuclear Safety* (1976). 17(1): 68.

[3] Strong insolation corresponds to a sunny midday in midsummer in England. Slight insolation to similar conditions in midwinter.

[4] Night refers to the period 1 hour before sunset and 1 hour after dawn.

[5] These values are filled in to complete the table.

[6] The neutral category D should be used, regardless of wind speed, for overcast conditions during day or night and for any sky conditions during the hour before or after sunset or sunrise, respectively.

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Table 5-2 Recommended Equations for Pasquill-Gifford Dispersion Coefficients for Plume Dispersion[1,2] (the downwind distance *x* has units of meters)

Pasquill-Gifford stability class	σ_y (m)	σ_z (m)
Rural conditions		
A	$0.22x(1 + 0.0001x)^{-1/2}$	$0.20x$
B	$0.16x(1 + 0.0001x)^{-1/2}$	$0.12x$
C	$0.11x(1 + 0.0001x)^{-1/2}$	$0.08x(1 + 0.0002x)^{-1/2}$
D	$0.08x(1 + 0.0001x)^{-1/2}$	$0.06x(1 + 0.0015x)^{-1/2}$
E	$0.06x(1 + 0.0001x)^{-1/2}$	$0.03x(1 + 0.0003x)^{-1}$
F	$0.04x(1 + 0.0001x)^{-1/2}$	$0.016x(1 + 0.0003x)^{-1}$
Urban conditions		
A–B	$0.32x(1 + 0.0004x)^{-1/2}$	$0.24x(1 + 0.0001x)^{+1/2}$
D	$0.22x(1 + 0.0004x)^{-1/2}$	$0.20x$
D	$0.16x(1 + 0.0004x)^{-1/2}$	$0.14x(1 + 0.0003x)^{-1/2}$
E–F	$0.11x(1 + 0.0004x)^{-1/2}$	$0.08x(1 + 0.0015x)^{-1/2}$

Atenção: assuma o coeficiente de X igual ao de Y

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Table 5-3 Recommended Equations for Pasquill-Gifford Dispersion Coefficients for Puff Dispersion[1,2] (the downwind distance x has units of meters)

Pasquill-Gifford stability class	σ_y (m) or σ_x (m)	σ_z (m)
A	$0.18x^{0.92}$	$0.60x^{0.75}$
B	$0.14x^{0.92}$	$0.53x^{0.73}$
C	$0.10x^{0.92}$	$0.34x^{0.71}$
D	$0.06x^{0.92}$	$0.15x^{0.70}$
E	$0.04x^{0.92}$	$0.10x^{0.65}$
F	$0.02x^{0.89}$	$0.05x^{0.61}$

A–F are defined in Table 5-1.

[1] R. F. Griffiths, "Errors in the Use of the Briggs Parameterization for Atmospheric Dispersion Coefficients." *Atmospheric Environment* (1994), 28(17): 2861–2865.

[2] G. A. Briggs. *Diffusion Estimation for Small Emissions*. Report ATDL-106 (Washington, DC: Air Resources, Atmospheric Turbulence, and Diffusion Laboratory, Environmental Research Laboratories, 1974).

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PUFF, fonte pontual localizada no chão, sistema de coordenadas na fonte, vento constante na direção X

$$\langle C\rangle(x, y, z, t) = \frac{Q_m^*}{\sqrt{2}\pi^{3/2}\sigma_x\sigma_y\sigma_z} \exp\left\{-\frac{1}{2}\left[\left(\frac{x - ut}{\sigma_x}\right)^2 + \frac{y^2}{\sigma_y^2} + \frac{z^2}{\sigma_z^2}\right]\right\}.$$

Pluma, fonte continua, avaliação no estado estacionário, fonte localizada no chão, sistema de coordenadas na fonte, vento constante na direção X

$$\langle C\rangle(x, y, z) = \frac{Q_m}{\pi\sigma_y\sigma_z u} \exp\left[-\frac{1}{2}\left(\frac{y^2}{\sigma_y^2} + \frac{z^2}{\sigma_z^2}\right)\right].$$

$$\Delta H_r = \frac{\bar{u}_s d}{\bar{u}}\left[1.5 + 2.68 \times 10^{-3} P d\left(\frac{T_s - T_a}{T_s}\right)\right],$$

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Puff, fonte a uma altura Hr em relação ao solo, sistema de coordenadas na Posição da fonte (mas no solo):

$$\bar{C}(x,y,z,t)=\frac{Q_m^{*}}{(2\pi)^{3/2}\sigma_x\sigma_y\sigma_z}\exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\left\{\exp\left[-\frac{1}{2}\left(\frac{z-H_r}{\sigma_z}\right)^2\right]+\exp\left[-\frac{1}{2}\left(\frac{z+H_r}{\sigma_z}\right)^2\right]\right\}\times$$
$$\times\exp\left[-\frac{1}{2}\left(\frac{x-ut}{\sigma_x}\right)^2\right]$$

Pluma, fonte continua, avaliação no estado estacionário, **fonte localizada em uma altura Hr do chão**, **sistema de coordenadas no chão na posição da fonte**, vento constante na direção X

$$\langle C\rangle(x,y,z)=\frac{Q_m}{2\pi\sigma_y\sigma_z u}\exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]$$
$$\times\left\{\exp\left[-\frac{1}{2}\left(\frac{z-H_r}{\sigma_z}\right)^2\right]+\exp\left[-\frac{1}{2}\left(\frac{z+H_r}{\sigma_z}\right)^2\right]\right\}.$$

$$\langle C\rangle_{max}=\frac{2Q_m}{e\pi u H_r^2}\left(\frac{\sigma_z}{\sigma_y}\right).$$

$$\sigma_z=\frac{H_r}{\sqrt{2}}.$$

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$$m_{TNT} = \frac{\eta m \Delta H_c}{E_{TNT}}$$

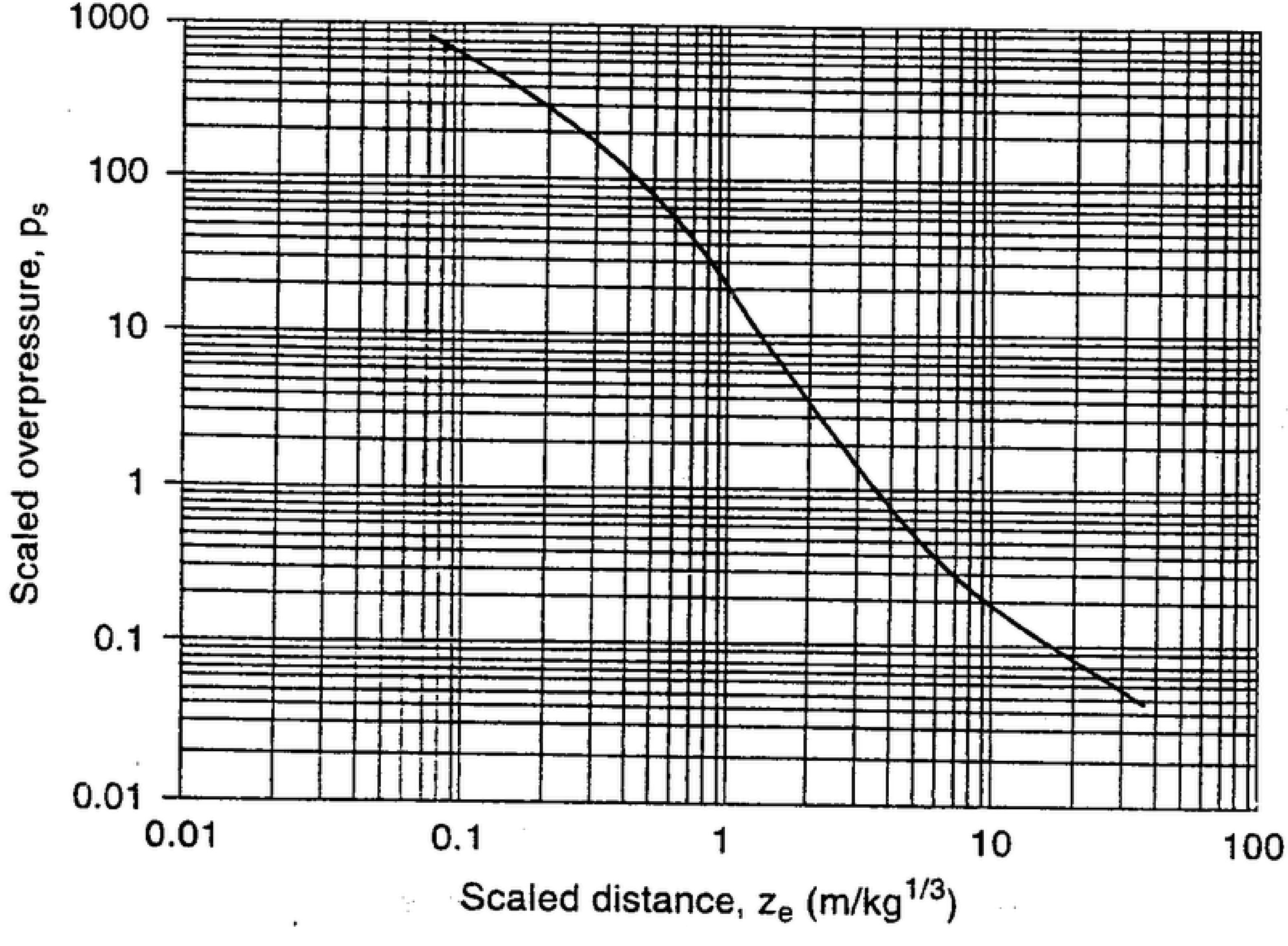
$$z_e = \frac{r}{m_{TNT}^{1/3}}.$$

E_{TNT} is the energy of explosion of TNT.

1120 cal/g = 4686 kJ/kg = 2016 BTU /lb

η is the empirical explosion efficiency (unitless),

Nuvem de Propano: 5%
Nuvem de dietil eter: 10%
Nuvem de acetileno: 15%



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Pressure		
psig	kPa	Damage
0.02	0.14	Annoying noise (137 dB if of low frequency, 10–15 Hz)
0.03	0.21	Occasional breaking of large glass windows already under strain
0.04	0.28	Loud noise (143 dB), sonic boom, glass failure
0.1	0.69	Breakage of small windows under strain
0.15	1.03	Typical pressure for glass breakage
0.3	2.07	"Safe distance" (probability 0.95 of no serious damage below this value); projectile limit: some damage to house ceilings: 10% window glass broken
0.4	2.76	Limited minor structural damage
0.5–1.0	3.4–6.9	Large and small windows usually shatter; occasional damage to window frames
0.7	4.8	Minor damage to house structures
1.0	6.9	Partial demolition of houses, made uninhabitable
1–2	6.9–13.8	Corrugated asbestos shatters; corrugated steel or aluminum panels, fastenings fail, followed by buckling; wood panels (standard housing), fastenings fail, panels blow in
1.3	9.0	Steel frame of clad building slightly distorted
2	13.8	Partial collapse of walls and roofs of houses
2–3	13.8–20.7	Concrete or cinder block walls, not reinforced, shatter
2.3	15.8	Lower limit of serious structural damage
2.5	17.2	50% destruction of brickwork of houses
3	20.7	Heavy machines (3000 lb) in industrial buildings suffer little damage; steel frame buildings distort and pull away from foundations
3–4	20.7–27.6	Frameless, self-framing steel panel buildings demolished; rupture of oil storage tanks
4	27.6	Cladding of light industrial buildings ruptures
5	34.5	Wooden utility poles snap; tall hydraulic presses (40,000 lb) in buildings slightly damaged
5–7	34.5–48.2	Nearly complete destruction of houses
7	48.2	Loaded train wagons overturned
7–8	48.2–55.1	Brick panels, 8–12 in thick, not reinforced, fail by shearing or flexure
9	62.0	Loaded train boxcars completely demolished
10	68.9	Probable total destruction of buildings; heavy machine tools (7000 lb) moved and badly damaged, very heavy machine tools (12,000 lb) survive
300	2068	Limit of crater lip

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Compound	Formula	Energy of explosion[1] (kJ/mol)
Paraffin hydrocarbons		
Methane	CH_4	−818.7
Ethane	C_2H_6	−1468.7
Propane	C_3H_8	−2110.3
Butane	C_4H_{10}	−2750.2
Isobutane	C_4H_{10}	−2747.9
Pentane	C_5H_{12}	−3389.8
Isopentane	C_5H_{12}	−3383.3
2,2-Dimethylpropane	C_5H_{12}	−3382.7
Hexane	C_6H_{14}	−4030.3
Heptane	C_7H_{16}	−4671.0
2,3-Dimethylpentane	C_7H_{16}	−4662.9
Octane	C_8H_{18}	−5301.8
Nonane	C_9H_{20}	−5948.6
Decane	$C_{10}H_{22}$	−6588.9
Olefins		
Ethylene	C_2H_4	−1332.4
Propylene	C_3H_6	−1959.0
1-Butene	C_4H_8	−2600.6
2-Butene	C_4H_8	−2594.1
1-Pentene	C_5H_{10}	−3239.3
Acetylenes		
Acetylene	C_2H_2	−1236.0
Aromatics		
Benzene	C_6H_6	−3210.3
Toluene	C_7H_8	−3835.1
o-Xylene	C_8H_{10}	−4467.0
Cyclic hydrocarbons		
Cyclopropane	C_3H_6	−1998.5

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