

Experimental Study on the Influence of HRR Evolution on the Pressure Variation in an Air-Tight Compartment

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Y OF ENGINEERING DEPARTMENT OF STRUCTURAL ENGINEERING AND BUILDING MATERIALS **AND ARCHITECTURE RESEARCH GROUP - FIRE SAFETY SCIENCE AND ENGINEERING EXPERIMENTAL STUDY ON THE INFLUENCE OF THE HRR EVOLUTION ON THE** PRESSURE VARIATION IN AN AIR-TIGHT COMPARTMENT Junyi Li^a, Hugues Prétrel^b, Sylvain Suard^b, Tarek Beji^a, Bart Merci^a ^a Department of Structural Engineering and Building Materials, Ghent University, 9000 Ghent, Belgium ^b Institut de Radioprotection et de Sûreté Nucléaire (IRSN), Centre de Cadarache, 13115 St Paul Lez Durance, France Results Background \succ Influence of fuel mass flow growth/decay rate coefficient α (g/s³) • Applications of air-tight buildings $\dot{m}_{f,max}$ =0.1 g/s, n=2 100 Residential, e.g., low-energy buildings (Hanger 190) (g/s)0.1 Air-tight buildings 50 (Pa) Industrial, e.g., nuclear constructions ng 150 -50 <u>ā</u>110 flov **Fire risks of air-tight buildings** Pres -100 mas 0 70 Hinder evacuation -0.2 -150 (100 Pa-200 Pa) [1] Low leakage area 30 -200 0.3 0.001 0.01 0.000001 0.00001 0.0001 0.1100 500 300 200 400 **Substantial** Compromise Fuel mass flow growth/decay rate coefficient (g/s^3) Time (s) structural integrity [2] $-\alpha = 0.0004$ $-\alpha = 0.01$ pressure rise $-\alpha = 0.000005 - \alpha = 0.00001 - \alpha = 0.00003$ $-\alpha = 0.0001$ •וm f,max=0.25 g/s ••m f,max=0.3 g/s $-\alpha = 0.000005 - \alpha = 0.00001 - \alpha = 0.00003 - \alpha = 0.0001 - \alpha = 0.0004 - \alpha = 0.001$ Hot combustion Peak over-pressure as function of Temporal pressure variations with different fuel mass flow growth/decay rate coefficients Loss of dynamic products the fuel mass flow growth/decay rate coefficient (solid lines: pressure variations, dashed lines: fuel mass flow rate evolutions) confinement [3] > Influence of maximum (steady state) fuel mass flow rate $\dot{m}_{f,max}$ (g/s) **Experimental configurations** *α*=0.0001 g/s³, n=2 (g/s)0.2 70 Inlet Outlet (Pa) Back 150 ā 100 -0.2 ^o -70 Left م -140 -0.4 na 50 Calcium silicate -210 -0.6 n 25 mm 100 300 500 200 400 0.05 0.15 0.3 0.25 0.2 Right Time (s) Steel 2 mm – Maximum (steady state) fuel mass flow rate (g/s) $-\alpha = 0.00003 \quad \neg \alpha = 0.0001 \quad \neg \alpha = 0.0004 \quad \neg \alpha = 0.002 \quad \neg \alpha = 0.01$ --m_f,max=0.05 --m_f,max=0.075--m_f,max=0.1 --m_f,max=0.15 --m_f,max=0.2 Peak over-pressure as function of • Pressure Temporal pressure variations with different maximum (steady state) fuel mass flow rates the maximum (steady state) fuel mass flow rate ► Gas temperature (solid lines: pressure variations, dashed lines: fuel mass flow rate evolutions) 1.25 Influence of fuel mass flow growth/decay exponent n ⊳ Valve Conclusions Flow meter : m_{f.max}=0.15 g/s $\begin{array}{c} 0.2 \\ 0.1 \end{array} \quad \overbrace{\texttt{S}}^{\texttt{S}} \end{array}$ 100 1.5 m Pilot flame pipe 50 Front Burner pipe (Pa) -0.1 § -50 Propane pressure and under-pressure. -0.2 🖫 -100 Sketch of the experimental facility -0.3 g å -150 $0 < t < t_1$ -0.4 🧕 -200 -0.5 $\alpha(t-t_1)^n$ -250 $t_1 < t < t_2$ Prescribed 100 300 150 200 250 50 $t_2 < t < t_3$ propane mass $\dot{m}_f =$ 2 m_{f,max} References Time (s) [1] Hostikka, et al, Fire Saf. J. 91 (2017). -n=0.3 -n=1 -n=3 -n=5 -n=0.1 -n=0.3 -n=1 -n=3 -n=5 $\dot{m}_{f,max} - \alpha(t-t_3)^n$ $t_3 < t < t_4$ flow rate [2] Janardhan, et al, Fire Technol. 53 (2017). Temporal pressure variations with different fuel mass flow growth/decay exponents $t > t_{4}$ (solid lines: pressure variations, dashed lines: fuel mass flow rate evolutions) [3] Pretrel, et al, Fire Saf. J. 52 (2012). Junyi.Li@UGent.be Contact

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