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TECHNICAL ARTICLE

THE WHOLE TRUTH ABOUT EXPANDED POLYSTYRENE

Thermal performance, environmental considerations and fire safety



AFRICHILL WEBSITE EDITION

Source article attributed to the Expanded Polystyrene Association of South Africa (EPSASA)

Historical technical content reformatted for clearer reading and presentation.

The whole truth about expanded polystyrene

Historical source note
This edition reformats the supplied 2006 article for clearer presentation. Dates, regulatory references, comparative figures and product claims are historical. Confirm current project requirements against applicable South African regulations, approved fire-test data and Africhill's current product specifications before use.

Recently, articles promoting polyurethane foam for the manufacture of metal-faced composite or sandwich panels have, by implication, stated that expanded polystyrene is not suitable for this application. The source article argues that incomplete information can cause confusion to the detriment of the insulation industry and that more accurate scientific information benefits all parties.

Both expanded polystyrene and polyurethane have been used as panel-core materials for decades. The original article states that both products have been used in regulated applications worldwide, with market share and popularity influenced largely by availability and cost in individual countries.

Purpose of thermal insulation

The purpose of thermal insulation is to conserve energy resources and help create comfortable living conditions. The range of insulation materials and systems available shows that no single material meets every technical and cost criterion for every application.

A direct property-for-property comparison does not always tell the whole story. The source proposes assessing insulation systems using the following criteria:

- Thermal performance
- Cost
- Environmental considerations
- Safety: fire performance
- Safety: smoke toxicity

Thermal performance

Thermal performance is commonly expressed as thermal conductivity (k-value in W/mK) and thermal resistance (R-value in m²K/W). For a homogeneous solid, the relationship is:

R = d / k	where d is the insulation thickness in metres and k is thermal conductivity.

Cost

The source suggests comparing sandwich-panel cost per unit area at an equivalent R-value. Where space is especially valuable, the higher R-value per unit thickness of polyurethane or polyisocyanurate may influence material choice.

The supplied source refers to a separate summary table, but that table is not present in the supplied PDF.

Environmental considerations

Limited resources

The most obvious resource limitation among synthetic insulation materials is fossil-fuel availability. Polystyrene is produced from ethylene, a natural-gas component, and benzene, a petroleum derivative. Polyisocyanurate and polyurethane use polymeric methylene diisocyanate and polyol, both petroleum-derived materials. The source notes that costs may rise as resources become scarcer.

Recycled content

Recycled content is a widely recognised environmental attribute of building products. The article identifies three advantages:

- Reduced demand for virgin natural resources
- Diversion of material from the waste stream
- Reduced manufacturing energy in some recycling processes

The source states that expanded-polystyrene products can contain recycled polystyrene, with the amount depending on product and process. Simple recycling can involve crumbling old moulded product and remoulding it with freshly expanded material. It describes this as mainly pre-consumer recycling, while noting that post-consumer recycling may become more feasible as material costs rise.

Pollution from manufacture and use

Nearly all manufacturing processes generate pollution, much of it related to energy consumption and fossil-fuel combustion. One comparative approach is therefore to assess manufacturing or embodied energy. The source also notes that embodied energy can be low compared with the energy insulation may save during service life.

CFCs and HCFCs: historical context

The article discusses chlorine-based blowing agents that damage the ozone layer. It records that CFC-11 was formerly used for polyisocyanurate, polyurethane and phenolic foam, and that industries later moved to HCFC-141b. These dates and phase-out statements reflect the historical source and must not be read as a current regulatory summary.

It also states that HCFCs have ozone-depletion and greenhouse effects, even though their atmospheric behaviour differs from that of CFCs.

Material life cycle

CFC-free foam insulation

The source describes expanded-polystyrene board-stock insulation as being manufactured without CFC or HCFC blowing agents. Polystyrene beads are expanded with pentane, a hydrocarbon; the pentane leaves the insulation and is replaced by air. Current environmental declarations and production information should be used for present-day product comparisons.

Durability

Expanded polystyrene, polyisocyanurate and polyurethane foams can provide long service lives when correctly specified, protected and installed. The article notes that rigid foams produced with low-conductivity blowing agents can experience changes in thermal resistance as the blowing agent leaves the cell structure and is replaced by air.

The source provides historical R-value examples for polyisocyanurate and notes that changes depend on facings, installation and application. These values are retained as historical discussion rather than current Africhill product ratings.

Re-usability and recyclability

Polystyrene is a thermoplastic and can be melted and reformed with limited chemical modification. Polyisocyanurate and polyurethane are thermoset plastics and do not melt. The source describes research into grinding thermoset materials and using the powder in other products.

The article also raises the legacy issue of CFC blowing agents retained in older insulation. It notes that some blowing agent used in older buildings may remain within the insulation until removal or disposal.

A complete system matters

The technical performance of a sandwich panel depends on more than the core alone. Facing materials, joints, fixings, penetrations, installation quality, fire barriers, service conditions and maintenance all affect the performance of the completed assembly.

Fire performance

Fire safety must be assessed for the complete panel system and the intended building application. The original article discusses historical South African practice and international test methods such as ASTM E84, ULC S102 and AS 1530.3. Test standards and building requirements should always be checked in their current editions.

The source argues that traditional tunnel testing can be strongly influenced by the covering material and may not reproduce every real-life fire condition. It lists common test considerations such as ignitability, flame spread, heat evolved and smoke evolved, with particular attention to flame-spread and smoke-development indices.

Thermoplastic and thermoset behaviour

Expanded polystyrene is a thermoplastic. The source states that it can soften and move away from a flame front as temperature rises. Polyurethane and polyisocyanurate are thermoset materials and tend to remain in place while decomposing or burning. These different behaviours do not, by themselves, determine whether a complete panel system is suitable for a particular project.

Influence on fire growth

The source quotes Canadian Building Digest CBD-218 to explain that insulation can retain heat in a room, potentially causing the flashover stage to be reached earlier. Once a lining or other material ignites, surface-temperature rise affects flame propagation and the production of flammable gases.

> The digest explains that foam plastics can reach a high surface temperature quickly, while timber warms more slowly under the same conditions. It adds that thermoplastic foam may melt before reaching a critical surface temperature, which can change the pattern of flame propagation.

This is a summary of the source’s quotation. Designers should consult the referenced publication and current fire-engineering guidance for the full context.

Fire behaviour in context

Reported fire observations

The article refers to fires involving buildings and foam-core panels, including a polyurethane cold store at Woodmead Makro and an expanded-polystyrene panelled restaurant in Kentucky in 1987. It reports that portions of the panel systems remained intact despite high surrounding temperatures.

The source suggests that restricted oxygen within correctly sealed metal-faced panels may limit burning of the concealed core. Site conditions, damage, joints, exposed edges, penetrations and the surrounding fuel load can materially change fire behaviour. These historical examples are not a substitute for current fire-test evidence or project-specific fire design.

Comparative assessment

A comparative survey cited in the article qualitatively assessed available fire-test information for polystyrene, polyisocyanurate and polyurethane. The source reports that the resulting scores were close and argues that the publications reviewed did not support broad claims that expanded polystyrene was unsuitable for sandwich-panel applications.

Practical specification

For a current project, verify the exact core grade, panel thickness, metal facings, joint design, surface spread-of-flame classification, smoke classification, fixing method, fire stopping and installation details. Product approval and fire performance apply to the tested or assessed system, not automatically to every panel using the same generic core material.

Before specifying a panel

Confirm current regulations, the required fire rating or reaction-to-fire classification, project insurance requirements, approved drawings, installation instructions and the supplier’s current supporting documentation.

Toxicity of smoke emissions

The source notes that some smoke-emission test methods focus on smoke density and visibility rather than the toxicity of individual gases. Smoke can obstruct vision, especially for occupants and firefighters.

Products of pyrolysis can include carbon dioxide (CO_2), carbon monoxide (CO), water (H_2O), methane (CH_4) and hydrogen cyanide (HCN). Carbon monoxide and hydrogen cyanide are colourless and highly toxic. Their concentration, exposure time and the complete fire environment all affect hazard.

Historical toxicity indices

The article cites Naval Engineering Standard NES 713, which calculates a toxicity index from measured combustion or thermal-decomposition gases. It reports historical index values of 1.8 for expanded polystyrene, 40 for polyisocyanurate and 45 for polyurethane.

It also describes a comparative model called “Acute Lethal Hazard”:

ALH = k × D / T / LC50

k = thermal conductivity D = in-situ density
T = decomposition temperature LC50 = sample weight lethal to 50% of test animals

In that historical study, the source says polystyrene was rated first and the other two materials shared second place. It concludes that, although burning plastics can emit toxic gases, gases released by surrounding furnishings and finishes may present a greater hazard than a foam core enclosed behind metal sheeting.

Use current evidence

Fire science, test methods and regulations continue to develop. The historical figures above should not be presented as current comparative certification. Use test reports for the exact panel system and application, interpreted by a competent professional where required.

Summary

Foam-core panels combine thermal insulation with fast, practical construction. The original article argues that properly installed expanded-polystyrene and polyurethane panel systems can perform safely when correctly designed and used.

Africhill presents this reformatted edition as historical background. The suitability of any panel must be decided from the project conditions, current legal and insurer requirements, the specified panel system, approved technical data and correct installation.

Source attribution

Expanded Polystyrene Association of South Africa (EPSASA). The supplied PDF lists telephone (011) 314-4021/7 and fax (011) 314-3764. These are historical contact details from the source document.

References reproduced from the supplied article

1. Canadian Building Digest: CBD 218 - Effects of Insulation on Fire Safety.
2. Insulation Products - “A Comparative Survey” - presentation by R. Ansems / Ansems Engineering & Management.
3. Canadian Building Digest: CBD 178 - Fire and Plastic Foam Insulation Materials.
4. Foam-Core Panels, doityourself.com/insulate/foamcorepanels.htm.
5. Insulation Materials: Environmental Comparisons - Environmental Building News, Volume 4, Jan/Feb 1995.
6. The Montreal Protocol - Fifth Edition (2000).
7. New Blowing Agents for Insulated Panels - source URL reproduced in the original article.
8. Canadian Building Digest: CBD 197 - Evaluation of the Toxic Hazard of Fires.
9. Canadian Building Digest: CBD 249 - Control of Ignition in Building Materials.
10. Canadian Building Digest: CBD 144 - Toxic Gases and Vapours Produced at Fires.
11. SA Builder, Nov/Dec 2001.
12. Architect & Specificator, Jan/Feb 2002.

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