PU Europe FIRE SAFETY HANDBOOK

IMPACT OF INSULATION ON FIRE SAFETY IN BUILDINGS

COMMON BUILDING PRACTICE

The way buildings are constructed has changed considerably over the last four decades. Shopping malls, industrial buildings or cold stores are larger. High amounts of goods are processed, stored and traded. In today's food industry, hot processing to produce ready-made meals for distribution is common. Generally the fire load of the building contents by far exceeds that of the construction products (see fire load densities of typical buildings – Table 1 – and of the insulation – Table 2). Furthermore the content is most likely to contribute first to a fire.

Finally, envelopes of all types of buildings, being residential, commercial, industrial and cold chain, are becoming increasingly insulated. Cold bridges are avoided and ventilation is controlled.

ESTIMATED FIRE LOAD

Building category	Fire load [MJ/m²]
Library	1 800
Hotel room	400
Office (standard)	500
School	350
Theatre, cinema	350
Transport building (public space)	150
Shopping centre (including corridors)	750
Residential building	950
Hospital	300

Table 1: One example for estimated fire loads. For more details on the declared values see the report Natural Fire Safety Concept, drafted in the framework of the Valorisation Project (20 August 2001) [1]

Material	Density [kg/m³]	Thermal conductivity [W/(m·K)]	Thickness [(mm) for U=0.21 W/m²K]	Calorific value [MJ/kg]	Fire load density [MJ/m²]
PIR/PUR	30	0.022	115	27	93
Stone wool (Euroclass A2)	120	0.040	200	3	72
	160	0.037	185	3	89
EPS	20	0.035	175	39.6	139
Wood insulation	100	0.040	200	16.2	324
Bituminous roofing membrane 2 layers (8 mm)	800	n.a.	n.a.	40	256

Table 2: Examples of calorific value and fire load density for different insulation materials and bitumen roofing membrane

These changes result in different fire risks and hazards.

THE NEW BUILDING PRACTICE: HIGHLY ENERGY EFFICIENT BUILDINGS

By 2050 the energy efficiency of buildings needs to be significantly improved [2] in order to achieve a climate neutral building stock. Key elements to improve the energy efficiency of buildings include the use of more and thicker insulation in the floor, walls and roof, the installation of double or triple glazed windows and airtight building envelopes. At the same time a controlled ventilation system is needed. Solar panels may be installed to produce the remaining energy that is required. Finally, traditional heating sources, which may have been the cause of fire in the past, are less or no longer present in low energy buildings.

Some media have reported that fires in highly energy-efficient buildings attain flashover more easily [3]. The higher incidence of flashovers has been correlated in the media to better insulated houses. A typical question is "Are there more intense fires in highly insulated buildings?", the response is not necessarily yes. A fire in a highly insulated building may grow faster compared to an un-insulated building because the heat is retained in the building. This happens irrespective of the type of insulation. However, it is also possible that through controlled ventilation and tighter windows/doors fires may stay smaller. Furthermore, triple glazed windows may not break or may do so only at a later stage of the fire. Together with air-tightness, this leads to a quick reduction in oxygen in case of fire. When a door opens and fresh air comes in, this can cause instantaneous revival of the fire when the temperature inside is still high (backdraft). Also to be noted, in some cases, solar panels have caused problems during fire extinguishing, when they came into contact with the extinguishing water.

A Dutch National study on the fire safety of combustible insulation materials concluded that using the current and correct application in the building envelope these products neither significantly

[1] *Valorisation project: Natural fire safety concept*, CEC Agreement 7215-PA/PB/PC – 042, Period from 01.07.1999 - 30.06.2000, CEC Agreement 7215-PA/PB/PC – 057, Period from 01.07.2000 - 30.06.2001

[2] See the revised EPBD issued in July 2018 and the European Green Deal issued end of 2019

[3] The point of flashover is the temperature at which suddenly all combustibles in the premise start to burn so that the fire suddenly changes from a local to an all involving fire

Table 3: Population, fatalities per capita and percentage of fatal fires in selected European countries [4]

Country	Population [million]	Fatalities per capita per year [approx.]	% fatal fires [related to all residential fires]
Belgium (2014-2015)	11.4	0.6 per 100 000	0.5 %
Denmark (2011-2012)	5.8	1.1 per 100 000	1.2 %
Estonia (2013-2017)	1.3	3.7 per 100 000	4.6 %
Finland (2011-2012)	5.5	1.4 per 100 000	
Netherlands (2011-2014)	17	0.2 per 100 000	0.6 %
Norway (2016-2017)	5.3	0.5 per 100 000	1.3 %
Poland (2011-2012)	38	1.3 per 100 000	
Sweden (2011-2013)	10	1.1 per 100 000	1.2 %
UK (2014)	66	0.6 per 100 000	
Total	160.3		
Total Europe	742.9		

contributes to the severity of the fire nor to an increase of fire victims [5]. This conclusion is confirmed by official statistics (see Table 3). The market share of non-combustible mineral wool insulation in Scandinavia is as high as 85 %, whereas combustible organic insulation materials including PU account for almost half of the insulation market in West and Central Europe. Still the number of casualties per capita is not lower, and even tends to be higher in Scandinavian residential buildings.

More specifically, a simulation study on fire safety in passive houses, commissioned by the Hoge Raad voor Brandveiligheid (High Council for Fire Safety in Belgium), did not give rise to great concern. The conclusion was that the early phase of the fire is quite similar to traditional buildings and that a passive house does not constitute a higher risk for escape of occupants. In the later phase, the simulated fire in the passive house resulted in lower temperatures because of lower oxygen levels. The report further concluded that there may be a higher risk for backdraft when a door is opened in this phase [6].

[4] *Fatal residential fires in Europe – A preliminary assessment of risk profiles in nine European countries*, Institute for Safety, Fire Service Academy, Netherlands, 2018
[5] 2009-Efectis-R0824, *Brandveiligheid van isolatiematerialen*, for Ministerie VROM (February 2010)
[6] S Brohez et al.: *Passive House and fire = Inferno?*, Final report financed by SPF Interieur, Direction générale Sécurité Intégrale, Issep, Belgium (2009-2010)

From the above, it may be concluded that fire growth may be different in highly insulated buildings compared to traditional ones and that, in most cases, it is due to the different building physics and not to the choice of the insulation material.

The changes in building design due to increasing energy efficiency need to be taken into account. When the causes and dynamics of fire are understood, effective recommendations can be formulated when and where needed.