The Bartlett School of Environment, Energy and Resources

MSc ESDA Title Page

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Coursework Title: **The performance of EPS as an insulator in UK cavity walls**

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Background

The UK has declared a net-zero emissions policy to mitigate climate change, a pillar of which is optimising heating in buildings as heating accounts for 30% of UK carbon emissions and is predominantly fossil fuel-sourced (86% natural gas, 9% other fossil fuels) (BEIS, 2021). The government intends to lead a 'fabric-first approach' by encouraging better insulation (BEIS, 2021).

UK houses are good candidates for a 'fabric-first' approach as 70% of them have cavity walls (Gregory, 2012) with significant capacity for insulation (Anupoju, 2018). Whilst cavity walls are better than solid walls at preventing dampness from indoor-outdoor temperature differences (Anupoju, 2018), they are nevertheless impacted by temperature and humidity fluctuations (Delghust et al., 2010), especially in the UK given a temperate oceanic climate with cool, wet winters and warm, wet summers (Beck et al., 2018). This essay will consider polystyrene's performance and socio-environmental suitability as an insulator in cavity walls.

Performance Suitability

Expanded polystyrene ("**EPS**") is a cost-efficient, versatile material which can be used as part of structural integrated panels and standalone enhancements to existing insulation. There are four key performance benefits to EPS as an insulator in cavity walls.

First, EPS conducts heat from warmer to cooler environments efficiently – this 'insulating performance' is measured in 'U' values. UK building regulations prevent U values over 0.55W/m^{2}K (HM Government, 2022) as they indicate inefficient insulation. Uninsulated cavity walls have U values of 1.4–1.9W/m^2 K (Hens et al., 2007), whilst EPS-insulated walls have shown 0.30–0.40W/m^{2}K (Gori et al., 2021), and so are compliant with government regulations. In comparative examples, U values of EPS-insulated walls have shown 36% less heat loss than uninsulated cavity walls in Jordan (Sobhy et al., 2017), and a 46% reduction in energy consumption in buildings in Turkey (Dombayci, 2007), suggesting a potential significant benefit to UK homes.

Secondly, EPS is durable. Whilst many insulation materials like vacuum insulation panels are easily influenced by external factors (climate and manufacturing conditions) and deteriorate with age (Baetens et al., 2010), EPS exhibits stable U values in diverse weather conditions and across its life-cycle (Vo et al., 2011). Similarly, EPS is shock-absorbing, enhancing structural integrity (Sulong et al., 2019).

Thirdly, EPS has a long life-cycle of approximately 50 years, which can extend by 70 years by increasing panel thickness by 100mm (Vo et al., 2011).

Fourthly, EPS is hydrophobic, which is particularly important given the UK's wet climate (Beck et al., 2018). Water immersion tests show the water content in EPS is around 1% in medium-density, and high-density polystyrene under high (2kPa) and normal (0.25-0.5kPa) pressure circumstances (Cai et al., 2017).

Socio-Environmental Suitability

EPS is a petrochemical, relying on fossil fuels in its production, which is a serious concern given the net-zero context (Asdrubali et al., 2015). Moreover, despite its long lifecycle, EPS is difficult to recycle as compared to bio-composite insulators (Asdrubali et al., 2015) with a high decomposition range of 388-427.6ºC (Lu et al., 2021). Nevertheless, several studies have considered mechanical, chemical, and thermal methods for recycling EPS which materially mitigate this concern (Maharana et al., 2007).

EPS is also highly flammable, melting at 100ºC and burning at 200ºC (Sulong et al., 2019). This is a significant concern in the UK given the Grenfell Tower fire starting due to flammable cladding (HSE, 2021). This can be overcome by using EPS as blending method (mixing EPS foam, flame retardant, and wood particle) (Lu et al., 2021) and by ensuring that there is no gap between insulation blocks (HSE, 2021), though there is also a public perception concern which needs to be managed.

Conclusion

Insulating UK homes is clearly vital in a zero-emissions policy given the contribution of heating to emissions. In addition to being cost-efficient and versatile, EPS exhibits strong insulation, water-resistance, and durability performance, which could materially contribute to the government's aim of reducing emissions generated by indoor heating. Whilst there are environmental concerns with EPS (in particular its fossil-fuel reliance), robust recycling and reuse policies could mitigate these. Nevertheless, there is a possibility that using EPS to reduce emissions could be counter-intuitive given the source material – this relationship should be studied directly as it goes to the heart of the viability of EPS as a sustainable insulator.

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