BLEVE Fireball: Size, Duration and Heat Flux at a Distance

Radius, duration and lift-off height of a BLEVE fireball, its surface emissive power, and the heat flux on a target at a ground distance (TNO Yellow Book).

Method: TNO Yellow Book; Methods for the Calculation of Physical Effects; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Mass of flammable material	10,000	kg
Heat of combustion	46,000	kJ/kg
Heat of vaporisation	426.00	kJ/kg
Specific heat of the vapour	2.0000	kJ/(kg·K)
Vapour pressure in the vessel at failure (absolute)	2,000.0	kPa
Ground distance from below the fireball to the target	200.00	m
Partial pressure of water vapour in air	2.0000	kPa

Calculated results

Parameter	Value	Unit
Fireball radius	64.646	m
Fireball duration	9.3420	s
Height of the fireball centre	129.29	m
Fraction of heat radiated	33.745	%
Surface emissive power	290.08	kW/m²
Atmospheric transmissivity	64.080	%
Heat flux at the target	13.697	kW/m²

Notes for this case

- Spherical fireball after lift-off with uniform emissive power and no soot. The transmissivity fit (6.29) holds for 10^4 < p_w·x < 10^5 N/m; outside that range use TNO's absorption charts.
- A screening estimate for training and early design, not a hazard or risk study.
- p_w·x is outside 10^4–10^5 N/m: the transmissivity is extrapolated.

Formula and method

$$r_{fb} = 3.24 m^{0.325}, \quad t = 0.852 m^{0.26}, \quad H = 2 r_{fb}, \quad F_s = 0.00325 P_{sv}^{0.32}$$

$$SEP = \frac{(\Delta H_c - \Delta H_v - C_p \Delta T)\, m\, F_s}{4\pi r_{fb}^2 t}, \quad q = SEP \left(\frac{r_{fb}}{X}\right)^2 \tau_a, \quad \tau_a = 2.02 (p_w x)^{-0.09}$$

Variables

m	Mass of flammable material	kg
ΔH_c	Heat of combustion	J/kg
ΔH_v	Heat of vaporisation	J/kg
C_p	Specific heat of the vapour	J/(kg·K)
P_{sv}	Vapour pressure in the vessel at failure (absolute)	Pa
x_{bleve}	Ground distance from below the fireball to the target	m
p_w	Partial pressure of water vapour in air	Pa

r_{fb}	Fireball radius	m
t	Fireball duration	s
H_{bleve}	Height of the fireball centre	m
F_s	Fraction of heat radiated	-
SEP	Surface emissive power	W/m²
τ_a	Atmospheric transmissivity	-
q	Heat flux at the target	W/m²

Method and standards

TNO Yellow Book fireball model (ΔT = 1,700 K between flame and ambient; X from the fireball centre, x = X − r from its surface).

Assumptions and limits

- Uniform SEP; spherical fireball after lift-off.

References

- TNO Yellow Book
- Methods for the Calculation of Physical Effects
- CPR 14E
- 3rd ed. (2005)
- ch. 6
- §6.5.7
- eqs. 6.21
- 6.22
- 6.29 and 6.90–6.96

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/chemical/process-safety/bleve-fireball

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Reopens the calculator with the inputs of this report.