Fire Modelling

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Introduction

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- This is where Fire Modelling comes into play

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  → Design fire based on use, geometry and fire load

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Design fire need engineering judgement!
$\rightarrow$ There is no single solution..

Design Fires

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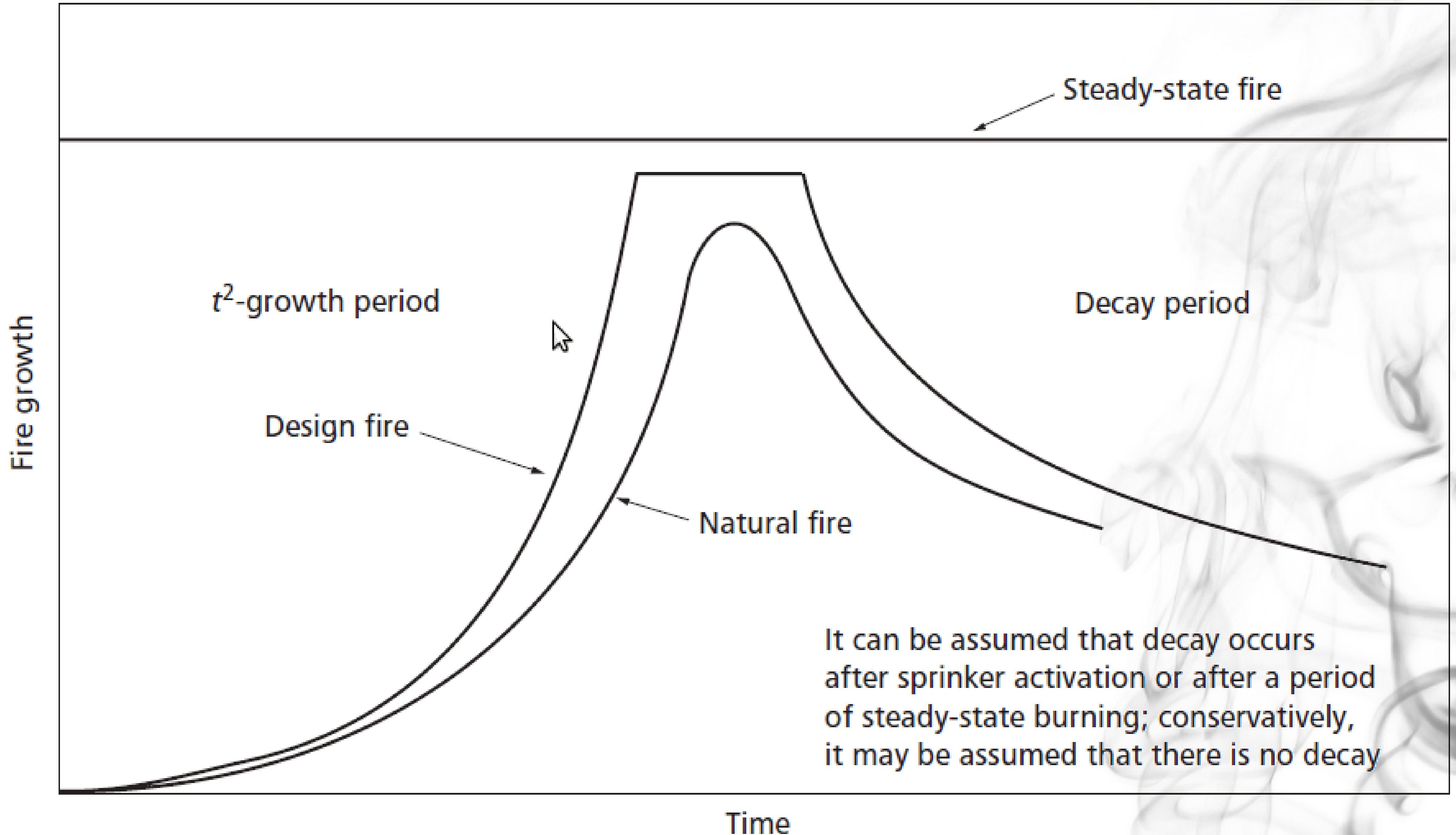

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Design Fires

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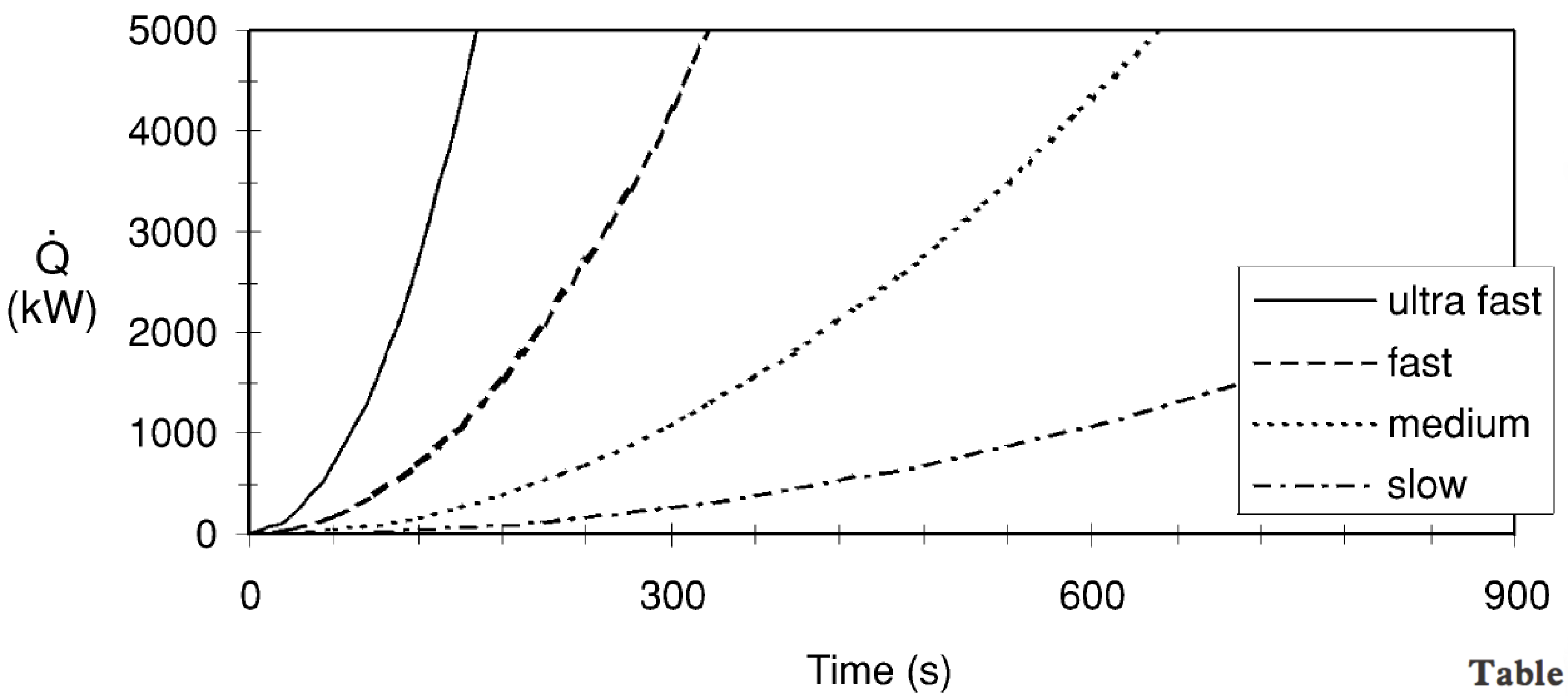

Karlsson – Enclosure Fire Dynamics

Table 10.1 Characteristic growth time for various classes of fire

Fire class	Characteristic growth time, t_g / s	Constant *a* / $kW \cdot s^{-2}$
Ultra-fast	75	0.1876
Fast	150	0.0469
Medium	300	0.0117
Slow	600	0.0029

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Design Fires

Table 10.2 Growth rates for growing fires

Building area providing fuel	Growth rate
Dwelling	Medium
Office	Medium
Shop	Fast
Warehouse	Ultrafast†
Hotel bedroom	Medium
Hotel reception	Medium
Assembly hall seating	Medium–fast
Picture gallery	Slow
Display area	Slow–medium

† depends on fire load

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Indications can be found in CIBSE Guide E, SFPE Handbook or NFPA.

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$$\dot{m}_{\mathrm{ent}} = E\left(\frac{g\rho_\infty^2}{T_\infty c_p}\right)\dot{Q}_c^{1/3}(z-z_0)^{5/3}\cdot\left[1+\frac{G\dot{Q}_c^{2/3}}{\left(g^{1/2}c_p\rho_\infty T_\infty\right)^{2/3}(z-z_0)^{5/3}}\right]$$

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  $\rightarrow$ Volume of smoke
- Plume temperature $T_{\mathrm{smoke}} = T_\infty + \dfrac{\dot{Q}_c}{\dot{m}_{\mathrm{ent}}c_p}$
- Plume velocity $u_{\mathrm{smoke}} = 3.4\left(\frac{g}{\rho_\infty T_\infty c_p}\right)^{1/3}\dot{Q}_c^{1/3}(z-z_0)^{-1/3}$

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→ If you need spatial resolution (e.g. location of exhaust outlets, gas temperatures for heat transfer calculations), use field models (CFD).