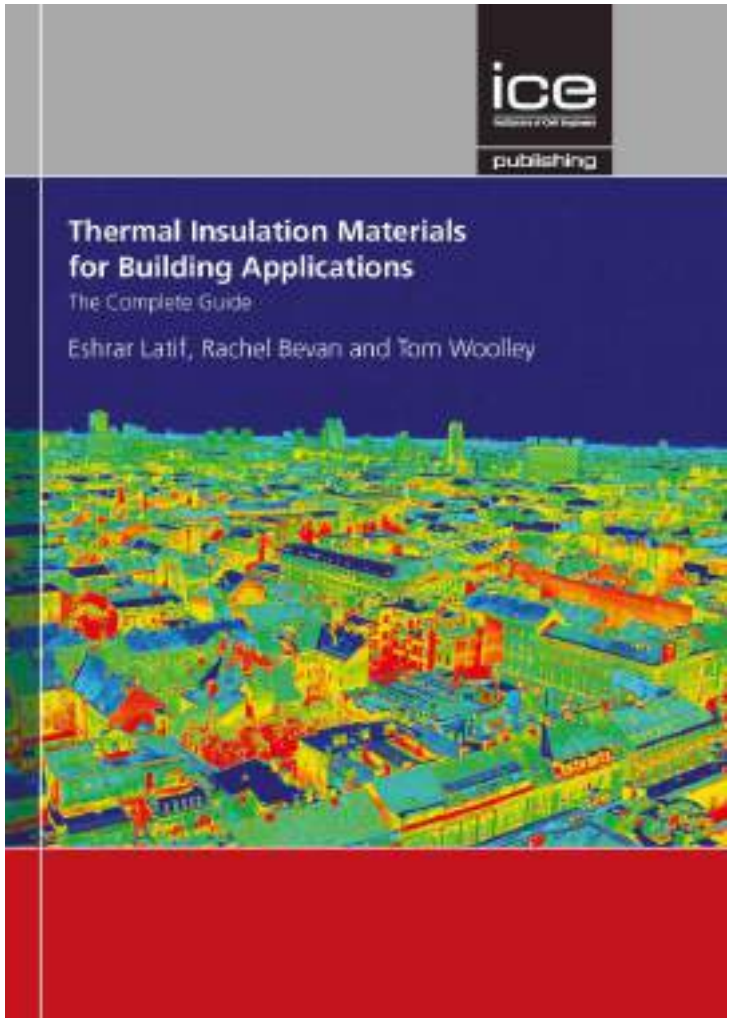
Reducing Energy Use in Housing: Insulation and Retrofit Problems in Wales and the UK

Tom Woolley, Rachel Bevan, Eshrar Latif

Cynhadledd ymchwil tai Cymru 2020 | Wales Housing Research Conference 2020 Thursday, 9 January 2020



Why is it important to understand insulation materials?
How do you choose insulation materials – what criteria?
Aesthetics, Cost, Construction, Environment???

- There is general agreement that existing and new build houses should achieve higher standards of energy efficiency.

- **Is all insulation the same?** There has been an assumption that all insulation materials are much the same and that, providing that thermal performance figures are satisfactory, any material can be used in any form of construction.

- **Insulation the elephant in the room**. Recent reports on climate action, zero energy and retrofitting amazingly barely mention insulation

- **Performance Gap**. Evidence shows, however, that inappropriate insulation and installation measures can lead to many unintended consequences and a gap between predicted and actual performance.

- **Retrofit disasters?** Far from reducing fuel poverty and carbon emissions, mould and damp can occur, aggravating health problems, which has been confirmed by academic research.

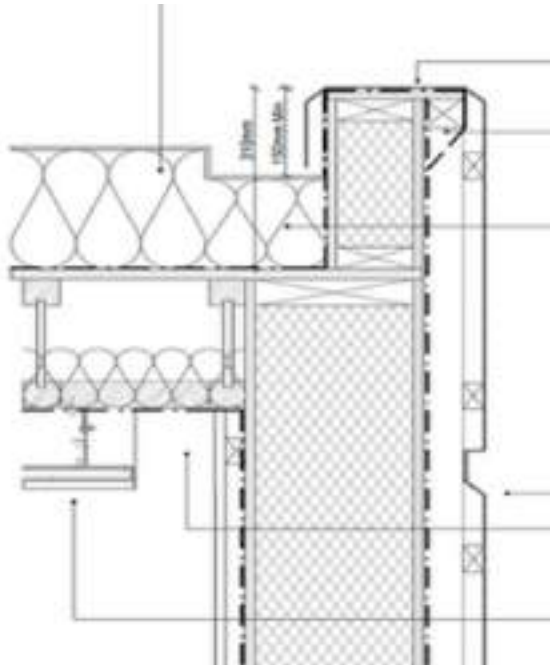
- **Fire Risks.** Flammable insulation materials are still widely used

- **Health Problems**. Sealing up increasingly airtight buildings with non-breathable, flammable and even hazardous synthetic materials can cause damage to building fabric and occupant health. The importance of indoor air quality and ventilation is often overlooked

- **Negative environmental impacts of insulation?** Furthermore the embodied energy and pollution involved in the production of many commonly produced insulation materials can be bad for the environment

- **Our book on insulation materials** tries to help people understand the differences between different kinds of insulation and indicates natural environmentally friendly alternatives

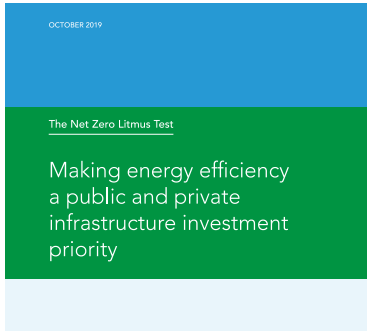
Insulation is central to keeping houses warm and to reducing CO2 emissions
But how much thought is given to which insulation to use?
Insulation is often ignored in climate and energy policies



Here are ten recent reports on housing, energy zero carbon and retrofit. In over 600 pages insulation is only mentioned 50 times and then only in a very vague and general way

The Green Construction Board

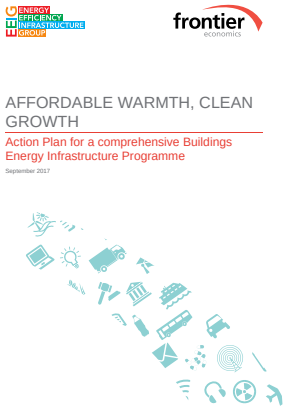
48 pages 2019.
insulation only 8 refs



Net Zero Litmus Test
2019. 48 pages.
Only mentions insulation 3 times

Zero Carbon Manchester
2017 26 pages
insulation mentioned only once

Zero Carbon Hub. 2014
44 pages
Insulation only mentioned twice



Energy Efficiency Infrastructure Group
2017
88 pages

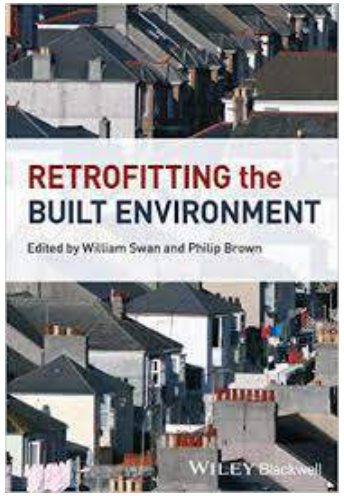
Only mentions insulation and then only in passing 9 times

2019 22 pages

Insulation only mentioned 10 times but only in passing

32 pages
2018
Only 6 references to insulation

Green New Deal.
2018?
37 pages with 8 insulation refs but mostly repetition



234 pages published 2013
Only 5 pages refer to insulation materials

2019 Only mentions insulation twice

This is the worst (2019) UK GBC ..insulation not mentioned at all

UK GBC
Together for a better built environment

ADVANCING NET ZERO

Net Zero Carbon Buildings:
A Framework Definition

APRIL 2019

Advancing Net Zero Programme Partners

Lead Partner: REDEVCO FOUNDATION

Programme Partners: bam, Berkeley Group, GROSVENOR, HOARE LEA, JLL

House of Commons

Business, Energy and Industrial Strategy Committee

Energy efficiency: building towards net zero

Twenty-First Report of Session 2017–19

Report, together with formal minutes relating to the report

Ordered by the House of Commons to be printed 9 July 2019

HC 1730
Published on 12 July 2019
by authority of the House of Commons

These are the best documents as they do recognise the importance of insulation and go into some detail

Each Home Counts

An Independent Review of Consumer Advice, Protection, Standards and Enforcement for Energy Efficiency and Renewable Energy

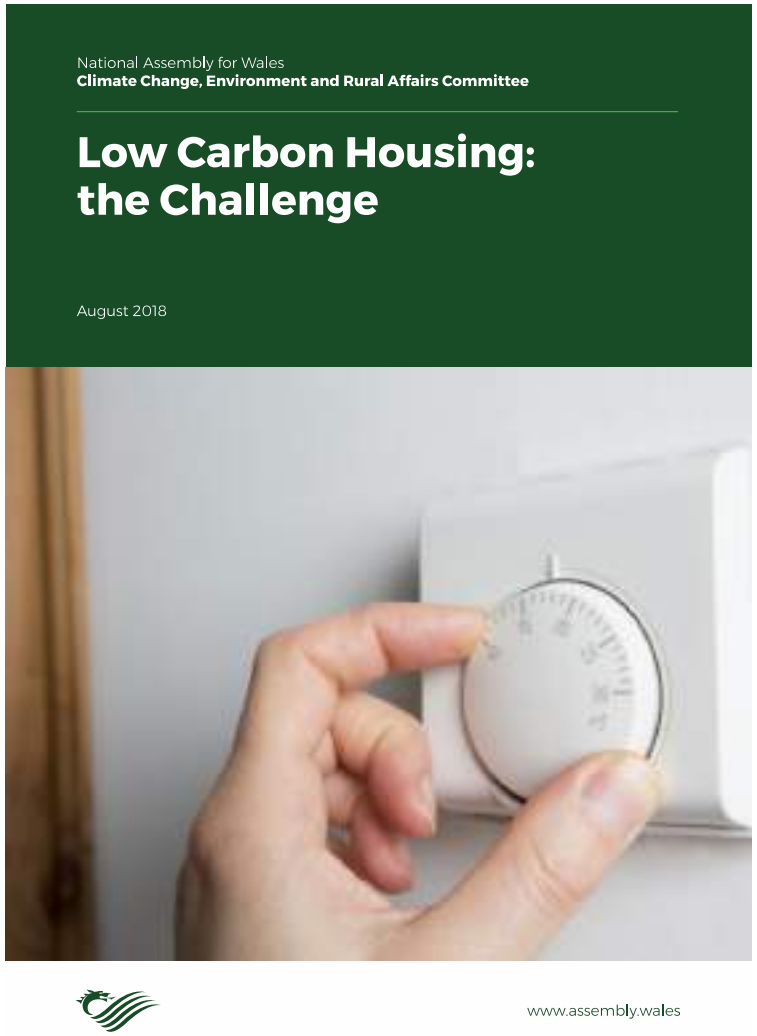
Dr Peter Bonfield, OBE, FREng

Department for Business, Energy & Industrial Strategy

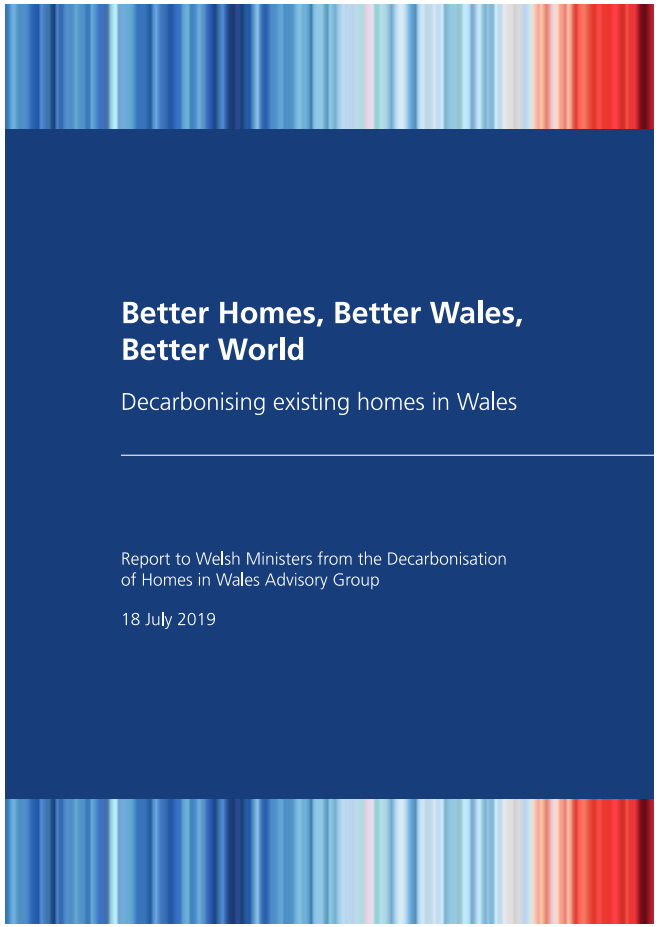
Department for Communities and Local Government

December 2016

How can you discuss retrofit and decarbonisation without discussing how to insulate homes safely and effectively?



44 pages
Insulation only mentioned 5 times



2019
66 pages
Insulation only mention once (though with twice in references)

Insulation not mentioned once

Insulation and retrofit problems

The Welsh Low Carbon housing report does mention problems from Mark Harris

49. Over the years, householders have experienced energy saving interventions, such as damp proofing and solid wall insulation, which have not delivered the benefits that were promised. This has eroded householders' confidence in such activities. Mark Harris from the Homebuilders' Federation gave the Committee an example of the historical problems:

> "I was working at Bridgend council delivering Arbed schemes, and we were merrily cladding buildings and filling cavities full of insulation. Five years later, we've got companies setting up now to take cladding off and to take insulation out because we've realised that, actually, either it wasn't the right thing to do or the skill set that delivered it wasn't properly skilled and it was done in a rush."[47]

Standards of installation

From BEIS

80. If the housing stock is to be decarbonised, almost every home will need some energy efficiency improvements. Yet scams and poor standards of workmanship have blighted confidence in energy efficiency installations.[196] Issues such as damp from poor installations, hard sell approaches, and scams related to the Green Deal have "exacerbated" the problem.[197] If there is limited trust in energy efficiency schemes, there will be limited progress in housing decarbonisation and fuel poverty alleviation.

RETROFIT PROBLEMS

HOME » FINANCE » PERSONAL FINANCE » ENERGY BILLS

Green Deal nightmares: 'British Gas botched our insulation – then offered £50 Nando's meal'

Non-existent cashback and dodgy works have left these householders out of pocket. We share their stories below

Heidi and Jonathan McInally-Henry say Green Deal works carried out on their home have left it barely habitable

The great cavity wall calamity: 1.5 million homes are blighted by damp after cowboy builders cash in on a Government insulation drive

- **Millions of homeowners persuaded to sign up to scheme with promise of cheaper bills by call-centre staff and salesman trying to meet targets**
- **The Government scheme was meant to make homes energy efficient**
- **But experts claim homes were not suitable for cavity wall insulation**
- **Victims left with houses riddled with damp and mould from botched fittings**

By BEN ELLERY FOR THE MAIL ON SUNDAY
PUBLISHED: 22:48, 21 January 2017 | **UPDATED:** 01:19, 22 January 2017

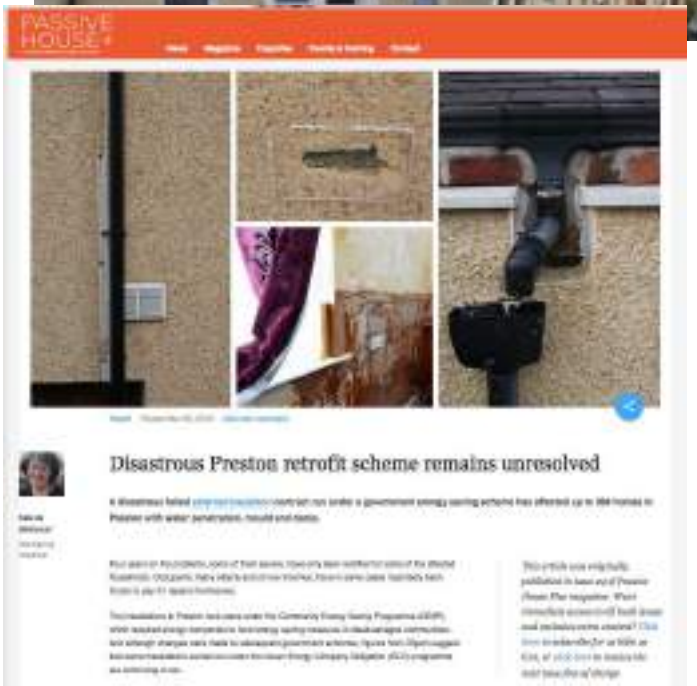
Stratus
LEGAL SOLUTIONS

BBC Radio 4 – Cavity Wall Insulation

BBC Radio 4 have reported the issues many people are suffering from caused by Cavity Wall Insulation. The report illustrates what can go wrong when Cavity wall insulation is installed incorrectly.

Listen to the recording below

One of the best documented disasters Fishwick in Preston



Deterioration Since October 2015

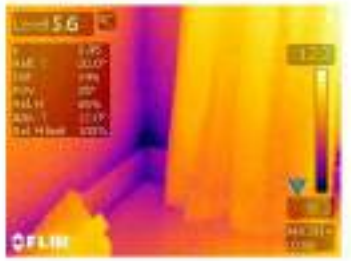
Another picture of Porch Interior – showing water ingress. Taken Mar. 2016

Now on to the exterior – below taken 14th Feb. 2016, note poor finish to silicone and messy fin to the topcoat which is spread over UPVC trim. Hardly done with great care.

Carmarthenshire

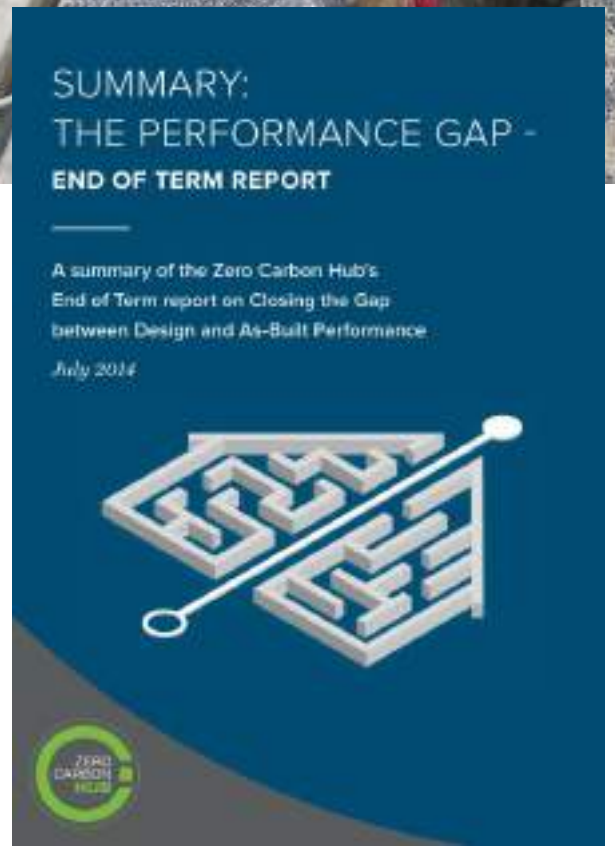
Mould and damp: Retrofit disasters case studies. Many are in Wales

Colin King BRE. Has done a lot of excellent work to draw attention to unintended consequences of retrofit
I have borrowed these from one of his presentations



bre

Poor installation of insulation is common in building construction leading to massive performance gaps.
Actual performance has been shown to be as much as 70% less than predicted SAP



Here are examples of how plastic foam insulation can shrink though often this can be unseen

Irish Examiner

News / Sport / Business / Views / Life / ExamViral / Property / Motors / Tech / Video

Building company sues firms over allegedly defective insulation boards which 'caused floors to sink'

By Ann O'Loughlin

A building company has sued for more than €2m damages over allegedly defective insulation boards which, it claims, caused floors in houses built by it to sink.

Tallaght-based Kelland Homes says extensive remedial works were required to about 58 houses at a development at Elder Heath, Kiltipper, Tallaght, because the insulation boards shrank, causing floors in the houses to sink.

It says it has suffered a loss of some €2m as a result of the remedial works and having to pay compensation to, and provide alternative accommodation for, affected homeowners.

It claims the boards were used in construction of houses at Elder Heath in 2015 and 2016 and were used under ground floor slabs.

THE IRISH TIMES

Thu, Dec 7, 2017

NEWS SPORT BUSINESS OPINION LIFE & STYLE CULTURE

Commercial Property › Construction

Kelland Homes sues over allegedly defective insulation boards

Builder claims €2m damages over shrinkage that caused floors in 58 homes to sink

Mon, Dec 4, 2017, 16:11

Mary Carolan

FIRE AND FLAMMABILITY

We're two years on from Grenfell, so why do these fires keep happening?

Luke Barratt

It's not just unsuitable cladding - a host of other safety issues are not being addressed by authorities and building owners

Barking, Crewe, Clapton, Worcester Park and now Bolton: 2019 has seen at least five major fires in blocks of flats. The latest blaze hit the Cube, a student

test shows potential risks with PIR sandwich panels

A burning issue

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Wales Wales Politics Wales Business North West North East Mid South Wes

Cardiff flats fire safety funding offer 'insulting'

By Paul Martin
BBC Wales Live

16 October 2019

Residents 'safe' after Cardiff high-rise flats fire

ECHO NEWS IN YOUR AREA WHAT'S ON LIVERPOOL FC EVERTON FC MORE

Bolton Cube student block fire: Everything we know so far

At least 40 fire engines and 200 fire fighters battled the blaze throughout the night

The catalogue of failures that make this huge Cardiff apartment complex a 'major concern' fire risk

Two reports identified a series of fire safety issues across the whole development with more than 450 flats

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Clapton flats fire: Woman rescued during 'suspicious' blaze

3 hours ago Share

Witnesses described seeing a large window on the top floor "explode" sending debris to the ground

ITV REPORT 9 September 2019 at 11:19am

Worcester Park fire: 'It's gone' – fire rips through block of flats

A four-storey residential block has been destroyed after a fire ripped through the building in the early hours of Monday.

FIRE WARNING

Persimmon and Bellway new-build homes 'are fire risk', BBC Watchdog investigation finds

House builders are required to make sure the homes they sell meet fire safety standards

By Alice Grahns, Digital Consumer Reporter
1 May 2019, 0:01 | Updated 1 May 2019, 8:37

HUNDREDS of new homes constructed by Persimmon and Bellway Homes have been built with "potentially dangerous fire safety issues", an investigation by BBC Watchdog Live has found.

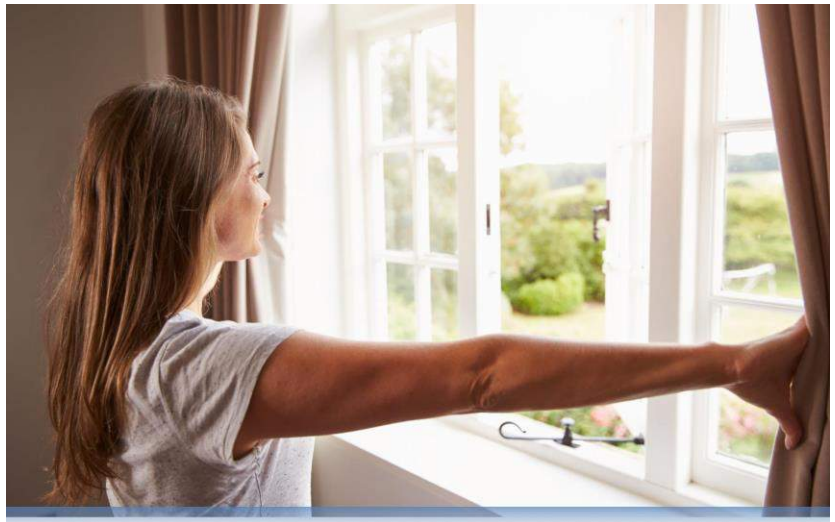
The Persimmon properties were sold with missing or incorrectly installed fire barriers, designed to prevent the spread of fire, according to a new episode airing on BBC One tonight.

'New-build homes not fire safe', BBC investigation finds

1 May 2019 Share

Houses developed by Persimmon Homes and Bellway Homes have potentially dangerous fire safety issues, BBC Watchdog Live has found.

Bad indoor air quality can be another consequence of airtight insulated houses



Health Effects of Modern Airtight Construction

HEMAC Multidisciplinary Network

Ministry of Housing, Communities & Local Government

Ventilation and Indoor Air Quality in New Homes

Dispatches Posted Apr 06, 2017 Add new comment

New build homes face emerging ventilation crisis

Despite increasing standards of insulation and airtightness, housing developers face few requirements to provide better ventilation and indoor air quality for new home buyers — beyond knocking extra holes in walls. But as reports of condensation and mould affecting new housing developments continue to surface in both the UK and Ireland, and research indicates many new homes may have poor indoor air quality, are developers finally waking up to the need for properly engineered ventilation systems?

September 2019
Aecom Limited
Ministry of Housing, Communities and Local Government

MACKINTOSH ENVIRONMENTAL ARCHITECTURE RESEARCH UNIT THE GLASGOW SCHOOL OF ART

Arts & Humanities Research Council

UNIVERSITY OF ABERDEEN

Ian Mawditt has shown that pollutants from plastic foam *external insulation* exceeded safe limits inside his house when the MVHR system is turned off

While it is frequently claimed that improved energy efficiency leads to better health, the evidence of this is questionable whereas studies have shown increased health problems

Environment International 75 (2015) 234–244

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

Higher energy efficient homes are associated with increased risk of doctor diagnosed asthma in a UK subpopulation

Richard A. Sharpe [a], Christopher R. Thornton [b], Vasilis Nikolaou [c], Nicholas J. Osborne [a,d,*]

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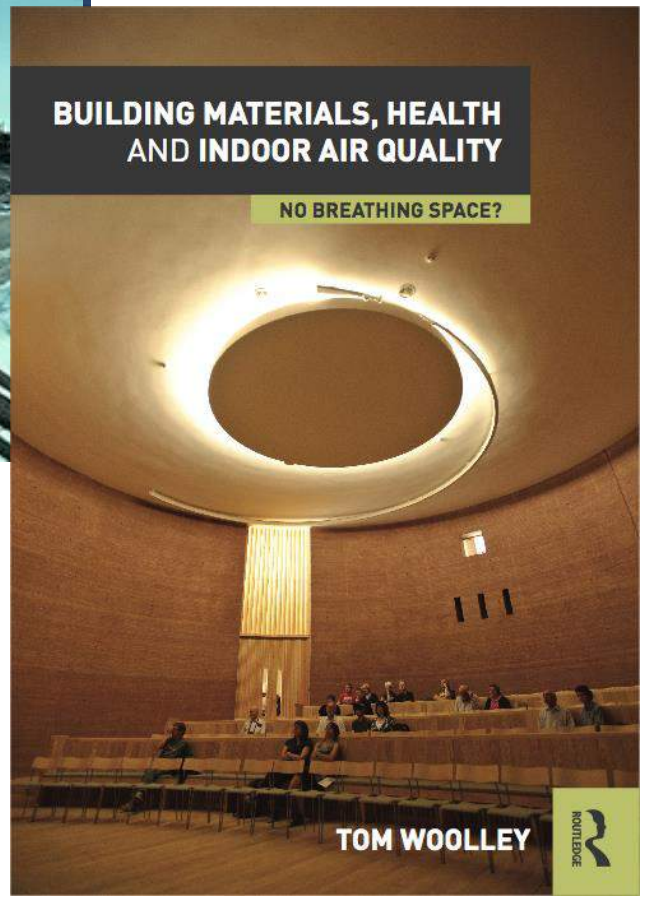
[b] College of Life and Environmental Sciences, University of Exeter, Stocker Road, Exeter EX4 4QD, United Kingdom
[c] University of Exeter Medical School, The Veysey Building, Salmon Pool Lane, Exeter EX2 4SG, United Kingdom
[d] Department of Paediatrics, University of Melbourne, Flemington Road, Parkville, Melbourne, Australia

Many insulation materials are made from hazardous chemicals



Chapter 1: Introduction

Chapter 2: Volatile Organic Compound Emissions

Chapter 3: Emissions from materials – Why do we need to use
hazardous chemicals?

Chapter 4: Cancer, Carcinogens and Building Materials

Chapter 5: Other Hazards and Radiation

Chapter 6: Hazardous Materials to be avoided and why

Chapter 7: Mould, Damp, Fuel Poverty and Breathability

Chapter 8: Ventilation and a critique of Passiv Haus

Chapter 9: Dealing with problems in existing buildings

Chapter 10: Healthy Building Theories

Chapter 11: How to building Healthier Buildings

Chapter 12: Policy Issues for Healthy Buildings –
Appendix A: Carcinogenic Chemicals
Appendix B: Useful Organisations

Building and Environment 169 (2020) 106559

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Polyurethane insulation and household products – A systematic review of their impact on indoor environmental quality

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ARTICLE INFO

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Exposure
Health
Air quality
Volatile organic compound
Polyurethane

ABSTRACT

We systematically review the impact of polyurethane insulation and polyurethane household products on the indoor environmental quality of buildings. The review breaks down polyurethane products into constituent compounds (isocyanate, polyol, flame retardant, blowing agent and catalyst) as well as secondary emissions, and discusses their implications on human health. Concentrations of compounds emitted from insulation, and household materials, measured in laboratory experiments and case studies are presented in the context of the built environment.

We outline that isocyanate exposure over the current legal limits could take place during spray foam insulation application in the absence of personal protection equipment. The study reports that flame retardants are not chemically bound to polyurethane products and they are found in measurable concentrations in indoor environments. Additionally, we provide evidence that catalysts are responsible for at least some negative impact on perceived indoor air quality. More data is required to determine the long-term emissions from spray foam products and the ventilation strategies required to balance energy savings, thermal comfort and good indoor air quality. However, it is not yet possible to determine whether potential health impacts could result from exposure to a single compound or a combination of compounds from spray foam products. We present a risk matrix for polyurethane compounds and propose that flame retardants, by-products, and residual compounds are particularly important for indoor air quality. We conclude by suggesting a framework for further research.

1. Introduction

In the UK, 19% of the total CO_2 emissions can be attributed to buildings [1], therefore the energy performance of buildings is a critical factor for reducing carbon emissions. Studies have shown that increasing or adding insulation within the thermal envelope of a building reduces the heating demand of the property by 20–60% [2], while also increasing thermal comfort [3].

Isocyanate based rigid board insulation (PUR/PIR) and spray polyurethane foam (SPF) insulation products have topped the $1bn mark in sales in 2015 [134]. The long term thermal benefits [4] and energy efficiency improvement from SPF have been demonstrated for retrofits [5], and in comparison to conventional insulation products [6]. Meanwhile, the total environmental quality of buildings is still a subject of continuing research [7]. While polyurethane (PU) materials are commonly found indoors in clothing, appliances (fridges and freezers), composite wood, floorings, furnishing, car seats, insulation and packaging materials [8], there is little information on their impact on indoor air quality. In an effort to address the impact of the building sector on CO_2 emissions, "green buildings" with lower air-permeability for improved energy performance, grow in popularity. The issue of indoor air quality to promote better health and well-being for building occupants [9] must, however, be considered alongside energy efficiency.

Isocyanate based insulation products are typically produced by mixing two liquids: an A-side component (isocyanate: MDI, pMDI or TDI) and a B-side component (polyol, fire retardant, catalyst, blowing agents and surfactants). These insulating materials could either be produced in factories (PUR/PIR rigid boards/sheets/panels) or applied in-situ (SPF insulation). To understand the implications of these products on indoor air quality, each of their constituent compounds should be considered. The main chemical bond of the insulation is between the isocyanate and the polyol, which form the urethane link, whilst other compounds enhance the reaction process (catalyst, blowing agents) or

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Available online 29 November 2019
0360-1323/

Hazardous emissions from PUR and PIR insulations
Isocyanates, polyols, flame retardants, blowing agents and catalysts, by products
Carcinogens and products causing respiratory problems

Research demonstrates that in isolation each group could impact human health, with some carrying higher risks compared to others [13,14].
During the production, and lifecycle, of PU products various organic compounds can be released from the foams into the indoor environment. Scarce data is available covering these emissions and to address the knowledge gap, a compilation of small studies was published by ASTM to provide further insight [15], followed by the ASTM D8142-17 standard for measuring SPF chemical emissions. This collection of reports provides data in relation to SPF emissions and their implications on indoor environmental quality (IEQ). Polyurethane products are found abundantly in modern indoor environments [8], however their cumulative volatile and semi-volatile organic (VOCs, SVOCs) long-term emissions and implications on human health are still largely unknown

"Isocyanates are highly reactive chemicals
That can cause skin, eye and lung irritation,
asthma and chemical sensitization"
US Environmental Protection Agency

Polystyrene insulation creates a massive waste problem

Non-aluminium cladding to be stripped from high rises after test failure

NEWS 15/01/18 7:30 AM BY NATHANIEL BARKER

Non-aluminium cladding which had previously been considered safe will be stripped from an east London high rise after experts warned the system may not resist the spread of flame.

Shortage of hazardous isocyanates

Has caused problems for the companies making foam insulation

Ercros

Estimated impact to Ercros of banning the use of mercury technology and Covestro plant shutdown from December 2017

CONTAMINATED SLUDGE CLEANUP BEGINS ON SPAIN'S EBRO RIVER TO REVERSE TOXIC LEGACY

Elimination of chemical pollution in Flix Reservoir

SPAIN / TPF Getinsa Euroestudios

Project management for the elimination of chemical poll

The Flix Fa… bro River… accumulatio… metals w… the use of … a sheet … work area. … with a suc… built to that… spillway … Additionally… r the tow… wells togeth… n.

THE IRISH TIMES

NEWS SPORT BUSINESS OPINION LIFE & STYLE CULTURE

Commercial Property › Construction

Builders face insulation 'headache' amid key chemical shortage

THE IRISH TIMES

Tue, Dec 24, 2019

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Kingspan and Quinn exposed to insulation ingredient shortage

Insulation group 'confident' issue won't have material effect on its business

Joe Brennan

Kingspan and Quinn Industrial Holdings have told customers they could only supply them with a fraction of their average weekly purchases of insulation materials of this product range for a period. Photograph: Chris Ratcliffe/Bloomberg

Kingspan and Quinn Industrial Holdings Ltd have been forced to temporarily curtail the supply of some insulation ranges as the European provider of a key ingredient has run short of stocks.

Pre-mixed Polyols with contaminants, CFS etc?
CFC emissions have been tracked to China

Blast at China's Wanhua kills four

Accident at world's largest producer of key polyurethane material adds to deadly year for China's chemical industry

By Jean-François Tremblay

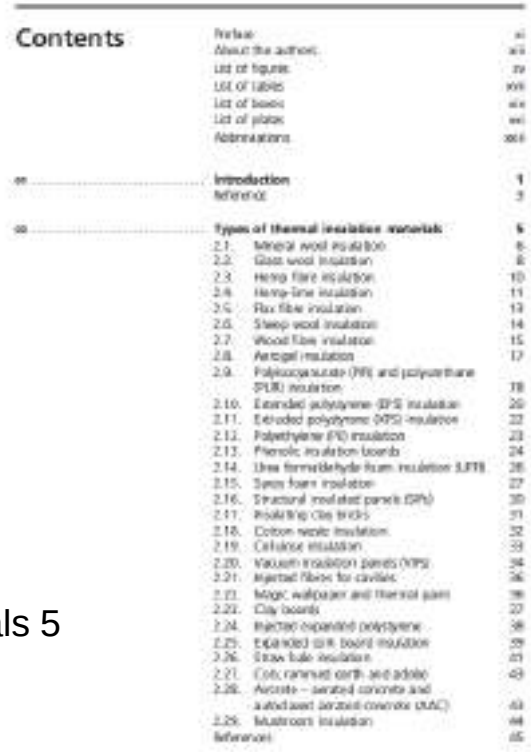
Wanhua Chemical's main production base in Yantai, China

Illegal CFC-11 production: response to China embassy letter

17th August, 2018

China has identified illegal use and production of CFC-11 in a series of actions undertaken in response to our report Blowing it, which recently revealed that companies making polyurethane foams in China continued to use the banned ozone depleting substance.

In a letter to the Guardian, which reported on our findings, a spokesperson from the Chinese embassy stated that an investigation of the 19 PU foam enterprises had been undertaken. Although no CFC use was found in 12 enterprises, CFC-11 was detected in one enterprise and six remain under further investigation. In addition, authorities uncovered two enterprises producing CFC-11 and CFC-12. According to the letter, "The seized CFCs and raw materials have been confiscated and sealed up, and the local police have filed charges against the enterprises and are hunting down the suspects in the cases".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BACKTOEARTH

Building Performance Specialists

« Unger Diffutherm

SheepWool®
INSULATION
OPTIMAL

2017-08

GUTEX Thermofib e² Data Sheet

Photographic images are property of GUTEX archive, HUF-house

GUTEX Thermofib e Technical Data

Package size (mm)	800 x 400 x 330
Weight per package	15 kg
Bales (packages) per pallet	21
Weight per pallet (kg)	330
Blown-in density (kg/m³) unenclosed enclosed (cavities)	25-30 29-45
Vapour diffusion factor (μ)	1/2
[illegible]	2/3
[illegible]	2100
Fire reaction Euro Class as per DIN EN 13501-1	E
European Union	
Nominal thermal conductivity [illegible]	0.039

German disposal category A2 (treated wood, without non-halogenated organic compounds), code number as per AVV 030105, 170201

GUTEX Thermofib e® is [illegible] insulation for blow-in installation in vertical or horiz cavities and horizontal unenclosed spaces.

Composition

- [illegible]
- [illegible]

Applications

- Between stud insulation in timber frame, post and bea interior and exterior wall structures
- Between rafter insulation
- Ceiling insulation
- Partitions/ drywall structures

Advantages

- Inherent elasticity makes it extremely form-adaptable
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- [illegible] and greater
- [illegible]
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- Improves acoustic insulation
- Quick and easy installation
- Regulates humidity
- Water vapour diffusion permeable
- Wood is a sustainable, recyclable natural resource
- Biologically harmless

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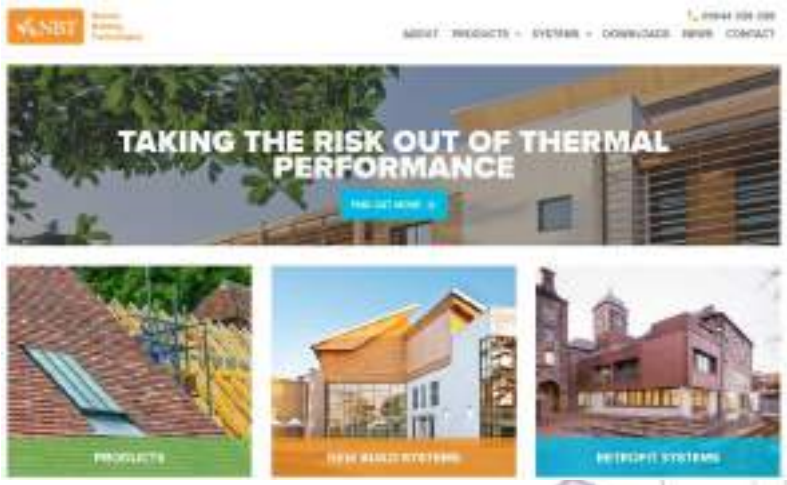
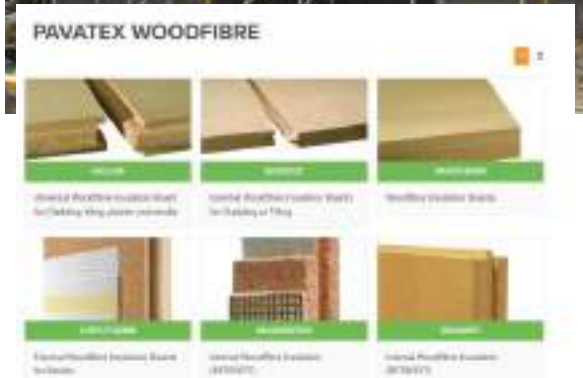
Nachhaltige Lösungen aus 100% reiner Schafschurwolle für Ihr Neu- und Sanierungsmaßnahmen. Gesund von oben bis unten: Die hochwertige ISOLENA Produktpalette reicht von der Wärmedämmung für Dach, Wand und Boden über Fenster- und Fugenabdichtungen bis hin zu Trittschall- und Akustikdämmungen, Raumluftfilter und Schallabsorbern. In allen ISOLENA Produkten stecken 30 Jahre Ingenieurswissen und Entwicklungsarbeit. Wir setzen ISOLENA Schafwolldämmungen ohne Klebestoffe und synthetische Stützfaser ein und binden ihnen mit unserem zertifizierten [illegible] Verfahren als einziger Partner weltweit einen biozidfreien Wollschutz.

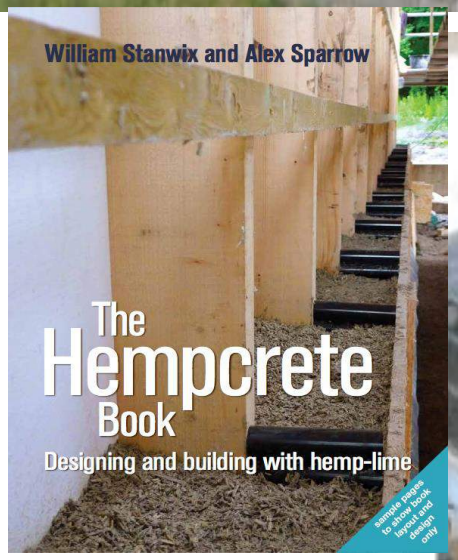
Wood fibre



Wood fibre. - 2 houses we designed in North Wales



Hempcrete has good insulation and thermal mass



Harrison Spinks Triples Hemp Production with New Machinery

By BioFibre on December 3, 2008

Luxury bed maker Harrison Spinks, based in Leeds, England, has increased its hemp processing abilities with new machinery.

The equipment investment follows a 52% increase in hemp orders over the past year, the company said in a news release.

The new streamlined process will boost the company's weekly output from 3 tons to 9 tons. Hemp is one of the natural mattress fillings grown on Harrison Spinks' 300-acre farm in Yorkshire, England.

The company said it designs, builds and installs its own machinery. For its hemp production, a new bale opener has been installed to help complete a formerly manual process, and a new high-tech machine tears and clean the bales. Also, a new step cleaner shakes the hemp and ensures any foreign materials are effectively removed.

As the most vertically integrated and sustainable bed

Thank you

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