Provisional Technical Information

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Palusol® Fireboard

The alpha and omega of using Palusol

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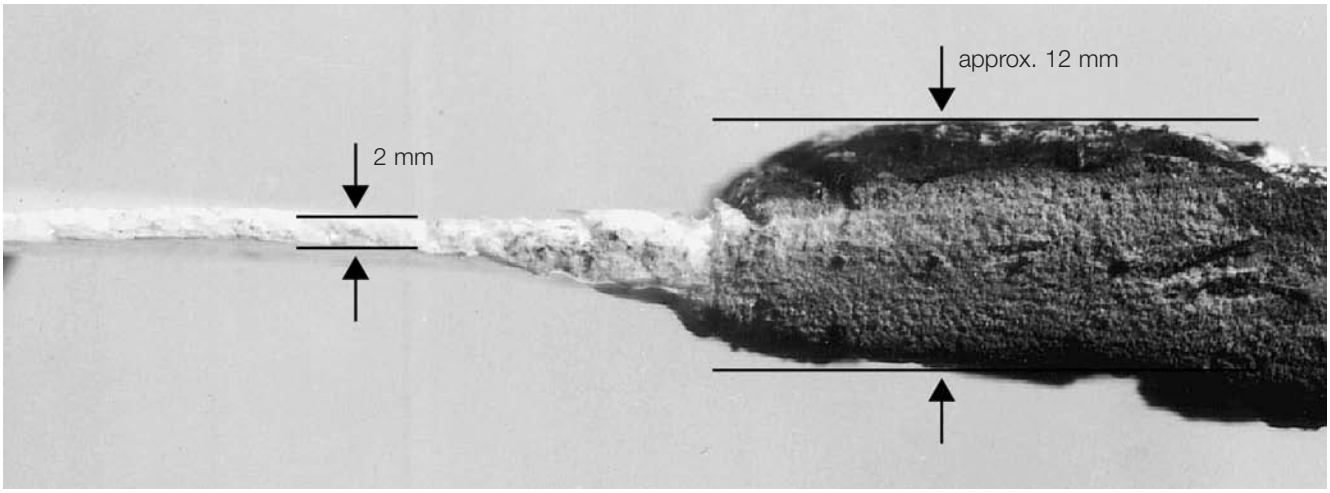


Palusol Fireboard, before…

and after heating

1 Properties and action

Palusol Fireboard consists of a core of hydrated sodium silicate – with a small proportion of organic binder – coated on both sides with epoxy resin. The core is reinforced with glass fibre and either textile-glass fabric or woven wire. The main purpose of the resin coatings is to exclude carbon dioxide and moisture.

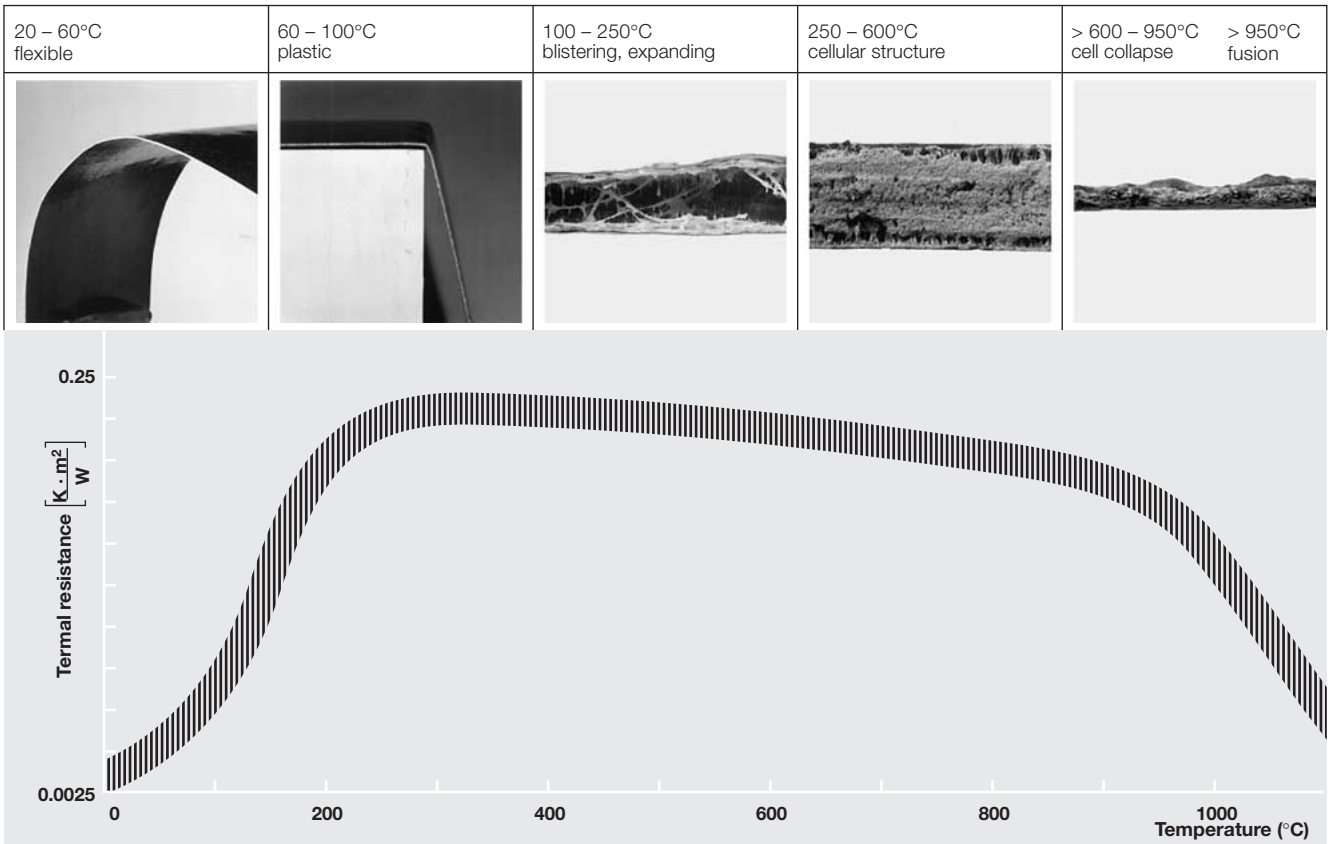
Palusol Fireboard is thin enough to flex easily at temperatures of 20 – 40°C, which facilitates handling. It softens on warming, and at temperatures of 60°C or more it can be bent sharply without its breaking. At temperatures above 100°C, the hydrated sodium silicate begins to lose water vapour rapidly enough to cause intumescence – it puffs up.

The final state of the sodium silicate is a mass of incombustible, finely cellular, heat-insulating, pressure-resistant glass.

When Palusol Fireboard is expanding (largely perpendicular to its faces), it exerts pressures of up to fifteen times atmospheric pressure, i. e. up to 1.5 MPa. This is quite sufficient to burst the confines of facing and edging materials bonded to it.

Once the heat-resistant cellular silicate has been formed, it both retards the passage of heat and, by sealing gaps and joints, seals against smoke and hot or burning gases.

It has been shown that the minor quantity of organic material in Palusol Fireboard forms no toxic pyrolysis or combustion products. This is a further distinction between Palusol Fireboard and many other intumescent materials used in building.



Thermal resistance, R, of Palusol Fireboard Type 100 vs temperature, ϑ

2 Product range; specifications

Palusol 100

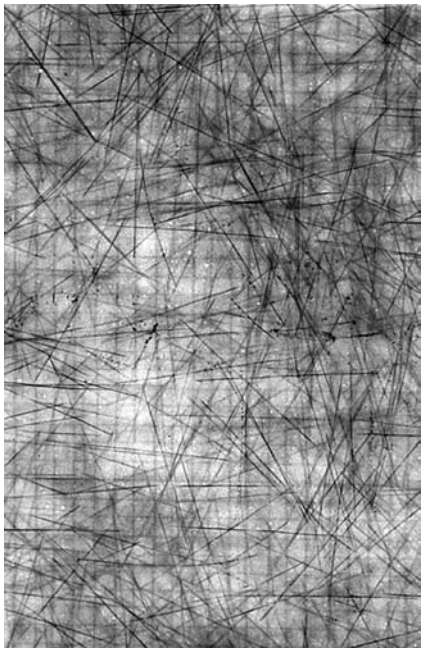
Palusol 100, which is intended for use in strips around doors, is reinforced by textile-glass fabric.

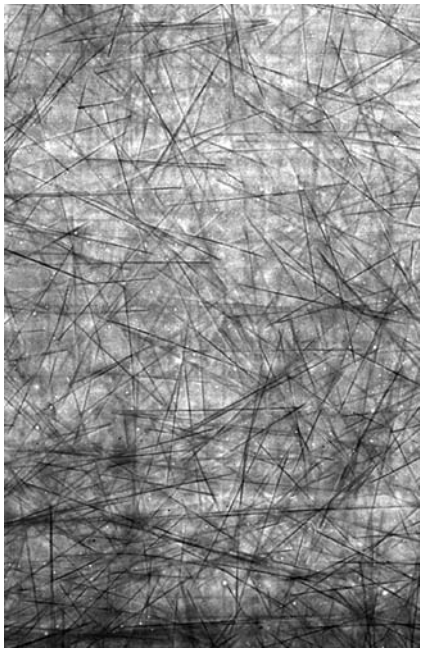
Palusol 104

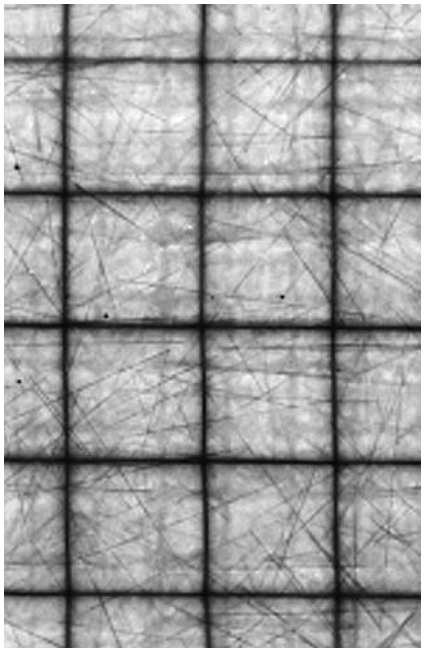
Palusol 104 has the same structure as Palusol 100 but is twice as thick. It is intended for special applications.

Palusol 210

To protect extended areas, Palusol 210 is used. It is reinforced with 25-mm mesh woven from 0.5-mm wire.

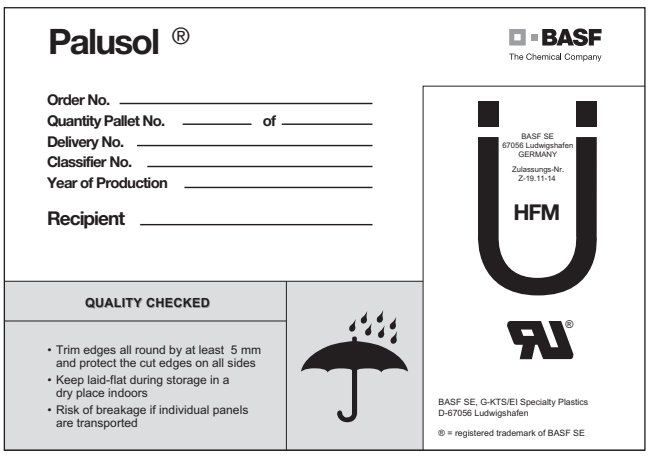






Specification

Water, mass fraction:	25 – 40% poids
Thickness:	
Palusol 100 & 210	1.5 – 2.3 mm
Palusol 104	3.0 – 4.2 mm
Mass per unit area:	
Palusol 100 & 210	2.25 – 3.75 $kg \cdot m^{-2}$
Palusol 104	4.30 – 7.30 $kg \cdot m^{-2}$



Lable for packaging unit

Other data

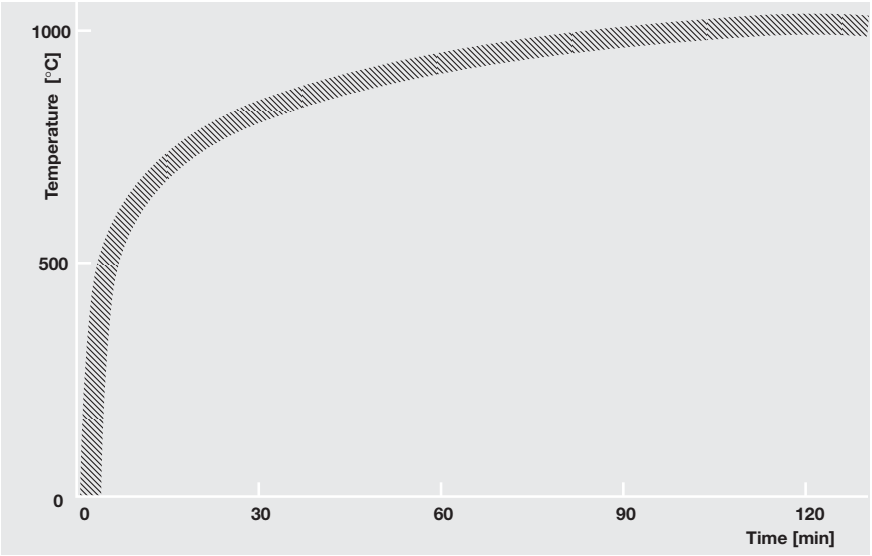
Density:	ca 1.6 $g \cdot cm^{-3}$
Panel size:	2.10 m x 1.10 m
Panels per pallet:	
Palusol 100 & 210	100 panels
Palusol 104	50 panels
Thermal conductivity:	0.8 $W \cdot m^{-1} \cdot K^{-1}$ at 20°C

3 Applications

3.1 Notes on fire protection

The ability of Palusol Fireboard to swell to several times its original thickness when exposed to fire allows designers to greatly improve the fire protection of structures.

A number of general design principles have become established through the use of Palusol Fireboard over a long period and in a variety of ways. Nevertheless, whenever a particular application is considered, thought must be given to how Palusol Fireboard can best meet present requirements. Note that there are proprietary rights in certain designs.



Standard curve of temperature, vs time, t (ISO 834)

Palusol Fireboard is always placed within components and elements of construction (e. g. doors, partitions, ducts) in such a way that it is not itself stressed **and protected against mechanical damage**. It can provide security at potential weak points in fire protection, either within joints or in the plane of components.

The use of Palusol Fireboard is not confined to the protection of features forming parts of buildings: it can also protect safes, cabinets for data storage, control consoles, etc.

Building components that should not be thick or heavy but must have enhanced fire resistance can be covered with Palusol Fireboard of Type 210 (cf. § 5.3). In case of fire, the thick layer of intumescent non-combustible material that is formed can maintain an adequate temperature difference for a long time.

In testing fire doors etc., the temperature on the hot side is generally allowed to increase with time in accordance with the curve shown in the diagram on the left, which reproduces that given in ISO 834. Identical or similar curves are given in national standards.

3.2 Shielding Palusol Fireboard

To preserve the ability of Palusol to form cellular material on heating, which depends on its chemical composition, it must be **shielded permanently** against the atmosphere. Palusol is adversely affected by

– water or humid air,
– atmospheric carbon dioxide, and
– prolonged exposure to temperatures exceeding 40°C.

Any of these cause changes in composition and reduced effectiveness, therefore protection must be maintained when Palusol is incorporated anywhere in a structure.

The following have proved to be effective ways of shielding Palusol:

– integration of the material in a sandwich construction bonded with adhesive;
– encapsulation in plastic film, metal foil, or extruded sections.

The agreement certificate for Palusol (Z19.11-14) issued in Berlin by the *Deutsches Institut für Bautechnik* prescribes that the permeance to carbon dioxide of encapsulating material *in intimate contact with the Palusol* (e. g. self-adhesive film) shall be equivalent to a transmission rate less than 300 $cm^3 \cdot W \cdot m^{-2} \cdot bar^{-1} \cdot d^{-1}$. If the Palusol is enclosed relatively loosely (e. g. by a section), the transmission rate must be less than 100 $cm^3 \cdot W \cdot m^{-2} \cdot bar^{-1} \cdot d^{-1}$.

Palusol Fireboard is not very thick and relatively easily broken, therefore it needs to be protected against mechanical damage and shock.

Palusol Fireboard in a wood fire-resisting door leaf is sufficiently shielded from the atmosphere and protected mechanically if it is fixed to the leaf and covered by a suitable facing bonded with adhesive over its whole area. Facings of decorative or structural plywood, hardboard, laminated sheet, or plastic sheet at least 0.8 mm thick may be used.

Individual certificates have been issued by the *Deutsches Institut für Bautechnik* for steel fire doors having strips of Palusol sealed in aluminium foil laminates or rigid PVC sheet 0.75 – 1.20 mm thick and protected mechanically by mild-steel strip.

In other applications too, the Palusol should be sealed within extruded plastic sections, plastic sheet, or metal foil or foil laminates. Seals may be made by means of welding or adhesive, provided the limits for transmission of carbon dioxide given in Agreement Certificate Z-19.11-14 (see above) are not exceeded.

Encapsulated Palusol strips are available commercially. They can be fixed in place, on door frames for instance (or as described in the relevant agreement certificate), by bonding with adhesive or double-sided adhesive tape or by means of metal clips.

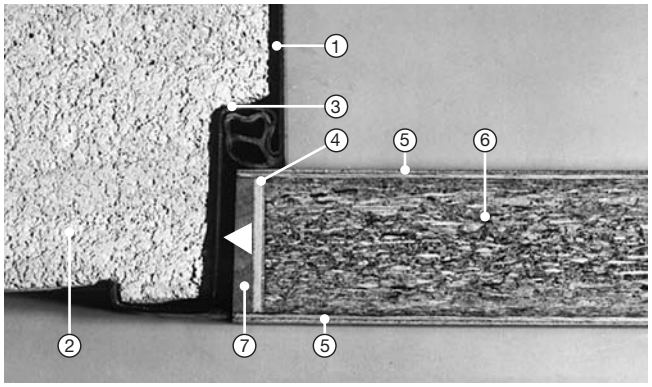
Where Palusol cannot be completely enclosed as described above, cut edges at least must be shielded against carbon dioxide and moisture. For instance, when a wood fire door has Palusol Fireboard behind the facing of the leaf and is trimmed to its final size, the cut edges of the Palusol should be coated with an epoxy or urethan resin or a similar solvent-free film-forming material. Both the composition and thickness of the coating must of course be such that the permeability of carbon dioxide is sufficiently restricted.

If Palusol Fireboard is exposed to temperatures exceeding 40°C for any length of time, the progressive loss of water can be sufficient to reduce the intumescence of the material when it is heated. However, short periods at temperatures of up to 90°C do no appreciable harm.

3.3 Examples

Wood fire doors

Palusol Fireboard behind the facing of a door leaf (e. g. cross-banded plies, hardboard, or laminated melamine resin sheet) is adequately shielded from moisture and carbon dioxide in the atmosphere. Strips used around the edges of the leaf – as shown here – may be encapsulated in aluminium foil.



Veneered chipboard fire door. Under normal conditions the draught excluder reduces sound transmission; at the start of a fire it prevents the passage of smoke.

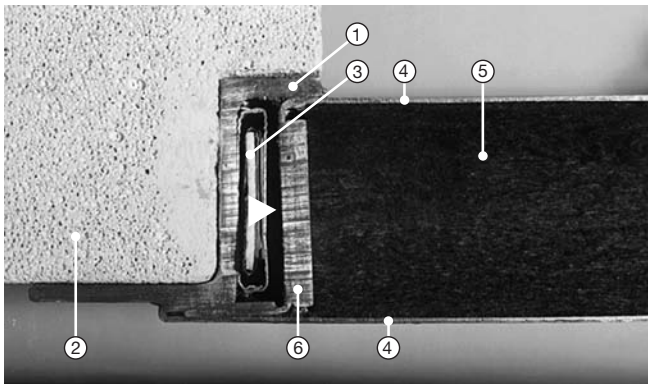
1 Steel door lining and frame
2 Masonry wall
3 Draught excluder
4 Palusol 100 strip enclosed in aluminium foil
5 Veneer plies
6 Chipboard core
7 Hardwood strip

On exposure to fire, the Palusol strip expands and forces the hardwood strip into the gap between door leaf and frame. The aluminium foil speeds the process.

Steel fire doors

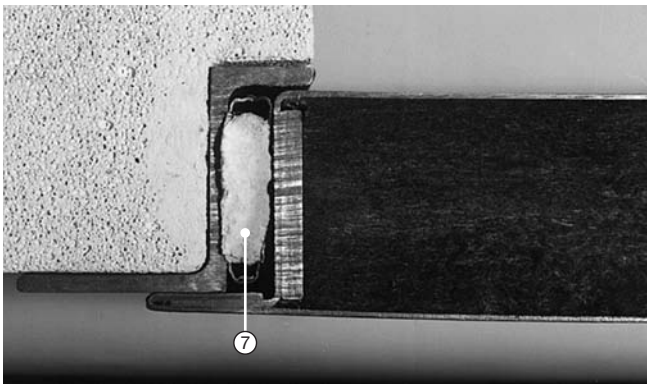
The door must be constructed so that the Palusol is not only shielded against carbon dioxide and moisture but also protected mechanically.

The Palusol strips can for instance be encapsulated in foil laminate and set in a channel formed from a steel strip. Since the expanded sodium silicate formed on exposure to fire should completely fill the gaps between the edges of the door leaf and the door frame, the strips of Palusol should be at least 15 mm wide.



Palusol strip encapsulated in aluminium foil and set in steel door frame behind a strip steel channel.

1 Steel door frame
2 Masonry wall
3 Palusol 100 strip, in aluminium foil, behind steel channel
4 Steel sheet
5 Mineral wool
6 Steel plate reinforcing edge of door leaf



After exposure to fire, cellular sodium silicate seals the gap and reduces heat transmission.

7 Expanded Palusol strip

Partitions, ceilings, platform floors

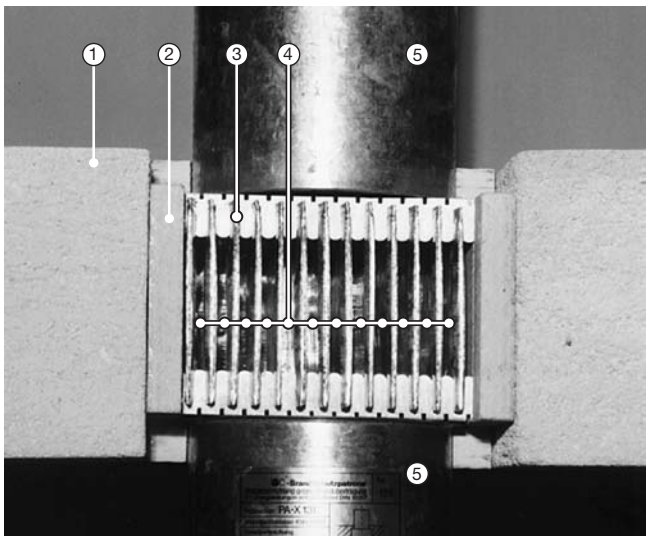
Palusol Fireboard has many applications where gaps at junctions between two elements or joints in a single element are unavoidable and may con-stitute weak points in fire protection.

Particular features for which Palusol Fireboard can be used include:
– joints between walls and ceilings; – vertical joints; – cupboard doors;
– metal partitions over carpeting or plastic flooring; – joints and piercings in suspended ceilings;
– demountable platform floors; – fire shutters in ventilation ducts; – electrical switchgear

Honeycomb fire dampers

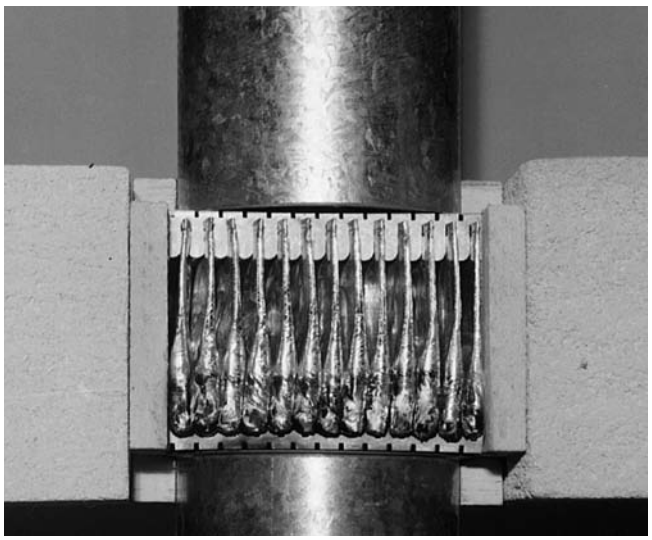
Fire dampers that need no maintenance but can provide fire resistances of up to 120 min or more may be constructed with strips of Palusol 100 encapsulated in aluminium foil laminate. Such dampers are used in air-conditioning ducts that pass through compartment walls or floors, particularly in inaccessible positions.

The fire resistance depends on the length of the strips parallel to the axis of the duct. The pouches that protect the Palusol against moisture and carbon dioxide also quicken the response, since they inflate immediately when warmed, even before the channels are securely blocked by expanded sodium silicate.



A battery of Palusol strips in aluminium foil allows air to flow unhindered through a 120-mm duct passing through a concrete compartment floor.

1 Concrete floor
2 Fibre-cement board
3 Metal frame
3 Metal frame
4 Palusol 100 strips, in aluminium foil
5 Duct

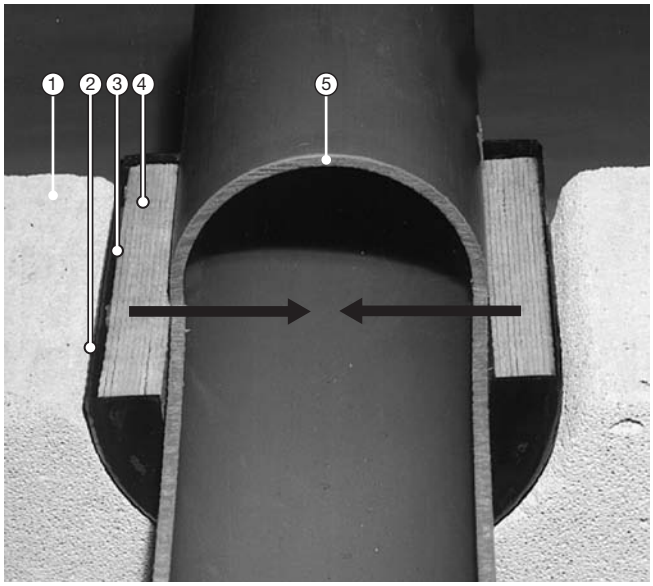


After exposure to fire, cellular sodium silicate seals the air channels.

Fire-stop sleeves

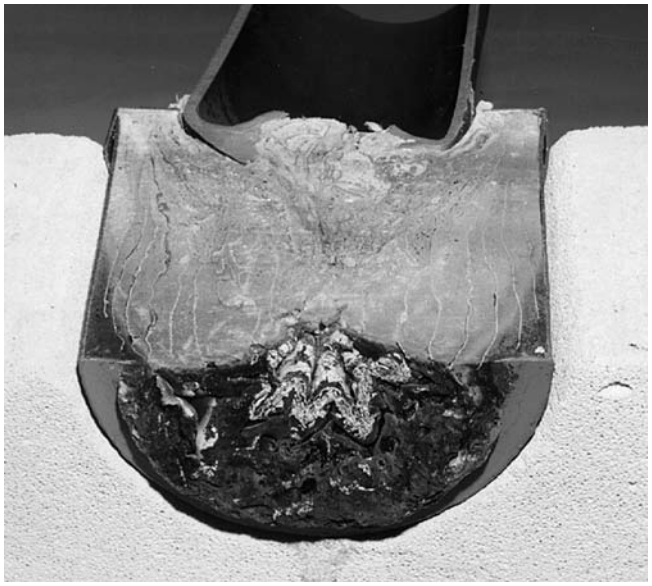
Where compartment walls or floors are penetrated by pipes, provision must be made for preserving their fire resistance. In the case of thermoplastic pipes, “proprietary seals” of the kind known as fire-stop sleeves or pipe closers may be used. These also act as expansion sleeves. The sleeve consists of a metal cylinder lined with Palusol wound to form a hollow cylinder and wrapped in aluminium foil. The ends of the sleeve are made airtight with silicone sealant.

The one restriction on the use of Palusol for this purpose is that it may not be subjected to temperatures above about 40°C for prolonged periods, although temperature excursions up to no more than 90°C are harmless



Polypropylene pipe passing through a compartment wall. A fire-stop sleeve preserves the wall’s fire resistance.

1 Masonry wall
2 Steel sleeve
3 Aluminium foil (0.1 mm)
4 Palusol 100 strips
5 Polypropylene pipe

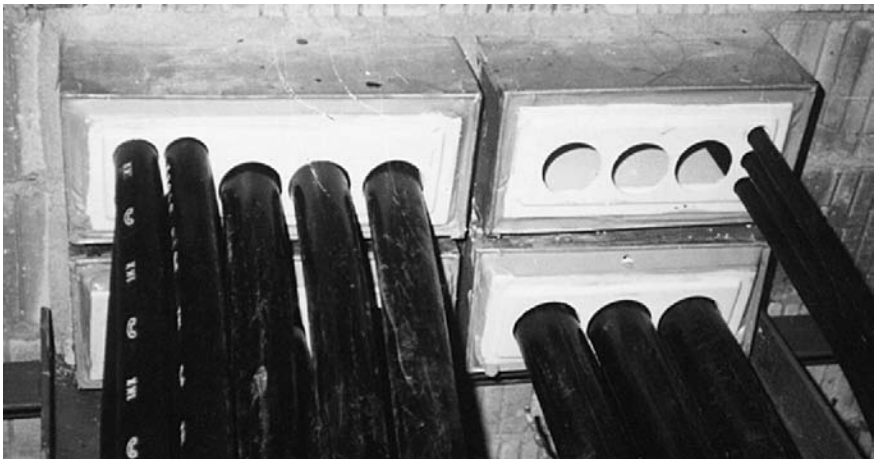


Fire softens the pipe; the expanding sodium silicate closes it and fills the entire space.

Fire stops for cable penetration

Openings to allow electric or other cables to pass through compartment walls and floors must also be fire-stopped. In principle, the method used for thermoplastic pipes is applicable: strips of Palusol wrapped in suitable plastic film are placed on either side of the cables, the whole opening being surrounded by a rectangular metal sleeve. The length and number of strips must be sufficient to provide the required fire resistance (as shown by fire tests). An alternative proprietary system is shown on the right.

Whatever arrangement is used, the Palusol may not be subjected to temperatures greater than 40°C for any considerable time.



Fire-stopped cable penetration giving a fire resistance of 90 min, approved for walls and floors. Extra cables can be added simply, without cutting through masonry. In the event of fire, cellular sodium silicate fills the opening.

(Photo: Wichmann)

Safes, data storage, etc.

The foregoing principles and the precautions described in § 3.2 apply to the use of Palusol elsewhere, e.g. for safes and storage areas for data.

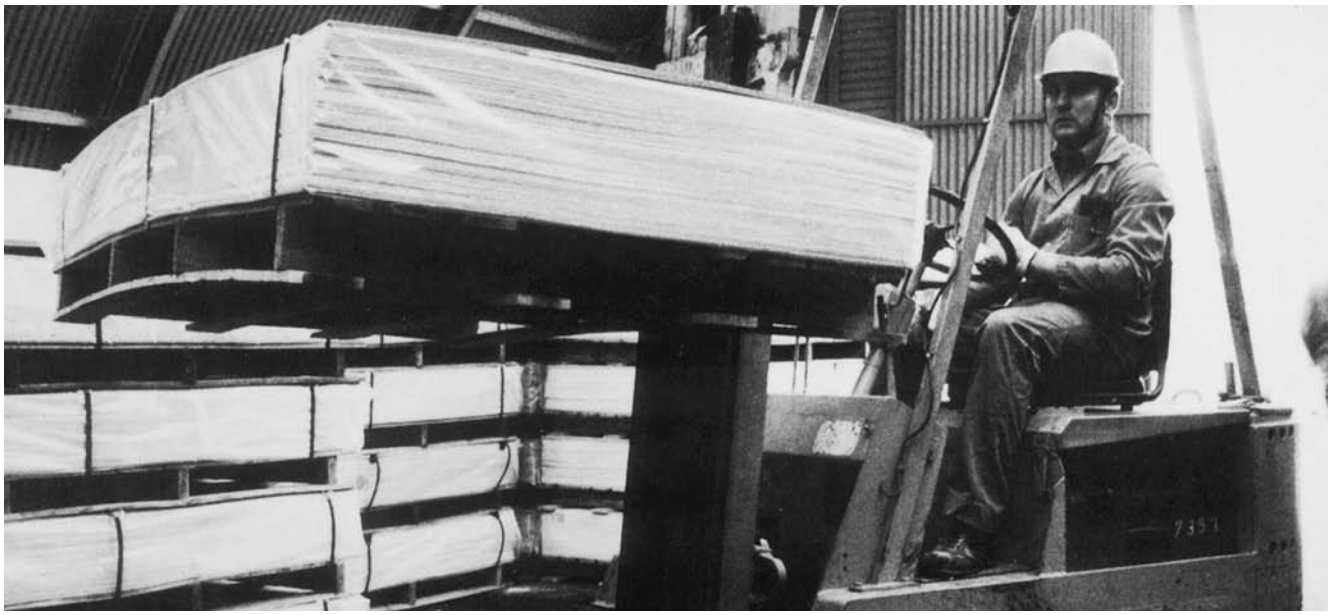
4 Storage and transport

Palusol Fireboard should be stored in a dry place indoors until it is used. On no account should it be exposed to water or excessively humid air.

Palusol Fireboard should also not be subjected to temperatures greater than 40 °C for any great time. Low temperatures have no *permanent* effect on it, but while its temperature is below room temperature it remains brittle and liable to breakage.

Even individual panels of Palusol Fireboard tend to plastic deformation under their own weight, gradually taking up the contours of whatever they are resting on. Palusol Fireboard must therefore be stored lying flat and supported over its entire area by a plane surface. Palletloads of Palusol Fireboard may be stood on top of one another, but not more than five high. In handling single panels of Palusol Fireboard, particular care should be exercised, since their edges and corners are then highly vulnerable.

No-one handling Palusol Fireboard may grasp the panels without leather protective gloves.



Palusol Fireboard is supplied on pallets; these may not be stacked more than five high.

5 Fabrication

5.1 Cutting and trimming

Palusol Fireboard can be cut into strips and other rectangular shapes with guillotine shears. Small pieces of any shape can be fly-stamped. In either case, **a clean cut is obtained only if the tools are in good condition and properly set.**

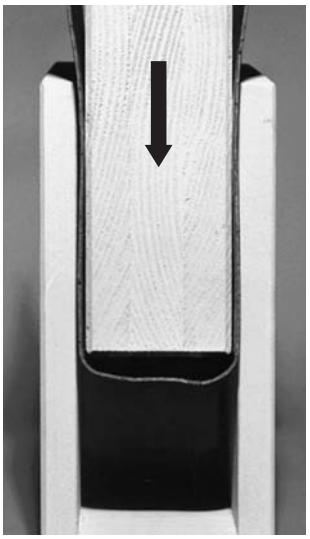
Attempts to cut panels whose temperature is much below 20°C is likely to lead to cracking: cold panels should be warmed to at least 20°C beforehand.

Strips or other pieces of panel must be transferred to the next stage immediately, so that their cut edges are not left uncovered for long.

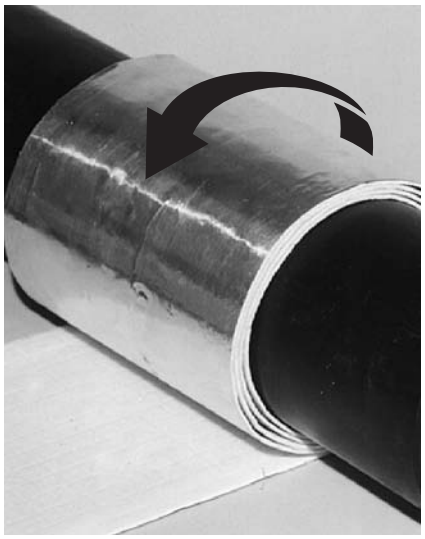
Cutting Palusol Fireboard with guillotine shears.

5.2 Shaping

After being heated dry to a temperature greater than 60°C (but not greater than 90°C), Palusol can be formed as required. Heating can be carried out in an oven, with hot air, under IR lamps, or on a hotplate. Heating with a flame however is *not* permissible.



Forming warm Palusol into a U-shape.



Rolling warm Palusol round a pipe.

5.3 Jointing

Bonding with water-free adhesives

The most suitable adhesives and conditions for bonding various materials to Palusol Fireboard (which has an epoxy-resin coating each side) must generally be found by trial and error. The table below gives a selection of types of adhesive that have been found appropriate and the conditions used.

Material	Type of adhesive	Temperature	Pressure	Remarks
Aluminium	epoxy resin	20 – 90°C	0.2 – 0.8 MPa	
Steel	epoxy resin	20 – 90°C	0.2 – 0.8 MPa	
Wood etc.	two-component urethan polymer	20 – 90°C	0.2 – 0.8 MPa	
	neoprene & curing agent	20°C		for small items
	hot-melt	180°C		for narrow strips
	phenol-resorcinol resin + curing agent	60 – 80°C	0.2 – 1.0 MPa	

Bonding with water-borne adhesives

When Palusol Fireboard Type 210 is to be bonded to large areas of absorbent material such as wood or some woodbased boards, aqueous dispersions of phenol-resorcinol-formaldehyde resins such as Kauresin 460 Liquid may be used.

We recommend a 4 : 1 mixture by weight of Kauresin 460 Liquid and Kauresin Hardener 465 Powder. This is applied to the Palusol Fireboard at the rate of 150 – 180 $g \cdot m^{-2}$. The parts are held together under a pressure of 0.2 – 1.0 MPa at a temperature of 60 – 80°C.

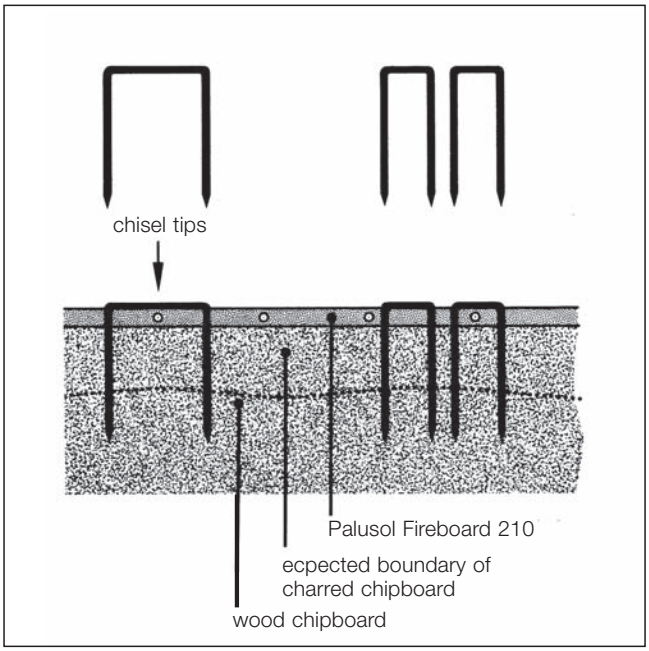
Veneers should be cross-banded.

Mechanical fixing

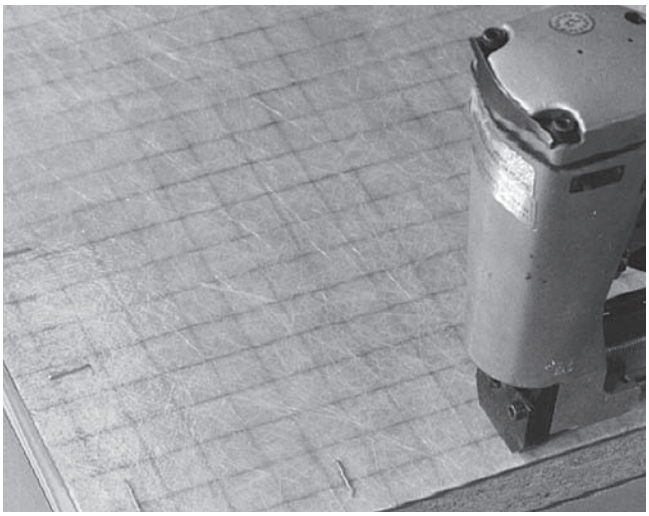
Where Palusol Fireboard Type 210 is applied to the faces of a door leaf or other component of comparatively large area, it must be fixed mechanically so as prevent its buckling or even falling off in the event of fire.

Screws or rivets and washers may be used for fixing Palusol Fireboard to metallic backgrounds. Chisel-pointed steel staples should be used in wood or wood-based materials.

Overlap the edges of adjacent panels of Palusol Fireboard.



Staples must go deep but not crush the Palusol.



Securing Palusol Firebord with a pneumatic stapler.

5.4 Fabricating laminates

The methods of fabrication used for laminates of which Palusol® Fireboard is a component are generally determined by the nature of the other components. For instance, wood based laminates can be sawn and drilled and fixed with screws or nails. However, it may be necessary to use carbide-tipped saws to avoid frequent blade changes.

5.5 Special precautions

Sodium silicate dust is formed when Palusol Fireboard is sawn, drilled, or abraded. This dust may not be allowed to enter the eye or respiratory passages, and appropriate goggles and half-masks must be worn. Local exhaust systems are recommended, but these may be connected to the central systems commonly used in wood-working shops, *except when Palusol Fireboard Type 210 is involved.* The latter contains wire reinforcement and can therefore produce sparks when sawn.

Since sodium silicate forms alkaline solutions in water, it acts as a strong irritant to the eye or mucous membranes. If its dust gets in the eye, immediate irrigation with cold running water is required. An eye-fountain should be used if available, but water from a tap or shower will do. The affected eye should be examined as soon as possible by a specialist, who should be told about the strong alkalinity of the dust.

Protective gloves must be worn by those handling Palusol Fireboard, and after work, hands and arms should be carefully washed and treated with protective lotion.

5.6 Disposal of waste Palusol

Off cuts and dust resulting from fabrication of Palusol Fireboards must be handled in due considerations of existing national waste regulations.

Additional information regarding the disposal of waste Palusol please double check the current material safety datasheet of Palusol.

** Institut für gewerbliche Wasserwirtschaft und Luftreinhaltung e.V., Cologne, May 15, 1987.*

6 Testing and approval

Whether or not elements of building construction and individual components are deemed to meet required standards of fire protection will generally depend on their performance in recognized tests carried out by approved bodies.

In the case of the fire resistance of elements such as partitions, access floors, suspended ceilings, beams, and columns, tests and classifications are carried out in accordance with national standards on the lines of ISO 834. The special requirements to be met by compartment walls and floors are described in ISO 3008 or national standards of similar scope.

In Germany, fulfilment of the appropriate technical requirements is examined by the *Deutsches Institut für Bautechnik in Berlin,* the country's national agreement body, on behalf of provincial governments (which are the competent authorities with respect to building regulations). If this body is satisfied with the evidence given it respecting a new building material or component, it issues a certificate to that effect. Apart from any other conditions the certificate may include, it also prescribes the system of quality surveillance to be followed.

* Decisions of the Deutsches Institut für Bautechnik dated August 14 and December 28, 1987.

Agreement Certificate Z-19.11-14 is of the kind described above. It deals with the use of Palusol Fireboard in manufactured components of fire-resisting assemblies to be installed in the interiors of buildings. Contracts for the quality surveillance it prescribes have been approved*.

Other applications of Palusol Fireboard, such as in compartment walls and floors, cavity barriers, and fire stops around pipes and cables, require individual approval based on evidence of the efficacy of the proposed construction. However, the existing evidence provides a useful basis, so that only the satisfaction of special requirements may need to be proved, experimentally or otherwise. For instance, for the use of Palusol strips around steel fire doors, only the effectiveness of the moisture-tight pouches had to be demonstrated.

In the case of novel applications or extensions of existing applications, those proposing them must of course carry out their own practical tests, both to establish how the product is to be made and to show how it should be used to meet specific requirements.

Since BASF has its own fire-testing facilities, it can help users and potential users of Palusol Fireboard solve technical problems arising out of new and existing applications.

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