



International Committee of the Decorative Laminates Industry

Technical Leaflet

An Introduction to Manufacturing and Material Types

July 2015



Preface

High-pressure laminate (HPL) in accordance with EN 438 has been used in the construction and furniture sector for decades. The European standard EN 438 defines the material, requirements and properties of HPL.

HPL is a resin and paper-based thermosetting composite material and features a unique, extremely robust, resistant, modern and very decorative surface. HPL is omnipresent in our day-to-day lives and is self-supporting or used in conjunction with substrates. The application and usage areas of HPL are extremely diverse and are constantly evolving. This requires knowledge management which provides regularly updated information and assistance with regard to different applications and processing, in the form of technical bulletins.

This technical leaflet “An Introduction to Manufacturing and Material Types” provides an overview of manufacturing of HPL.

This document makes no claim of completion regarding listing the full details of any standards referred to in the text.

All information is based on the current state of technical knowledge, but it does not constitute any form of liability. It is the personal responsibility of the user of the products described in this information leaflet to comply with the appropriate laws and regulations.

For more than 50 years the ICDLI has been the international representative of the interests of European laminate manufacturers. Further information about the ICDLI and the data sheets published up to now can be found at www.icdli.com.

This application was compiled by the International Committee of the Decorative Laminates Industry. It considers the conditions of application technology in the European countries. If you have further questions, please contact us:

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Contents

1. The origin of HPL
 - 1.1 The history of HPL
 - 1.2 The success

2. High pressure laminates – Production process
 - 2.1 Raw materials
 - 2.2 Resin production
 - 2.3 The impregnation (treating) of papers
 - 2.4 Assembling and build-up
 - 2.5 The high pressure process
 - 2.6 Trimming, Sanding, Inspection
 - 2.7 Fabrication of HPL elements and compact sheets
 - 2.8 Note

3. Different types of HPL

4. Main application fields

5. Environmental relevance
 - 5.1 HPL: eco-sustainable production
 - 5.2 HPL in use: durable, hygienic and environmentally safe
 - 5.3 HPL: recovery

6. Technical data, chemical and physical properties

1. The origin of HPL

1.1 The history of HPL

In 1907 the first patent was granted to the Belgian chemist Leo H. Baekeland for a product type with the commercial name "Bakelite": A mixture of wood flour or fibres with phenol resins could be pressed in metal forms and simultaneously cured by heat.

In flat form produced as sheet material by impregnating paper with phenol formaldehyde resin and cured between steel plates, it became a replacement for mica as carrier for electrical components in consumer products of the 1920's such as radios and switchboards.

First melamine formaldehyde reactions were explored in 1906 and made commercially during the 1930's by different companies.

The development of decorative papers with a high absorption for melamine formaldehyde resins was the basic step to a decorative laminate during the 1940's.

A combination of phenol resin impregnated Kraft paper with a lightfast and coloured melamine resin impregnated decorative paper on top pressed together and cured under heat had an rapid development during the 1950's:

Some key-developments of HPL for special market segments are:

1960's:

- Heat resistance or cigarette-proof quality with an inlay of aluminium foil for heat transfer.
- Self supporting HPL or compact HPL in thickness between 2 and 30 mm.
- Postforming HPL

1970's:

- Fire retardant HPL for transport and wall cladding.
- HPL with highly textured surfaces.
- Electrostatic dissipative laminates for antistatic applications.

1980's:

- Wear resistant laminates for counter tops and domestic flooring systems.
- Outdoor HPL compact laminates with weather-resistant surface protection.
- HPL with metal surfaces.
- HPL with wood veneer surfaces.
- HPL with chemical resistant surfaces.

1990's:

- Continuously pressed high pressure laminates.
- Compact laminates with alternative core materials.
- Translucent HPL.

2000's:

- Fluorescent effect HPL
- Digital decor prints.

2010's

- Antibacterial surfaces
- Synchronised surfaces structure

1.2 The success

HPL can be made in nearly every decorative colour or pattern to fulfil the designers wishes in a cost effective way.

The colour (print) is identical over millions of m² and does not change like paints from batch to batch.

The colour (print) is more lightfast than natural veneer or wood.

The surface is resistant against high temperature, scratch, wear and impact, water, solvents, and most household chemicals. HPL are very heat-resistant, are not easy to ignite and do not melt or cause burning droplets in case of fire.

HPL are easy to clean, attractive, have a long service-life and need little maintenance. They can be easily machined with common wood-working tools.

2. High pressure laminates – Production process**High-pressure decorative laminate(s) (HPL)**

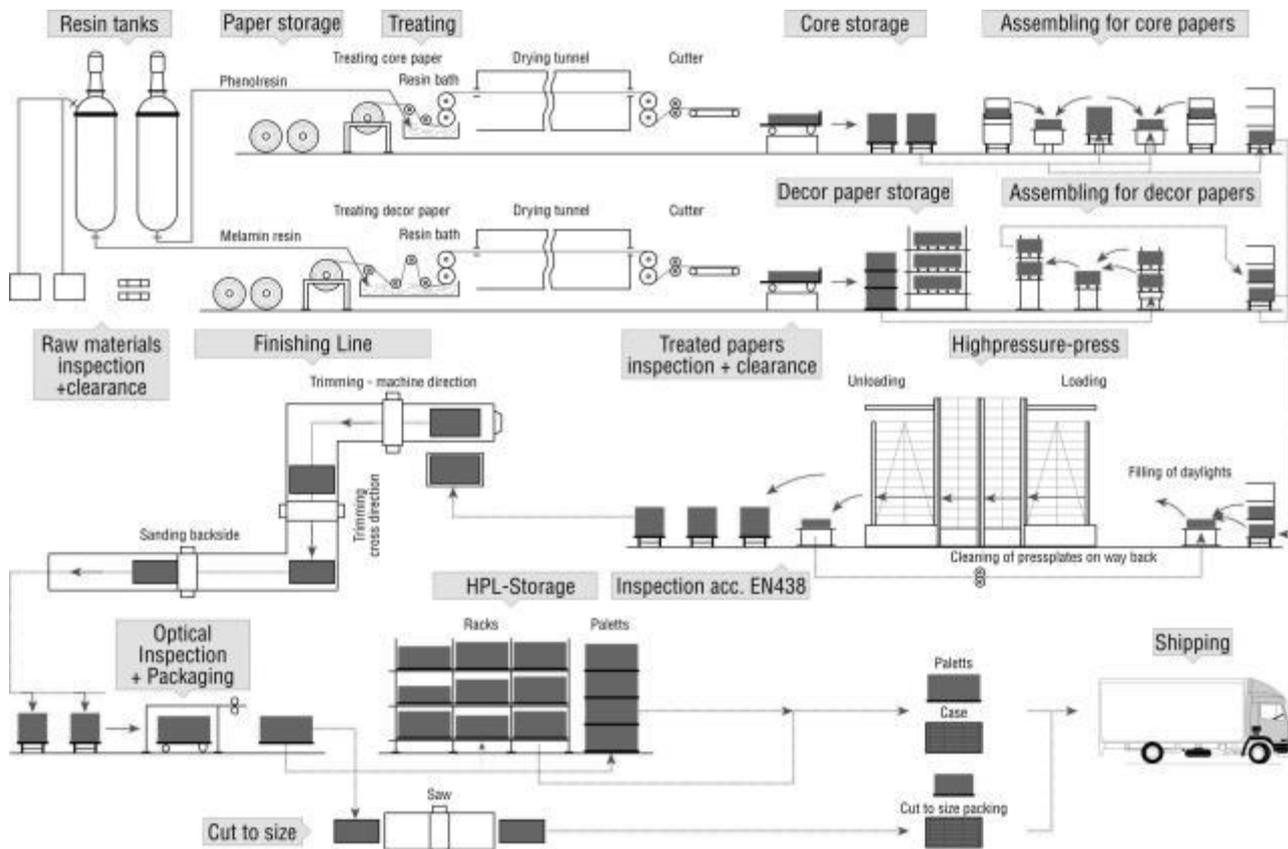
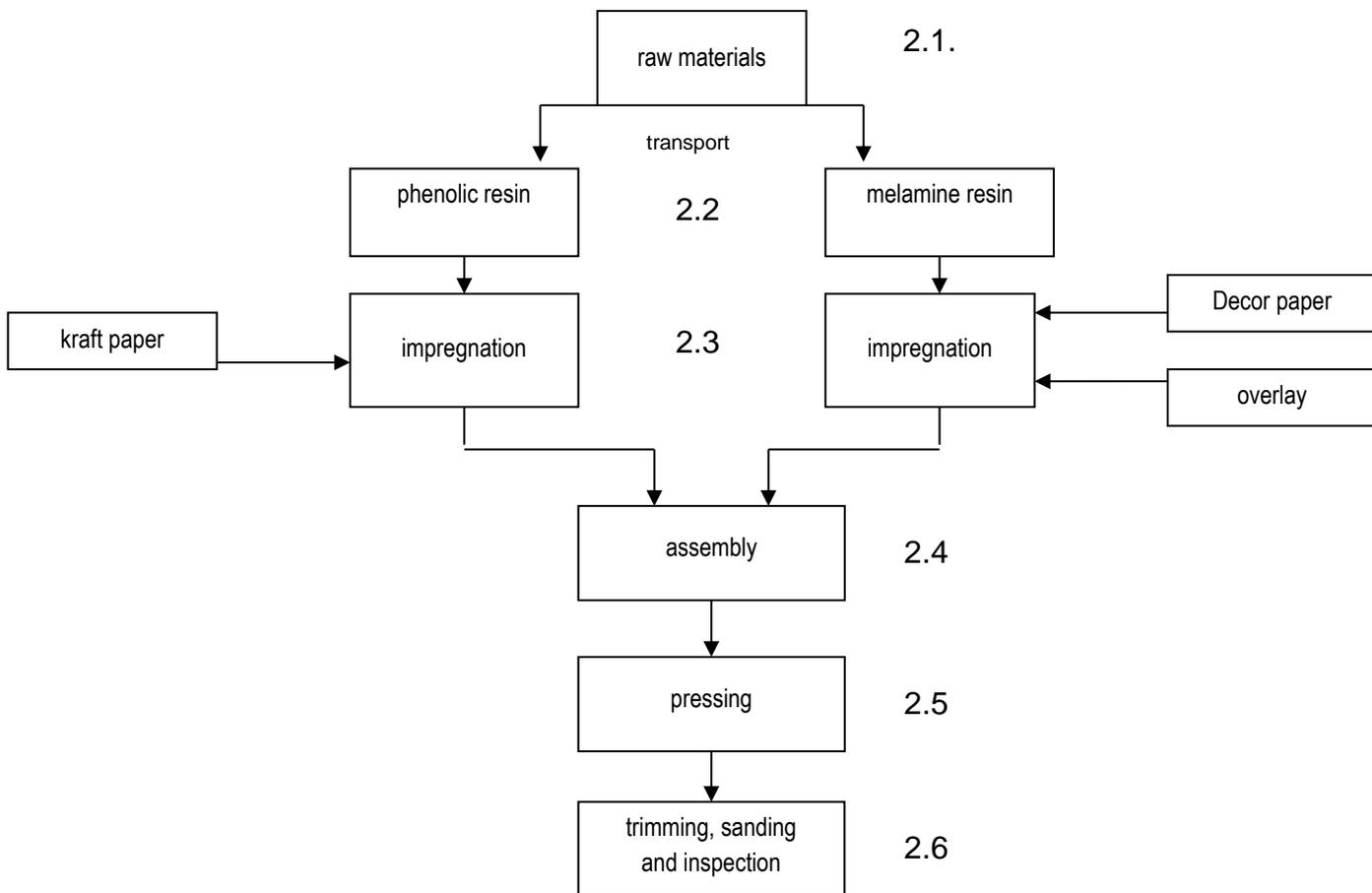
Sheet(s) consisting of decorative surface layer(s) and core layers bonded together by a high pressure Process. Typical values for the high pressure process are a temperature of ≥ 120 °C and a pressure of ≥ 5 MPa.

Surface layer

upper decorative layer consisting in one or more sheets of fibrous material (usually paper) impregnated with aminoplastic thermosetting resins (usually melamine based resins) or other curable resins or other decorative design surfaces such as metal foils, wood-veneers and textiles, etc. which are not necessarily treated with thermosetting resin. The surface layers can appear on one or both side(s) of the laminate(s). In case of one-sided laminates, the back of the sheet(s) may be made suitable for adhesive bonding to a substrate.

Core layer

Core layer consisting of fibrous materials (usually paper) impregnated with thermosetting resins (usually phenolic based resins) or other curable resins, eventually reinforced by metal layer(s) or metal mesh(es) and others which are not necessarily treated with thermosetting resin.



2.1 Raw materials

2.1.1 Kraftpaper (80 - 300 g/m²)

Saturating Kraft paper for HPL has absorption capacity suitable for resins. Kraft paper may be made of virgin and/or recycled fibres.

2.1.2 Decor paper (50 - 160 g/m²)

Decor paper is bleached and pigmented paper providing an aesthetically pleasing appearance. The decorative layers can be pigmented solid colours or more unique patterns using gravure roll or digital printing technologies such as wood grains, stone patterns and individual designs.

2.1.3 Overlay paper (15 - 80 g/m²)

Overlay is a bleached unpigmented, transparent paper with very high absorption capacity for resins. It is used to improve abrasion resistance.

2.1.4 Melamine Resin

Melamine resins are made from melamine and formaldehyde solution. Melamine resins are transparent, lightfast, scratch resistant, hard coatings best applicable for the surface layers of HPL.

2.1.5 Phenolic resin

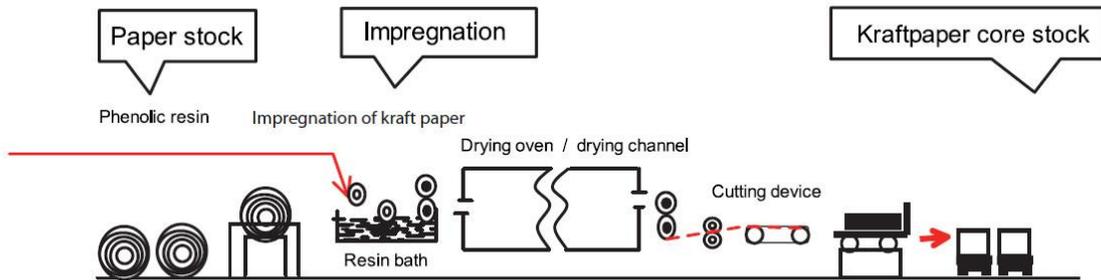
Phenolic resins are made from phenol and formaldehyde solution. Phenolic resins are brownish, relative elastic compounds for the core layers of HPL.

2.2 Resin production

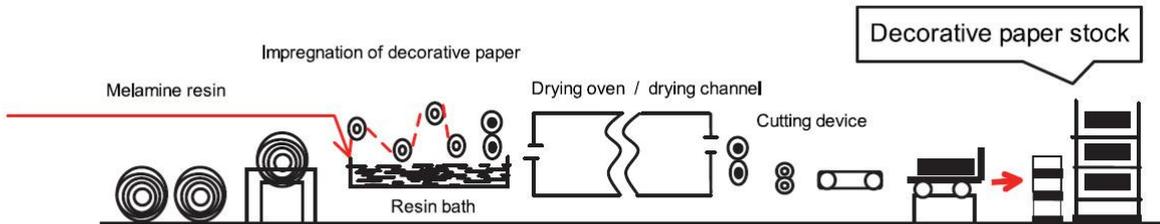
Both resins are produced in a batch process. In kettles the chemical components react together under well controlled conditions. Formaldehyd connects to melamine molecules or phenol molecules and forms reactive compounds for the further impregnation and press process.

2.3 The impregnation (treating) of papers

Kraft paper and decor paper are delivered in large rolls. In continuous horizontal "treaters" (i.e. impregnation machines) the paper is unwound, immersed into the resin bath, saturated with resin and then dried. The dry paper, filled with still reactive resin, is cut to sheets of the desired length or wound up again and stored in conditioned rooms for later use.



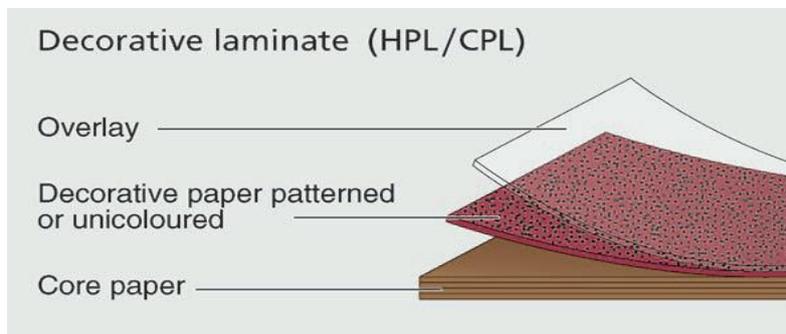
Impregnation of kraft paper



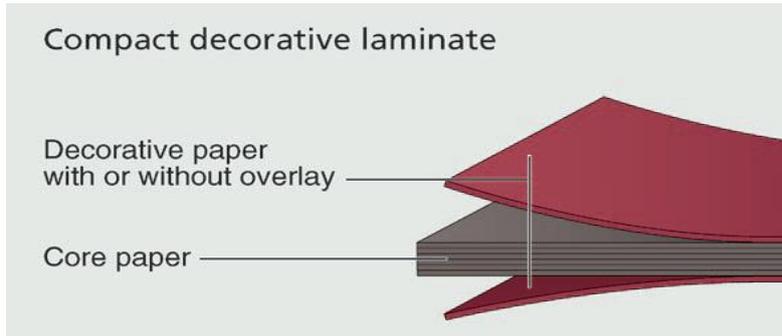
Impregnation of decorative paper

2.4 Assembling and build-up

The treated papers are collected from stock and assembled in clean, dust free rooms to build the right order in the desired colour, size, thickness and backing:



Typical build-up of a HPL



Typical build-up of a compact laminate

Single sided laminates are always produced "back to back", using a release paper. Release papers (i.e. coated special papers) or foils are applied to avoid sticking of laminates together in the press.

In case of multi-opening-presses (multi-daylight-presses) the assembling must be repeated many times to fill the press. Presses with up to 45 openings are in use. Every opening is filled with up to 24 single sided laminates (usually 0.5 – 1.9 mm thick) or at least with one compact laminate (usually 2 to 20 mm thick).

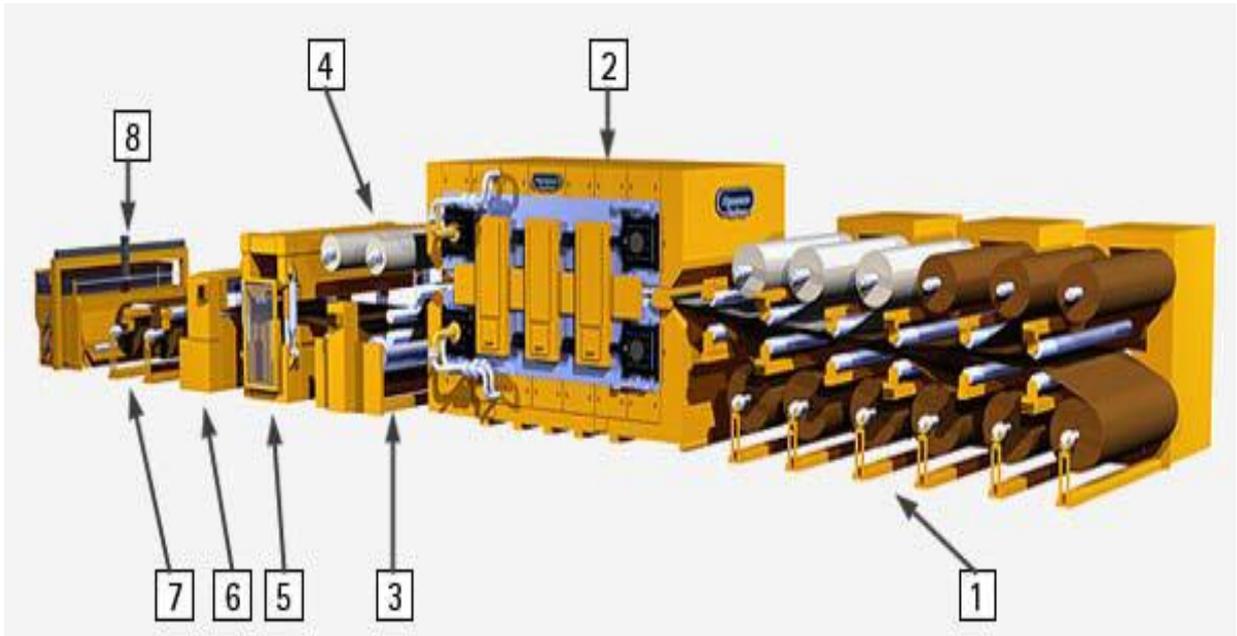
2.5 The high pressure process

Multi-daylight presses are loaded at room temperature, closed, set under hydraulic pressure (5 – 8 MPa) and heated up to more than 120 °C. The heat causes a liquefying process of the melamine- and phenolic resins. At high pressure the liquid resins are pressed between and into the cellulosic fibres - the density increases followed by the completion of the chemical reaction (polycondensation), called "curing". That forms a homogenous rigid, completely cross-linked network in the form of the sheet. The result is a non-porous laminate, which will not melt.

The cellulose fibres reinforce the laminate. They are chemically bonded and fully integrated into the new compound. The structure of the surface (high gloss, matt, textured etc.) is formed by the press plate (or templates) pressed against the liquefied and afterwards cured melamine layer.

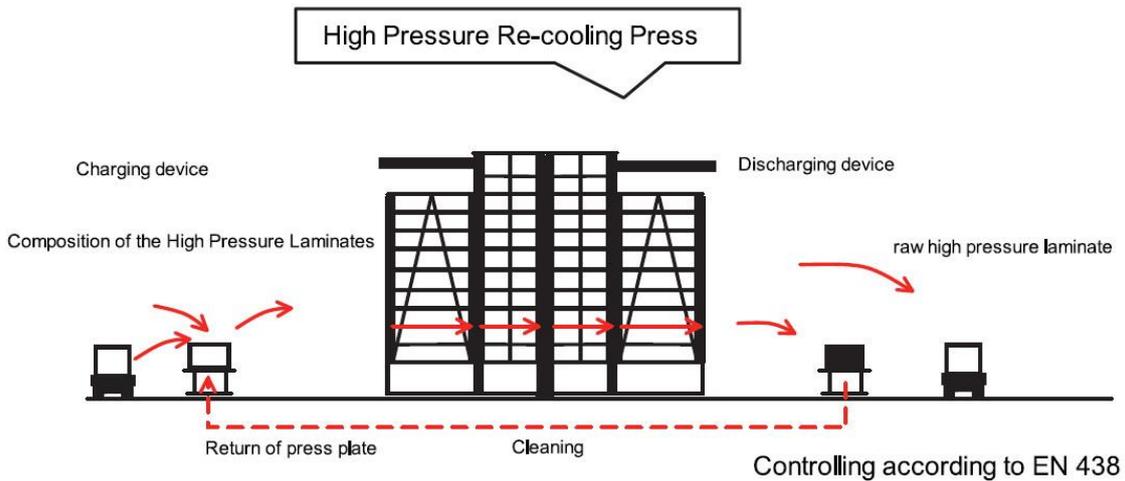
After curing is completed, the laminates is cooled down under pressure to release any tensions.

The complete press cycle may take up to 100 min. depending on press load and max. temperature.



- | | |
|------------------------------------|-------------------------|
| 1. unwinding station | 5. sanding station |
| 2. double belt press | 6. edge cutting machine |
| 3. cooling station | 7. rewinding station |
| 4. rewind station for texture film | 8. clipper |

Continues Production Process (source: Hymmen Industrieanlagen GmbH)



Another production method utilizes continuous presses, where endless strips of treated paper are pressed between two steel belts. Depending on the thickness of the laminate (usually 0.5 – 1.0 mm) and the length of the line, speed varies between 8 and 25 m/min.

2.6 Trimming, Sanding, Inspection

The laminates are unloaded from the press, and any release material is stripped off. The length and width of the laminate are cut to the required size. Single sided laminates are sanded on the back to improve gluing.

After surface and quality inspection for defects the laminates are labelled, packed and stored for further disposition.

2.7 Fabrication of HPL elements and compact sheets

Single-sided laminates are usually glued to substrates (e.g. chipboard, MDF etc.) to obtain composite elements.

Edging strips may be applied or the laminate may be postformed (e.g. for kitchen worktops).

Compact laminates are cut to size, and fittings are attached to make them ready to be installed as lockers, cubicles, partition-walls, etc.

2.8 Note

Statement of the International Committee of the Decorative Laminates Industry (ICDLI) at the Plenary Assembly 2014.

The ICDLI aims at creating a strong and successful European community of manufacturers as well as the continuation of the success story of decorative high pressure laminates.

To achieve these goals the ICDLI uses exclusively the term HPL (High Pressure Laminate) independent of the production process.

'HPL' is a product, whose quality is defined and standardized in EN 438 and ISO 4586.

3. Different types of HPL

EN 438 parts 3 to 6 and parts 8 and 9 include product classification systems. While each of these systems is different, they contain some common elements as follows:

Main classifications:

H = Horizontal grade

V = Vertical grade

C = Compact laminate

E = Exterior grade

AC = Abrasion Class for flooring grade (AC 1 to AC 6)

A = Pearlescent laminate

M = Metal laminate

W = Wood veneer laminate

B = Coloured core laminate

R = Metal reinforced core laminate

T = Thin laminate < 2mm

Sub-classifications:

D = Heavy duty or severe use

G = General purpose or moderate use

S = Standard grade

F = Flame-retardant grade

P = Postforming grade

Out of these letters HPL can be classified as e.g.:

HGS = Horizontal General Standard

HGP = Horizontal General Postforming

VGFR = Vertical General Fire Retardant

etc.

4. Main application fields

- Furniture (working table top, doors, backsplash)
- Self-service restaurant (tables, wall-linings, seats, counters)
- Interior (hospital: bed ports, cabinets, service ducts, wall-linings, bumper rails)
- Flooring
- Exterior (balconies, decorative façades)
- Railcars (interior fitting, wall-lining, ceiling)
- Ship (interior fitting)

5. Environmental relevance

5.1 HPL: eco-sustainable production

Paper is a bio based product. Both sustainable forests and recycled fibres are sources for the production of unbleached Kraft paper.

The various types of decorative papers are composed of bleached pulp and contain pigments free of toxic heavy metals.

The most relevant chemical products for the environment are formaldehyde and phenol, but when transformed into resins, they are no longer present at significant levels in HPL because irreversible cross-linked chemical bonds have been formed.

Volatile emissions produced during the paper impregnation are typically burned and the heat can be recovered. In the pressing phase the simultaneous application of heat and high pressure provides a stable and non-reactive material.

Production residuals can be recycled as raw materials or burned for energy recovery in modern, officially approved industrial incinerators.

5.2 HPL in use: durable, hygienic and environmentally safe

- Emission in use

HPL surfaces do not need any special treatment or care for maintenance. No harmful emissions are released during machining or use. Formaldehyde emission levels are far below the standard for indoor air quality.

- Hygienic merit

Decorative laminates are often used in applications where cleanliness and hygiene are particularly important, such as hospitals and kitchens.

HPL are suitable for contact with foodstuffs. The solid and non-porous HPL surfaces prevent particles of food or chemical products from penetrating and depositing. They are easy to clean.

- Safety in fire situations

Laminates are difficult to ignite, do not melt nor create burning droplets and have properties that retard "spread of flame", thus prolonging evacuating time.

Due to incomplete burning, as with many organic materials, HPL release smoke. However, HPL are capable of meeting the best performance for organic surfacing materials specified in the French standard NFF 16101 (i.e. at least class F2 for smoke density and toxicity).

In dealing with fires involving laminates the same firefighting techniques should be employed as with other wood based building materials.

5.3 HPL: recovery

- Thermal recovery

The high calorific value of HPL allows recovery of most of the energy necessary for their production when HPL are burned under controlled conditions.

- Recycling



Laminates can be recycled, for instance crushed sheets or moulded parts can be used as fillers or can be transformed into moulds together with virgin resins.

- Waste disposal

When thermal recovery is not practical, HPL waste can be brought to controlled waste disposal sites according to current national and/or regional regulations.

6. Technical data, chemical and physical properties

HPL are not classified as hazardous substances and therefore they do not require a special marking nor a description by a safety data sheet.

Technical characteristics can be found in different parts of EN 438 Standard.

Environmentally relevant data can be found in product data sheets for HPL and for HPL Composite Panels.

An EPD (Environmental Product Declaration) is available on the ICDLI webpage www.icdli.com.