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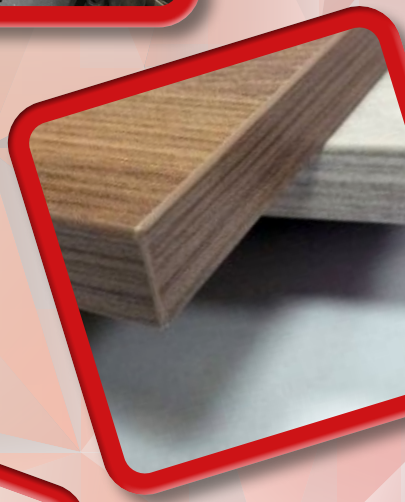

EDGE BONDING HANDBOOK

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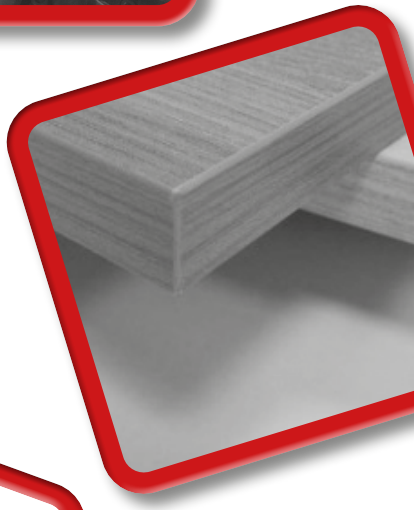

EDGE BONDING HANDBOOK

AVISA is one of the 17 Sector Associations of Federchimica, the Italian Federation of the Chemical Industry, part of Confindustria and member of CEFIC (European Chemical Industry Council).
AVISA represents companies producing adhesives and sealants, printing inks, paints and varnishes. The Association is entrusted with the exclusive task of representing and safeguarding the interests of its member companies, dealing with problems of specific interest of its sector, providing technical and economic assistance to its member companies and protecting their image.

CATAS is the most important Italian laboratory for testing, certification and research in the wood and furniture sector.
With over fifty years of experience, CATAS is a special partner for companies in the development of products, in controlling their safety and in verifying that their performance meets the needs of the market and those imposed by technical standards. The training of companies on these issues pursued with its own dedicated section, the CATAS Academy, combined with analysis and testing activities form the mission of CATAS, which is to contribute to making the products in this sector safer and more durable.

Legal notes

This handbook has not been prepared with the aim of examining and solving all the critical points that companies may encounter during edgebanding activities, but it is intended to provide operational support guidelines.
It has been written on the basis of current knowledge and may therefore be subject to revision.
The contents of this publication have a purely informative purpose and therefore provide only general indications that will then be contextualised in the individual company.

In 2014 Avisa, the Association, inter alia, of woodworking adhesives producers organised a round table discussion with the provocative title "Do woodworking adhesives really bond?", inviting all players along the supply chain to discuss the issue. Experts from companies producing adhesives, paints, materials and equipment for the production of furniture dealt with the topic. The result was a symposium on cases of unsuccessful bonding, collected by Catas over a decade, for which appropriate solutions were proposed. The success of the initiative convinced the players of the industry to transfer what had been discussed at the conference into a handbook.
During the work clearly and unequivocally emerged how important the contribution of each individual experience is for the success of the final product; each company challenged itself and tried to provide all the elements useful for the production of a final product of controlled quality.
The woodworking adhesives sector of Federchimica Avisa, in collaboration with Catas and the whole supply chain, has published this handbook which demonstrates an ongoing commitment to the development of the industry. Dialogue between stakeholders is a guarantee of success and this handbook clearly demonstrates that.

Fabio Chiozza
Chairman
Woodworking Adhesives Sector
Adhesives and Sealants Group
Federchimica Avisa

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Introduction (objectives)

This handbook is a tool designed by woodworking adhesives manufacturers members of Federchimica - AVISA together with Catas for the benefit of those who carry out edge bonding operations in the furniture industry for the production of, for instance, doors, shelves, sides, etc.
Edgebanding is the lamination operation of the side surfaces of panels. It is carried out at industrial level, using automatic and semi-automatic plants, called edgebanding machines, with edges of various materials (plastic, wood, cellulose, metal) bonded with hot melt adhesives or applied with other technologies.
The edgebanding process completes the finishing of the panel, giving it its final aesthetic characteristic.
The variety of materials (panels, edges, adhesives), the complexity and multiplicity of edgebanding machines, the increasing attention to aesthetic and performance requirements demand a careful monitoring of the edgebanding process, its parameters, variables and characteristics of raw material.
Hence the need to write a handbook, shared by the various players along the chain and intended for operators of the sector.
The definition of good practices is fundamental in the management of all stages of the process (from the purchase of the raw materials to the storage of the edged panels, through the quality controls of processes and materials), in order to guarantee a reliable, durable and qualitatively constant product to the benefit of both the producer and the end consumer. The handbook provides the elements to collect all the necessary documentation to guarantee the control of the production process and its traceability.
We would like to thank all the companies along the supply chain who have collaborated in writing this handbook and shared their knowledge, expertise and professionalism, with the aim of contributing to the qualitative improvement of the edging process.
We would also like to thank FSC® (Forest Stewardship Council®) and PEFC (Programme for the Endorsement of Forest Certification) for their kind cooperation.

1 Field of application

Edge bonding consists of covering the side surfaces of the panels. The operation aims to complete their finishing after their faces have been ennobled by painting or lamination processes.
The materials with which this operation is carried out are called "edges" and the process is called "edging".
Edging is a process carried out on surfaces that have a limited width, but with a considerable development in length.
For the application of the edges, usually consisting of long and thin strips of various materials, different types of automatic or semi-automatic machines are used with the almost exclusive use of hot-melt adhesives.
The application of thin edges using hot-melt adhesives is the solution most adopted by furniture industries for finishing the side surfaces of the panels.
This process is, in fact, very effective in terms of productivity, also guaranteeing appreciable results, both from an aesthetic point of view and for the performance offered by the finished product.
Edge gluing techniques vary depending on the morphology of the substrate and can be classified as:

- edging of linear and squared surfaces

- edging of curved and squared surfaces

- edging of linear or curved shaped surfaces (soft forming)

2 The materials used

The substrates subjected to edging operations are represented by all types of panels used by the furniture industry (particleboard, MDF, plywood, solid wood panels and honeycomb boards).
The hot melt adhesives used in the edging processes include all the existing types: EVA, PO and HMPUR.
The edges are usually long and thin strips of various materials (plastic, wood, cellulosic derivatives, metals) generally supplied in the form of coils.

2.1 Edges

2.1.1 Wood and derived products

This type of edges is made of thin sheets of wood, including multilaminar wood (reconstituted wood), with thicknesses usually ranging from 0.3 mm to about 3 mm for rolled edges and up to 25 mm for solid wood edges. Considering that wood is sensitive to climatic variations, the edges made with these materials must have a moisture content between 8% and 12% in order to ensure adequate bonding. These conditions are usually achieved by conditioning the edges in a temperature range between 15°C and 35°C and a relative humidity of the air between 40% and 65%. To improve flexibility and to prevent cracking, edges made with wood veneers are often produced by gluing together several layers. Sometimes they are also backed with a non-woven fabric (NW) of various kinds, plastic materials (for example ABS) or impregnated papers bonded with vinyl or polyurethane hot melt adhesives. If necessary, the wooden edges can be coloured and varnished. There are also particularly flexible edges for soft forming applications. For certain applications or to preserve the edge surface during all the working operations, it is also possible to provide the reels with a removable protective film applied on the top.

Figure 1. Real wooden edge

CRITICAL PARAMETERS FOR BONDING

Table 1

Parameter	Test method	Requirement
Moisture content	UNI EN 13183	8%-12%
Waiting time after the application of the backed material to the edge (NW or others)		5 ÷ 7 days for PVAc –VAE adhesives 3 ÷ 5 days for HM PUR adhesives

Table 2

Parameter	Test method	Requirement					
Thickness	See annex 1	Range in mm	0,30÷0,60	0,61÷0,80	0,81÷1,20	1,21÷2,00	2,01÷-3,00
		Tolerance in mm	±0,05	± 0,10	± 0,15	± 0,25	± 0,30
Width	See annex 2		±0,3 mm				

OTHER PARAMETERS

Formaldehyde emission

Edges made with materials derived from wood can release formaldehyde into the air as a result of hydrolysis phenomena that involve certain resins and adhesives used for their production. There are currently no specific test methods and limits for the control of these materials, even though some studies have been performed and have led to the definition of unofficial references.

These unofficial parameters are currently adopted by some manufacturers of wooden edges and derivatives, by furniture manufacturers and by distributors in order to use raw materials that allows to reach the emission values expected for the finished product.

TABLE 3

Parameter	Test method	Requirement
Formaldehyde emission	EN ISO 12460-3	1,3 mg/m^2 • h

Certifications FSC® e PEFC

The FSC (Forest Stewardship Council®) and PEFC (Program for the Endorsement of Forest Certification) schemes, certify wood-based materials and derivatives coming from responsible and controlled forest management. Public and private specifications often require the certification of all wood materials (including edges) that constitute a finished product according to these schemes.

2.1.2 Impregnated and laminated papers (HPL and CPL)

The edges of impregnated paper and laminates are available in solid colours or printed with wood grain effects.
The weights of impregnated papers for edges are significantly higher than other papers used for finishing the faces of the panels. Higher weights are in fact required to improve mechanical performance such as impact resistance.
The single-layer paper edges are sometimes laminated with preparation papers (only impregnated) in order to produce thicker materials. Such laminated papers become more resistant, but the main purpose of this operation is to guarantee more homogeneous surface, less sensitive to the irregularities of the substrate (for example particle boards). With special impregnations, the single-layer paper edges can be used for soft-forming applications.

Figure 2. Paper edge soft-forming application

The edges produced by impregnated papers and laminates must be stored in dry conditions possibly closed inside plastic bags to isolate them from the environment.
Due to their stiffness, HPL edges usually are supplied in the form of long strips.
CPL and HPL edges have a higher surface resistance than single-layer edges which are, on the other hand, easier to apply.

CRITICAL PARAMETERS FOR BONDING

Table 4

Parameter	Requirement
Expiring date	6-12 months depending on the composition (see supplier technical data sheet)

Table 5

Parameter	Test method	Requirement					
Thickness	See annex 1	Range in mm	0,30÷0,40	0,41÷0,80	0,81÷1,20	1,21÷2,00	2,01÷-3,00
		Tolerance in mm	±0,03	± 0,05	± 0,10	± 0,15	± 0,20
Width	See annex 2		±0,3 mm				

OTHER PARAMETERS

Formaldehyde emission

The paper edges are normally impregnated with amino-resins which can release formaldehyde into the environment due to resin hydrolysis phenomena.
There are currently no formaldehyde emission limits or test methods specific for these materials although some studies have been carried out leading to the definition of unofficial requirements currently adopted by some paper edge manufacturers, furniture manufacturers and distributors in order to select raw materials able to guarantee the respect of the required limits for finished products.

Table 6

Parameter	Test method	Requirement
Formaldehyde emission	EN ISO 12460-3	1,3 mg/m^2 • h

Light resistance

Light resistance is a characteristic associated with the product aesthetic quality. In principle, the colour of the edges should be maintained over time, not highlighting fading or colour changes that could also lead to significant differences with the surfaces of the panels to which they are applied.

Table 7

Parameter	Test method	Requirement
Light resistance	EN 15187	≥ 6 blue wool scale

Certifications FSC® e PEFC

The FSC (Forest Stewardship Council®) and PEFC (Program for the Endorsement of Forest Certification) schemes certify wood-based materials and derivatives coming from responsible and controlled forest management. Public and private specifications often require the certification of all wood materials (including edges) that constitute a finished product according to these schemes.

2.1.3 Plastic (PP, PET, ABS, ABS-PMMA, PS and PVC)

The use of plastic edges is widespread in the furniture sector, mainly thanks to the good ratio between costs and performance offered by the finished products. Plastic material edges are produced by a hot extrusion process of thermoplastic materials which are then reduced into thin strips and thickness varying from a few tenths to a few millimeters.

Figure 3. ABS edges of various colours

Different types of polymers are used in combination with suitable additives and colouring substances to produce edges of plastic materials.

The internal surface is usually coated with a specific "primer" to allow the proper adhesion of the edge to the panel with the adhesive.

A removable protective film can be applied on the surface of the edge to protect it during processing or for particular applications.

CRITICAL PARAMETERS FOR BONDING

Table 8

Parameter	Requirement
Edging and primer lifetime (expiration)	Normally 12 months unless otherwise specified in the supplier data sheet
Lifetime of any physical treatment (plasma or corona)	See the supplier data sheet
Primer: presence, type (water, solvent, etc.), compatibility with adhesive, quantity, homogeneity	See the supplier data sheet
Selection of the adhesive	See the supplier data sheet

Table 9

Parameter	Test method	Requirement				
Thickness	See annex 1	Range in mm	0,20÷0,70	0,71÷1,40	1,41÷2,50	2,51÷3,00
		Tolerance in mm	±0,05	± 0,10	± 0,15	± 0,20
Width	See annex 2	±0,3 mm				
Longitudinal distortion	See annex 3	max 3 mm/m				
Convexity	See annex 4	max 0,2 mm				

OTHER PARAMETERS

Light resistance

Light resistance is a characteristic associated with the product aesthetic quality. In principle, the colour of the edges should be maintained over time, not highlighting fading or colour changes that could also lead to significant differences with the surfaces of the panels to which they are applied.

Table 10

Parameter	Test method	Requirement
Light resistance	EN 15187	≥ 6 Blue Wool scale

2.1.4 Functional edges for laser, hot air, plasma and NIR applications

The edgebanding systems based on functional edges allow bonding without the use of adhesives and the aesthetic result is defined as "zero joint".
The edges used with this technology are characterized by a "functional layer" which is melted by an energy source (for example laser beams or hot air jets) and then pressed to the panel.
The internal layer with adhesive function can be generally classified into two types:

- Spread
  A polyolefin-based hot melt adhesive is spread on the back of a primed edge. The adhesive is then reactivated by heating, induced by an energy source.
- Coextruded
  A polymer with suitable characteristics is coextruded together with the plastic edge, forming its internal layer. This polymer is reactivated during the edging process by heating the back of the edge with a suitable energy source.

As regards the requirements, reference is made by analogy to those of plastic edges.

2.1.5 Aluminum

Another category of edges is made with aluminum, particularly appreciated for the uniqueness of their surface appearance. They are normally ABS or paper-based edges with a thin aluminum surface layer, with a thickness generally ranging between 0.1 and 0.2 mm. The total thickness of the product is between 0.4 and 2.0 mm.

The coupling of the metal film is obtained by means of a co-extrusion or gluing processes.
Generally, these products are supplied with a removable protective film to preserve the particular visible surface during application.
From a technical perspective, the application does not substantially differ from those used for ABS and paper edges.

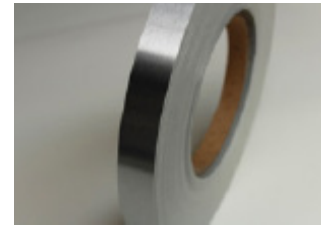


Figure 4. Aluminum edge

2.1.6 Edges for special applications

The edges used for soft-forming edging and for CNC working centers (whether the adhesive is applied on the edge or on the panel) must ensure adequate flexibility in order to be bent on non-straight panels and to be applied on shaped surfaces. Their thicknesses are generally between 0.3 and 0.5 mm for soft-forming edges and between 0.4 and 2 mm for those suitable for processing with working centers (CNC). Edges that are too rigid and consequently not very flexible may not guarantee a good bonding result, considering that they could give rise to the appearance of unpleasant cracks and unsightly whitening. For these processes edges made of impregnated paper, wood, aluminum and plastic material (ABS, PVC, PP) can be used. As regards the requirements, reference is made to the category of material they are made of (paper, plastic, wood).

2.2 Panels

2.2.1 Particleboards

Particleboards panels are manufactured under pressure and heat using wood particles with different size and using resins normally derived by condensation reaction of urea and formaldehyde (UF resins).
Usually, in the production of particleboards for furniture, coarser particles are concentrated in the core, while finer ones form the external layers (so-called "layer distribution"). Core improves mechanicals properties and decreases the board density. External layers create a homogeneous and smooth surface ideal for adhesions of films or direct painting.
Moisture content, dimensional tolerances and

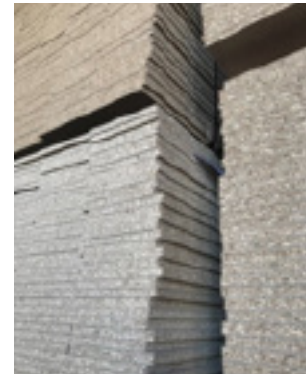


Figure 5. Particleboards

particle size distribution in the internal part of the panel are three fundamental parameters related to the edging processes. Considering the latter, coarser the size composition of the panel, the greater the "filling" capacity of the adhesive must be, especially when using very thin edges (for example those thinner than 0,5 mm).
The "constancy" of the density profile among different panels of a production lot or between different production lots is therefore a fundamental characteristic to ensure that the quantity of adhesive applied is always adequate.
Relating to the moisture content, storage in suitable climatic conditions is of fundamental importance.
Furthermore, a storage in cold conditions can excessively reduce the panel temperature with negative effects on the edging process (immediate cooling of the hotmelt adhesive applied to the panel).
Even storage in no flatness conditions can compromise the final edging result, due to deformations suffered by the panel. An important property of the panels is their pronounced tendency to swell irreversibly when they come into contact with water. This swelling can be particularly evident in the case of furniture placed in humid conditions or near steam sources (e. g. ovens, dishwashers), where an imperfect edging can cause water infiltration, resulting in swelling of the panel.
It should be noted that there are panels suitable for humid conditions and classified as P3 compared to those classified as P2 intended for dry conditions. For P3 panels the extent of swelling induced by water absorption is lower than the P2 panels only suitable for dry conditions. In order to make the gluing more effective, it is advisable to proceed with a preliminary trimming of the panel since its perimeter part normally has a more grainy structure.

CRITICAL PARAMETERS FOR BONDING

Table 11

Parameter	Test method	Requirement
Density	EN 323	± 10 % compared to the average data of the technical data sheet
Moisture content	EN 322	5 ÷ 13 %
Squareness	EN 342-2	Max 2 mm/m
Internal bond	EN 319	see standard EN 312 tab. 3

OTHER PARAMETERS

Table 12

Thickness swelling	EN 317	P2: no requirement
		P3: see standard EN 322 tab. 4

2.2.2 MDF

Fiber panels are obtained by hot pressing of wood fibers. Both softwood and hardwood are used for the production of fibreboard.
The most used process of fibreboard production is the dry process which, through the main use of urea-formaldehyde adhesives, can lead to the production of panels with different thicknesses and densities. These fiberboards are called MDF (Medium Density Fibreboard) and represent the most used class of fiberboards in the furniture sector.
The density is not homogeneous through the thickness, resulting greater for the external layers and lower in the core. The undesired lack of symmetry of the density profile can lead to the bending of the panel during time.
With regard to storage conditions and swelling caused by water, the same considerations already expressed for particleboard apply also to MDF panels.

CRITICAL PARAMETERS FOR BONDING

Table 13

Parameter	Test method	Requirement
Density	EN 323	± 10 % compared to the average data of the technical data sheet
Squareness	EN 342-2	Max 2 mm/m
Moisture content	EN 322	4 ÷ 14 %
Internal bond	EN 319	see standard EN 622-5 tab. 3

OTHER PARAMETERS

Table 14

Parameter	Test method	Requirement
Thickness swelling	EN 317	MDF see standard EN 622-5 tab. 3
		MDF H see standard EN 622-5 tab. 4

2.2.3 Plywood panels

Plywood panels are produced via an odd number of layers of wooden veneers hot pressed together, generally using UF adhesives. The wooden fibers of adjacent layers are usually crossed, thus improving both the dimensional stability and the mechanical characteristics of panels.

Figure 6. Plywood panels

CRITICAL PARAMETERS FOR BONDING

Table 15

Parameter	Test method	Requirement
Moisture	EN 322	8 ÷ 12 % (EN 315)
Orthogonality	EN 324-2	Max 1 mm/m (EN 315)

OTHER PARAMETERS

Table 16

Parameter	Test method	Requirement
Thickness tolerance	EN 324-1	EN 315:2002

2.2.4 Composite panels (honeycomb boards)

The main feature of honeycomb boards is their particular lightness, even though their considerable thicknesses.

They consist of two covers, usually thin, a frame and a core material, mutually glued. The two covers are made of thin wood-based panels (usually particleboard or MDF).

The frame is made of strips of solid wood, particleboard or MDF.
The core is almost always made with honeycomb cardboard, polyurethane foams, polystyrene or cellular aluminum.
Concerning the edgebanding of the side surfaces, it should be highlighted that honeycomb boards can be produced in fixed dimensions with the insertion of frames. Another type are the so-called "frameless" honeycomb boards that are produced without these lateral boundaries to be cut according to the needed dimensions. In this second case the side surfaces are open and, consequently, they must be properly sealed and finished. This operation is normally carried out by inserting different types of slats, with subsequent application of the edges.
In the first case, the edgebanding operation mainly depends on the materials the strips are made of.

In the second case, due to the multiplicity and variety of existing technologies, it is recommended to directly refer to the manufacturer of the edging machines.

Figure 7. Composite panels

In any case, it can be remembered that:

- for panels made of covers with high thickness, typically equal to or greater than 8 mm, it is possible to operate with a traditional edging, using edges of high thickness that allow to obtain a surface with adequate mechanical strength;
- for honeycomb panels with thinner covers, the following options can be used:
  - > insertion of MDF or particleboard slats which completely cover the perimeter of the panel. Edging is then carried out with traditional systems;
  - > use of special "supporting" edges applied before the decorative one. These edging provide a solid foundation for the following application of the decorative edging.

The edge bonding on honeycomb boards shall consider the type of material present on the lateral surface of the panel. For example, more adhesive will be used in the presence of a frame made of particleboard and less in the case of a frame made with MDF.

An excessive pressure on the pressing rollers can cause the covers to slightly lift, causing possible problems during trimming.
In the case of frameless boards made with thick covers, the adhesion of the edge is limited to the glued part on the lateral surfaces of the two covers. In this case it is strongly recommended the use of thick edges.
In the case of a wooden frame, moisture content must be checked carefully.

CRITICAL PARAMETERS FOR BONDING

Refer to the parameters of the constituent materials of honeycomb board.

2.2.5 Wood-based panels

Solid wood panels are made using wood elements (sawn wood), glued together to form large surfaces.
The most common in the furniture sector are those made with wood strips and mainly used to produce elements such as tabletops, seats and "cores" for the production of blockboard panels.

CRITICAL PARAMETERS FOR BONDING (EN 13353)

Table 17

Parameter	Test method	Requirement
Moisture content	EN 322	8 ± 2 %
Straightness of the edges	EN 324-2	1,0 mm/m
Orthogonality	EN 324-2	1,0 mm/m

OTHER PARAMETERS

Table 18

Parameter	Test method	Requirment
Formaldehyde emission	EN ISO 12460-3	E1 Class *

• This requirement depends on the specific rules of the Country considered

2.3 Adhesives

The adhesives used for edge banding are hot melt adhesives, the main characteristic of which is that they are supplied in solid form, i.e. they are free of solvents or water. To be used, these adhesives are melted and applied while hot. Subsequently, cooling leads to solidification.
For one particular type of hot melt adhesives (called isocyanates or polyurethanes), physical hardening is accompanied by chemical cross-linking.
In edgebanding processes, the hot melt adhesive is applied by means of rollers or slot nozzle and the bonding with the edge is carried out immediately after application.

2.3.1 EVA

EVA resins are the result of the polymerization of two monomers, ethylene and vinyl acetate.
The copolymers used for the production of adhesives are characterized by the different ratios of the two monomers on which the main characteristics of this type of adhesives depend (adhesion, open time, softening temperature).
EVA-based hot melt adhesives are therefore a family of products with different characteristics that can be selected according to the application needs or the performance requirements of the finished product. In any case, EVA-based hot melt adhesives have a thermoplastic nature and mechanical properties such that they are not particularly resistant to stresses caused by solvents, heat, steam or humidity.

2.3.2 PO

A further group of hot melt adhesives used for edgebanding are the polyolefin-based adhesives. These polymers are produced from various monomers such as ethylene, propylene, butene and homologues. Compared to EVA-based adhesives, polyolefin adhesives are characterized by a narrower melting range and a good initial bonding strength. They are also generally more resistant to heat and solvents than EVA-based adhesives.

2.3.3 HMPUR

Isocyanate hot melt adhesives (also known as reactive polyurethanes) differ from the previous ones in that their setting depends on both a physical (cooling of the adhesive) and a chemical (cross-linking) process.
Physical curing, which is relatively fast, allows the activation of a sufficient initial adhesive force. The materials can be then fixed quickly. The chemical reaction is then triggered by humidity. The development of the final force is achieved later, due to progressive cross-linking of the adhesive.
The chemical cross-linking of the adhesive makes it possible to achieve high resistance to water, humidity, solvents and heat, which is superior to the other families of adhesives mentioned above.

2.3.4 Characteristics of adhesives

Physical-chemical properties

Viscosity

Viscosity is a physical property that indicates the resistance of a fluid to flow and can be considered as the frictional force that is exerted between two layers of fluid flowing on each other.
Viscosity is measured using a specific instrument (Brookfield viscometer) which is associated with an equipment able to melt the product and to keep it stably at a defined temperature (e.g. 200°C for EVA/PO and 140°C for HMPUR) according to EN ISO 2555 "Plastics - Resins in the liquid state or in emulsions or dispersions – Determination of apparent viscosity according to the Brookfield method".
This parameter provides an indication of how the product flows inside the machine with practical consequences on its application by the spreading roller (quantity) and its penetration inside the panel according to the applied pressure.
In general, adhesives characterized by high viscosity values are more suitable for low density panels (less penetration between the rough particles of the panel).

Figure 8. Brookfield rotational viscometer with heating unit

Table 19

Parameter	Test method	Requiriment
Viscosity	EN ISO 2555	Declared value ± 25%*

*Unless otherwise specified in the manufacturer data sheet

Softening point (Ring & Ball)

The softening point is defined as the temperature at which a hot-melt adhesive subjected to heating, under specified conditions, reaches a critical fluidity. To measure it, a steel ball of specified mass is placed on a sample of solid adhesive contained in a metal ring of specified dimensions. The temperature at which the sample is soft enough to allow the ball to pass through the ring and reaching a predetermined distance is referred as the "softening point". The reference method is EN 1238 "Adhesives - Determination of the softening point of thermoplastic adhesives (ring and ball method)".
The softening point is related to the open time of the adhesive and to the thermal resistance of the glue line.
As general rule the adhesives characterized by high Ring & Ball values show short open time and higher heat resistance, while those with low Ring & Ball temperature show long open time and lower heat resistance.

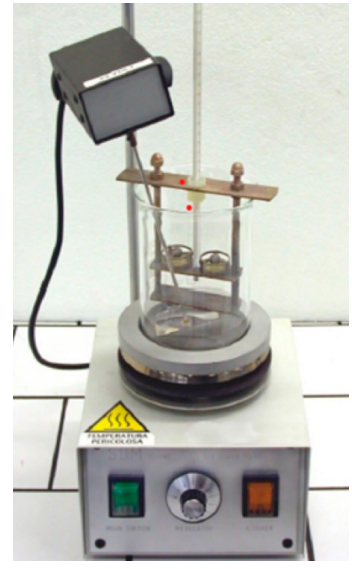


Figure 9. Instrument for determining the softening temperature of hot melts (Ring&Ball)

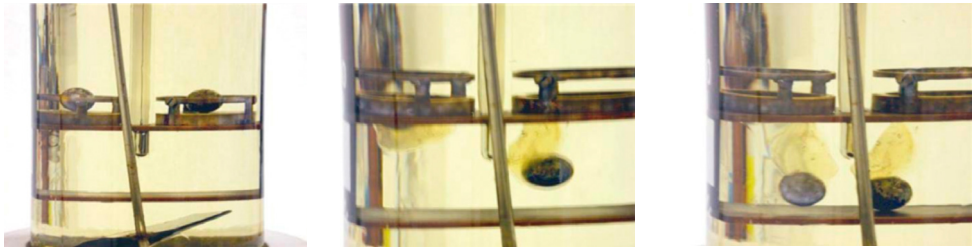


Figure 10. Test for the determination of the softening temperature

Phase 1: Two steel balls are placed on disks of solid adhesives
Phase 2: Heating causes the softening of the adhesives. The steel balls start falling through the disks
Phase 3: Both balls touch the plate at the base; at this point the temperature is recorded.

CRITICAL PARAMETERS FOR BONDING

Table 20

Parameter	Test method	Requiriment
Softening point	EN 1238	Declared value ± 10 %

Density

Density is defined as a volumetric mass: mass per volume unit.
It is measured at 23°C, calculating the ratio between the mass of a defined amount of adhesive and the mass of the same volume of a reference liquid of known density, multiplied by its volumetric mass.
The reference method is EN 542 "Adhesives – Determination of density".
Density is related to the adhesive's composition:
polymers of different nature have different densities and their respective adhesives formulated with mineral fillers have a higher density than those that do not contain them.
Adhesives formulated with the addition of mineral fillers are characterized by better filling properties which are especially useful in the case of edging of particularly coarse panels.

However, an excessive presence of mineral fillers, normally highlighted by a high-density value can compromise the adhesive and cohesive characteristics of the adhesive.
Finally, it should be noted that the presence of mineral fillers tends to reduce the economic value of the adhesive.

CRITICAL PARAMETERS FOR BONDING

Table 21

Parameter	Test method	Requiriment
Density	EN 542	Declared value ± 10 %

Open time

The open time is defined as the maximum time that can elapse between the application of the adhesive and the coupling between the materials that must be glued.
In the case of a hot melt adhesive, the open time depends on the cooling of the adhesive and the consequent increase in its viscosity up to the value at which it is no longer able to adequately "wet" the surfaces to be glued.
In the case of hot melt adhesives with a long open time, cooling causes a slow increase in their viscosity, allowing to carry out gluing over a relatively broad period of time. On the other hand, hot melt adhesives with a short open time are characterized by a rapid increase in their viscosity consequent to their progressive cooling after application. The time range within which gluing can be performed will be, therefore, reduced.
There is currently no criterion to objectify this parameter and therefore in this handbook can only be expressed in very general concepts, based on the experience of formulators.

Application parameters and selection criteria

Application temperature

Regarding the application temperature, it is suggested to refer to the technical data sheet of the adhesive. It is worth to verify the correspondence of the temperature of the adhesive on the spreading roller with that measured by the machine. If the two values differed by more than 10°C, a calibration of the machine is recommended.
To measure the temperature of the adhesive on the spreading roller, refer to paragraph 7.1.1.

In general, the values read for the adhesive present in the tank, in the melting tank and in the applicator (roller/slot) should vary within the following intervals, depending on the type of adhesive used:

PUR	120-150°C
PO	190-210°C
EVA	180-210°C

Assembling temperature

It is the temperature of the adhesive, measured on the panel surface before the assembling with the edge (near the first pressure roller).
For proper bonding it is recommended that the coupling temperature is greater than 15°C than the Ring & Ball value of the adhesive used.

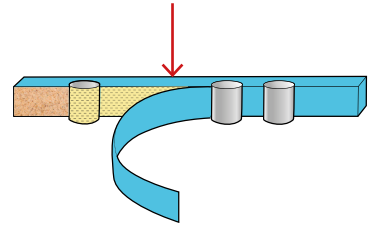


Figure 11. Position for measuring the assembling temperature

Intended use

The following table shows some of the general characteristics of the various types of hot melt adhesives. Water and heat resistance are decisive in the case of finished products intended for humid environments such as bathrooms and kitchens. The heat resistance also depends on the characteristics of the applied edge and in particular on its thickness.
Resistance to cold can represent a further criterion of choice especially where working steps on already edged panels are foreseen and possibly carried out in cold climates. Resistance to solvents is a relevant feature when the edged panel is possibly subjected to painting or to contacts with these substances during normal use (for example chemical laboratories).

Table 22

Type of adhesives	Water resistance	Heat resistance	Cold resistance	Solvent resistance
PUR	High	High	High	High
PO	Medium	Medium-high	Medium	Medium-high
EVA	Low	Medium-low	High	Medium-low

Table 23

Type of adhesives	Edge thickness			
	>2 mm	1÷2 mm	0,5÷1 mm	< 0,5 mm
	Heat resistance			
PUR	High	High	High	High
PO	Medium-high	Medium-high	High	High
EVA	Low	Medium-low	Medium	Medium-high

Features of the edgebanding machine

The following table shows the required characteristics of the edgebanding machine related to the various types of hot melt adhesives in use.

Table 24

Type of adhesives	Pre-heating of the panel	Nitrogen tank	Premelter	Machine speed (m/min)	Manual edgebanding for curved element
PUR	Recommended	Recommended	Recommended	3 ÷ 80	YES
PO	Recommended	Not necessary	Necessary	15 ÷ 80	NO
EVA	Recommended	Not necessary	Not necessary	3 ÷ 80	YES

3 Transportation, expiration, storage of materials

3.1. Edges

3.1.1. Wood and derivatives

Considering that wood is sensitive to climatic variations, edges made with this material must be stored in such a way that their moisture content is between 8% and 12%. These values are usually reached by conditioning the edges in a temperature range between 15°C and 35°C with a relative humidity between 40% and 65%. Particular attention should be paid to the edges with protective film applied on their surfaces. As a matter of fact, not complying with the recommended storage temperatures and any prolonged exposure to sunlight can alter the product.

3.1.2. Paper and derivatives

Paper-based products are sensitive to moisture and the packaging must include the use of a plastic bag. Storage must be carried out inside a proper box at room temperature and protected from direct solar sources. Respecting such conditions paper edges can last for 12 months.

3.1.3 Plastic (PP, PET, ABS, ABS-PMMA, PS e PVC)

Plastic edges must be stored between 15°C and 35°C protected from direct solar sources that could alter the product.
Storage at temperatures outside the indicated ranges could compromise the functionality of the primer and possibly alter the mechanical properties of the edge. Also for this type of edges, wrong storage can of protective film applied.
Use is normally guaranteed for 12 months from the date of production.

3.1.4. Aluminum

For this category, what has already been stated in point 3.1.3 applies.

3.2 Wood-based panels

Considering that wood is sensitive to climatic variations, panels made with wood must be stored in such a way that their moisture content is within the ranges specified by the relevant reference standards and reported in the tables of each paragraph describing these materials. These conditions are usually reached by conditioning wood-based panels in a temperature range between 15°C e 35°C and relative humidity between 40% and 65%.

3.3 Adhesives

3.3.1 EVA

Table 25

Transport	Avoid exposure to high humidity conditions
Expiry date	See the technical data sheet
Storage	Store in a fresh and dry place
Check before use	Absence of adhesive packing and/or water condensation

Figure 12. White EVA adhesive

Figure 13. Brown EVA adhesive

3.3.2 PO

Table 26

Transport	Avoid exposure to high humidity conditions
Expiry date	See technical data sheet
Storage	Store in a fresh and dry place
Check before use	Absence of adhesive packing and/or water condensation

Figure 14. Polyolefin based adhesives

3.3.3. HMPUR

Table 27

Transport	Avoid exposure to high humidity conditions; the packaging must be hermetic (air-tight).
Expiry date	See technical data sheet
Storage	Store in a fresh and dry place
Check before use	Packaging must be intact

Figure 15. Reactive polyurethane adhesives

4 Preparation of materials

4.1 Edges

The edge as supplied is ready for application, unless its storage complies with the conditions set out in point 3.1. Before use, it is advisable to check that the temperature and humidity are in the ranges specified at point 2.1.
If not, proceed with conditioning the edge in a suitable environment for at least 24 hours.

4.2 Wood-based panels

Before use, it is advisable to check that the panels have been conditioned in a temperature range between 15°C e 35°C and in a relative humidity between 40% and 65%.
In this regard, it is important to note that the first panels of the stack are in direct contact with the environment while the innermost ones remain more isolated. Such conditions can produce possible differences in their moisture content and temperature.

4.3 Adhesives

The adhesive as received is ready to be used in the edgebanding process. This is valid if its storage and its integrity comply with the conditions described in paragraph 3.3. Before use, it is advisable to check the operating parameters of the process, specified in paragraph 2.3.4.

5 Edgebanding process

The purpose of the edging process is to cover the side surface of a panel with materials of various kinds called “edges”.
As already mentioned in paragraph 1, the edging process can be basically divided into the following types:

5.1 Linear edging of straight panels

The automatic edging process of linear and squared surfaces is carried out with machines called linear edgebanders. These machines can have different level of complexity, depending on the processes and companies types they are intended for. The hot melt adhesive is normally applied on the panel whose surface must be perfectly parallel to the glue spreading roller. Then the edge is coupled and pressed to the panel by special pressure rollers.

Postforming

The ‘postforming’ term describes a process of bending covering materials, especially laminates (HPL) in order to cover the side surfaces of the panels, maintaining continuity with their faces. It is therefore a particular edging technique that allows to obtain aesthetically pleasing products, avoiding the creation of vulnerable points represented by the junction lines between the faces and that of the edges that could facilitate the permeation of water, humidity or dirt accumulation.
There are special machines called “post-forming machines” to carry out this process. They have lower or higher complexity depending on the process that must be carried out on the panel. The postforming process involves one or two sides of the panel. The remaining straight sides are edgebanded through the linear edgebanding machines.

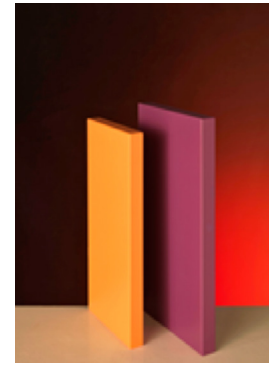


Figure 16. Linear edging of straight panels

5.2 Linear edging of shaped surfaces – soft forming

The technique called “soft forming” is used for the continuous application of edges on panels with a shaped profile.
The edges, which for these applications must be characterized by a certain flexibility and good mechanical resistance, are normally made of backed veneers, impregnated papers or low

Figure 17. Postforming examples

thickness plastic materials.
The process normally involves the application of the hot melt adhesive on the back of the edge or alternatively the use of pre-glued edges is also possible.
The pressure is applied by means of a series of shaped rollers, sequentially arranged with different positions and orientations, in such a way as to follow the profile along its entire design.

Figure 18. Shaped MDF panel (JPull type) for soft forming application

5.3 Edging of curved elements with manual systems

In this case, the edge application on the shaped panel is carried out with manual pressure. The panel advancement is manual too.

5.4 Edging of shaped panels with CNC

The edgebanding machines for shaped elements are named "CNC machining centers", being controlled by computerized systems capable of automatically managing all stages of processing.
These systems consist of a fixed worktable, on which the panel to be edged is placed, and a movable head equipped with the various tools and devices that perform the various functions required by the edging process.

Figure 19. Shaped panels

Figure 20. CNC edgebanding process

5.5 Liquids for surface treatment and edgebanders maintenance

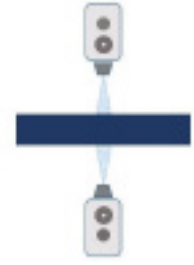
The edgebanding process can be defined as high quality, when at its end the edge is perfectly glued to the panel, the workpiece is completely clean, free of adhesive residual and ready for the next operations, without further processing. The adhesive excess coming out of the glue line, as well as being aesthetically unpleasant, can make the panels sensitive to bond to each other when they are stacked at the end of the machine, resulting in a loss of time and money for their reworking and subsequent

cleaning (strictly by hand). In the case of normal thermoplastic adhesives, they can be easily removed with suitable cleaners, while in the case of HM-PUR, manual cleaning may not be sufficient. Furthermore, adhesive residues do not allow the tools positioned along the machine to work properly and efficiently. The solution to this problem is to install an integrated spray system on the edgebanding machine.

Special liquids are so sprayed through dedicated nozzles, each with specific technical characteristics and specific functions (Release agent, Cooling/Antistatic agent and Cleaning agent) which, combined together, allow to obtain a high quality edgebanding process, with a total and effective cleaning of the panel. Along with their functionality, they keep all the machine components in contact with the panel (copying units, cutters, knifes, etc.) in the right condition, protecting them from wear and damage.

Figure 21. Correctly glued edge

5.5.1 Nozzles



These are specially engineered dispensing systems that ensure the correct application of liquids and optimize their consumption.
It is essential to choose compact nozzles, able to spray a minimum and almost imperceptible quantity of product, produced with high quality and durable materials, easy to maintain and resistant to dust and dirt.

5.5.2 Liquids

In order to guarantee the performance efficiency, it is necessary that the liquids are properly formulated with selected raw materials characterized by a quick drying, in order to avoid liquid residues on the panel, as well as to protect and safeguard the operators, materials and machines.
Furthermore, it is very important that they do not contain substances, which compromise the safety of the working environment and process performance.

The features of the various types of liquids are listed below:

1. **RELEASE AGENT:** is sprayed before the pre-milling unit on the top and bottom of the panel near the edge area. It creates an imperceptible film, preventing the adhesive from coming into contact with the panel.

2. **SLIDING AGENT:** is mainly used for edges with protective film, as well as to prevent unintended scratches on delicate edges. It keeps tools lubricated and in perfect condition. If sprayed onto the first pressure roller at regular intervals, it prevents the adhesion of the glue to the roller. In addition, the sliding agent is transferred to all pressure rollers by the edge advancing, keeping them clean avoiding any adhesive residue.

3. **ANTI-STATIC COOLING AGENT:** this liquid is sprayed immediately after the last pressure roller and just before the cross-cut saws, directly onto the adhesive line and the edge. It helps to cool down them quickly and drastically, allowing cutters, saws and copying units to work without the risk of sticking. The antistatic component removes the electrostatic charge from the edge chips during milling, so they will no longer stick to the workpiece or copying units.

4. **CLEANING AGENT:** it is sprayed before the flat scraper on the upper and lower side of the panel. Assisted by the buffing wheel, it helps to remove any residue of the previously sprayed liquids and any small residue of adhesive still present on the panel. It keeps the glue scraper knife lubricated and helps to polish the edge at the radius area, making it uniform to the surface.

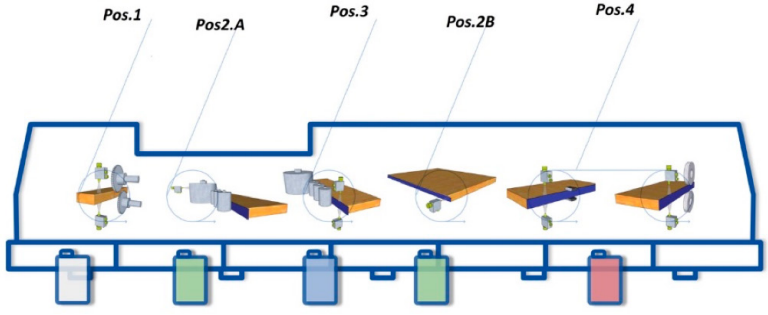


Figure 22. Setting and function of the main liquids

	Release Agent Position 1	Sliding Agent Position 2A + 2B	Anti- Static Cooling Agent Position 3	Cleaning Agent Position 4
Positioning within the machine	Prior to the pre-milling	2A: First contact pressure roller 2B: Prior to the cross-cutting saws	After the pressure zone and prior to the cross-cutting saws	Prior to the flat scraper and the buffing wheels.
Application area on the workpiece	Prior to the pre-milling an ultra-thin coat of the Release Agent is sprayed to the upper and lower edge area of the workpiece.	2A: with adjustable timer operation on the first pressure roller 2B: laterally to the edging material surface	Continuous application of a low amount of product to the upper and lower edge area of the workpiece, directly on the glue line.	Continuous application of a low amount of product on the top and bottom surface of the board edge, as well as the edgeband area
Properties	This prevents squeezed out glue from adhering to the workpiece.	2A: the glue adhesion to the contact pressure rollers is avoided. In addition, the special sliding agent is taken from the edge and transferred to the next contact pressure rollers, tools and anti-friction devices. The contact pressure rollers and the anti-friction shoes remain free of glue residue 2B: As result damage to sensitive edging material (Acrylic/ Aluminum) caused by the detection shoes is avoided.	The temperature of the adhesive is considerably reduced and consequently the glue line is hardened and no longer transfers on the tools, getting them dirty. Furthermore, the edging chips are statically discharged. Tracer rollers and workpieces remain free from milling chips.	Assisted by the subsequent activity of the buffing discs, it allows the total removal of any liquid previously applied and eliminates any more persistent adhesive residues. It also allows the polishing of the edge, making it uniform to the surface.

Buffing wheels

Fabric buffing wheels or Fabric-Sisal-Lamellar wheels, in combination with the cleaning agent, polish the edge radius, making it uniform to the surface and remove any residual adhesive, if still present.

Figure 23. Buffing wheels adjustment

- approx. 3° inclined to the board (vertical)
- approx. 10° inclined to the support (if possible)
- approx. 1400 rpm motor speed (if possible)
- No oscillation
- Rotational direction in synchronous run

5.6 Classification of linear edgebanders

Linear edgebanders are by far the most used systems in the furniture industry, since the side surfaces of the panels are almost always straight and square. For this reason, Systems with various complexity level have been developed which can thus satisfy the different production needs of companies in this sector.

In principle, linear edgebanders can be divided into:

- Manual edgebanders
- Automatic edgebanders:

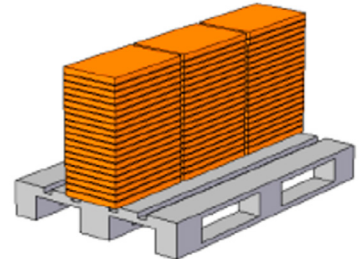


Figure 24. Edging of panels of equal size

For continuous batch production (edging batches of panels of equal size)

- Double-sided edgebanders (double shoulder)
- Double-sided squaring edgebanders (double shoulder)

The substantial differences between a double-sided edgebander and a squaring edgebander are related to the squaring module and the working speeds:

> Squaring edgebander:
Machines with high working speeds and high material removal.
The squaring module includes both the double hogger and the premilling unit, to ensure high material removal

> Double-sided edgebanders:
Machine with lower working speed and low material removal.

The squaring module only includes premilling unit.

- For flexible production "BATCH ONE" for edging panels with different dimensions.
  > Flexible single-sided edgebanders (single shoulder)
  > Flexible single-sided squaring-edgebanding machine (single shoulder)

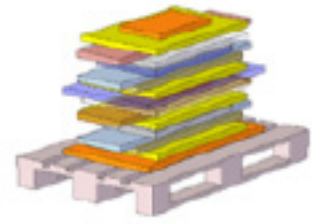


Figure 25. Edging of panels of different sizes

If the squaring module is added to the single-sided edgebander, there is a flexible single-sided squaring edgebanding machine.

- The Squaring Module is a system consisting mainly of:
- Feeding area with "dogs"
- Material removal groups:
  > Double hogger
  > Premilling

A single-sided edgebander is able to process one side of the panel for each step. To complete the four-sided machining, the process therefore requires four steps.
On the other hand, a double-sided edgebanding machine is able to edge two sides of the panel for each pass. To complete the processing, the process needs two steps.
The double-sided machines can be placed in line to be able to complete the panel processing on four sides in a single step.
In these cases, the systems consist of two edging stations called respectively:
> First of the line: usually works the longitudinal side of the panel
> Second of the line: usually works the cross side of the panel.
The linear edgebanders are equipped with a panel introduction area equipped with a panel advancement system ("dogs").
As the panel advances along the edging line, it encounters a series of operating groups which are described below.

5.6.1 Working groups

In order to allow the operating groups to carry out the required processing regardless of the dimensional variations of the panel and the edge, it is necessary that they are equipped with a copying system called "compensation", consisting of special movement mechanisms of the group that allow to follow the dimensional profile of the panel and edge.
The compensation can be defined as the maximum nominal displacement that each operator group is able to bear in order to remain adherent to the panel/edge system. The compensation value must therefore be greater than the dimensional tolerance of the edge thickness and that of the panel.

As consequence, when the dimensional variations of the panel or of the edge are greater than the compensation, the unit is not able to move and adapt to them (copy) and carry out the processing correctly for the entire length of the panel.
The compensation strength is the strength with which the copiers push towards the panel/edge.

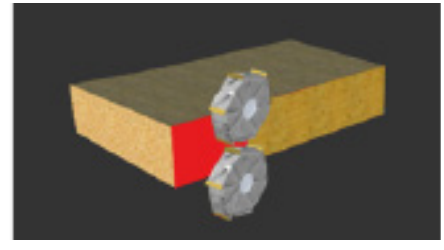
CHARACTERISTIC PARAMETERS OF THE COPYING SYSTEM

Table 28

Parameter	Property	Nominal reference value
Compensation	It must be able to compensate for the dimensional tolerances of the edge and panel	0,5 mm
Compensation strength	It must guarantee the contact of the copiers on the panel/edge	7-12 kg

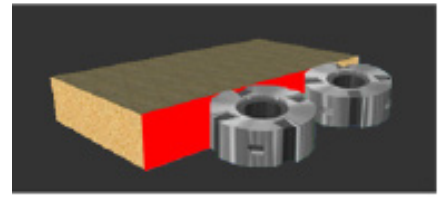
5.6.1.1. Double hogger

The double hogger consists of two horizontal motors, to which specific tools are coupled to remove large quantities of material from the side surface of the panel during the squaring process.



5.6.1.2 Premilling unit

The premilling unit consists of two vertical motors with specific cutters for small material removal from the side surface of the panel. The premilling process aims to make the surface of the panel perfectly smooth, in preparation for the next gluing phase.



The premilling units are generally of 2 types:
- Without copiers

They are used to make the square of the panel; they are unable to copy the panel profile.
- With copiers

Figure 26. Premilling unit without copiers

They cannot make the panel square, but they are able to copy the panel profile.
The choice of premilling is driven by the furniture manufacturing process and the type of machine.
Example:
- Nesting → squared panel → flexible single-sided edgebander → premilling with copiers (to remove material by copying the square of the panel)
- Sizing → non-squared panel → Flexible single-sided squaring-edgebander → premilling without copiers (to remove material and make the square).

Figure 27. Premilling unit with copiers

Tools are generally of two types:
- Symmetrical

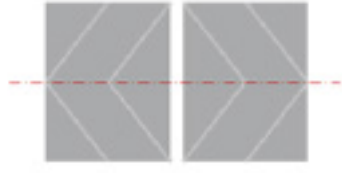


Figure 28. Symmetrical tools

These tools have a mirror orientation of the knives and the axis that identifies the inversion of the inclination of the cutting edges is an axis of symmetry (in the center of the cutter).
The symmetry axis must coincide with the center of the panel.
The adjustment of the position of the symmetry axis must be performed every time the height of the panel changes.
These tools are particularly recommended for processing postformed panels because they allow to have, for any height of the panel itself, the cutting forces in the "incoming" direction, thus avoiding chipping problems in the postformed area.

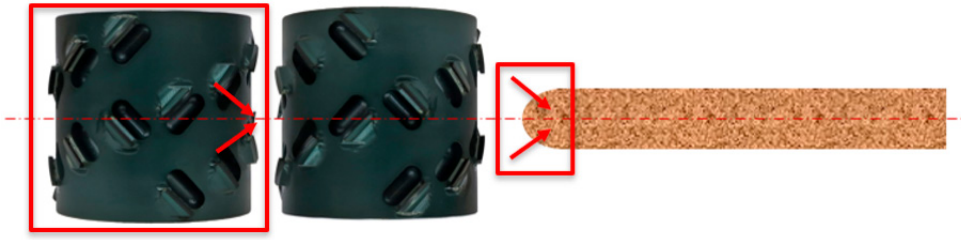


Figure 29. Symmetrical tools for processing postformed panels

- Asymmetrical

  Unlike symmetrical tools, the axis that identifies the inclination inversion of the cutting edges is not in the center of the cutter, but much lower.

  Normally a row of cutting edges is located under the axis and all the others are above.

  These tools do not need to adjust the position of the symmetry axis (fixed position).

  The tool life is longer (less wear over time), but they have height limitations of the postformed panels that can be machined.

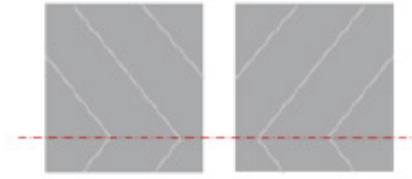


Figure 30. Asymmetrical tools

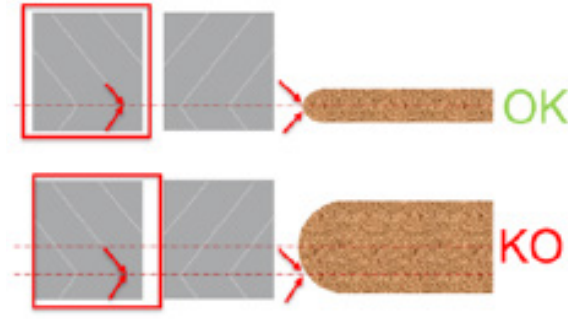


Figure 31. Asymmetrical tools on postformed panels

CHARACTERISTIC PARAMETERS OF THE PANEL PREMILLING

Table 29

Parameter	Property	Nominal reference value
Number of tool cutting edges (Z)	They must ensure a perfectly straight cut line	Z2 for feed rate ≤ 20 m/min Z3 for feed rate 20 < v ≤ 30 m/min Z4/Z6 for feed rate > 30 m/min

The cutters are usually made of diamond and can be sharpened more than once. The number of times a cutter can be sharpened depends on its composition and the percentage of diamond dust present in.

5.6.1.3 Gluing

The gluing unit that includes the edge loading area, the application of the adhesive and the pressing is the real heart of the edgebander, as it represents the functional group that allows the edge to be bonded to the panel.

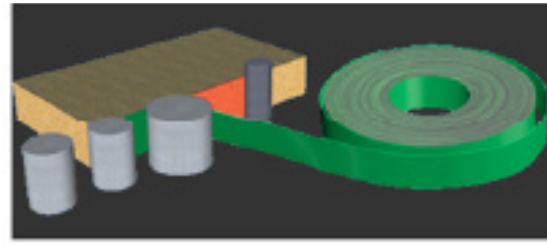


Figure 32. Gluing unit

Edge loading area

The edge loading area can be "single", i.e. consisting of a roll holder surface (coil) and an edge loading track or "multiple", when it consists of a coil magazine (storing unit) and multiple edge loading tracks (2 - 6 - 12 - 24 - 48 - 96 positions).
This second option allows both not to interrupt the edging process to change the coil if it is over, and to quickly change the production (for example the colour of the edge).

Adhesive application device

As for the gluing system, the gluing unit can be equipped with one of the following devices for applying the adhesive:
a. Glue spreading roller

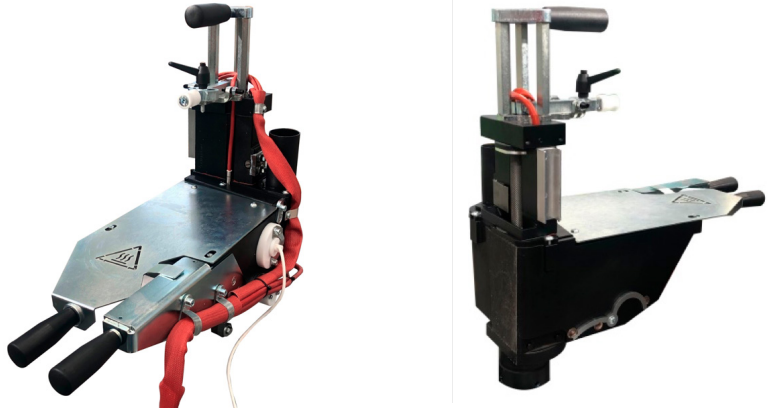


Figure 33. Glue spreading roller fed from the pot (from below)

The roller can be smooth or knurled.
The depth of the knurling is variable and is chosen according to the adhesive to be applied and the working speed of the machine.
For polyurethane adhesives, the knurling is normally less deep than that adopted for EVA and PO adhesives, as the amount of glue applied is lower.
The following values can be indicated:

- the knurling for HMPUR adhesives allows to apply quantities between 90 and 150 g/m^2
- the knurling for EVA/PO adhesives allows to apply quantities between 150 and 300 g/m^2.

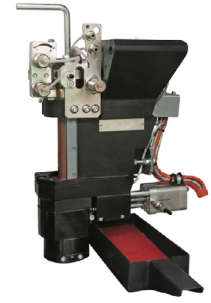


Figure 34. Glue spreading roller fed from the top (gravity feeded)

The amount of adhesive to be spread on the panel is regulated by the opening of a device – glue gate/blade – which can be adjusted manually or automatically.

b. Slot

The slot is an "on demand" adhesive spreading system equipped with an adjustable gluing gate/blade and powered by an external melting unit. The slot system is mainly used with HMPUR adhesives and guarantees a thin and homogeneous adhesive layer.
Traditional gluing systems with both rollers and slots can be equipped with a pre-melter, with the aim of having the adhesive always ready at the temperature of use.
The pre-melters can be installed directly above the tank / head containing the adhesive, or they can be systems external to the machine.
In the latter case, the adhesive reaches the tank / head via heated pipes.

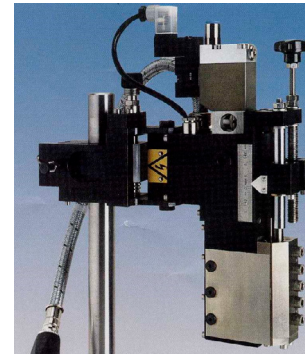


Figure 35. Slot

Energy transfer gluing system

The energy transfer gluing systems allow gluing without the addition of adhesive during the application of the edge and the aesthetic result is called "zero joint".
The edges used with this technology are characterized by an adhesive functional layer, which is melted by an energy source and then, pressed to the panel.
The energy sources used can be of different type.
The most common are the following:

> Laser (diodes)

The physical principle recalls the optic laws, in which the beam of coherent laser light is incident to the edge. A part of the ray is reflected and diffused, a second part passes through the material and a third part is "absorbed", converted into heat, thus allowing the instantaneous melting of the polymer. Since the polymer is transparent, specific absorbers (activators) are used for the laser which allow to limit the necessary power for the process.

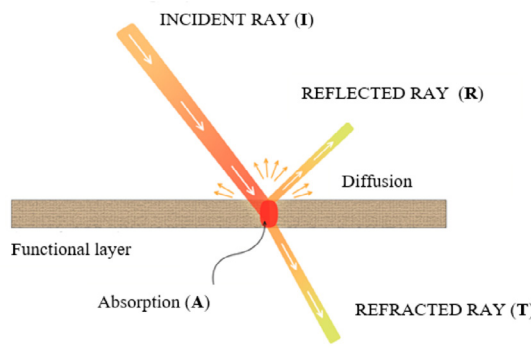


Figure 36. Schematic of the interaction between laser beam and edge

> Hot Air

Hot air edgebanders work the same way as laser edgebanders, with the difference that the back of the edge is melted through hot air nozzle. For this reason the presence of activators in the edge is not necessary differently from the laser technology..

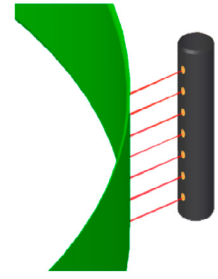


Figure 37. Schematic diagram of the operation of the hot air nozzle

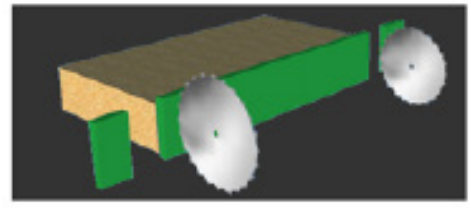
Pressure rollers

In the edging of straight panels, in the area of the pressure rollers there is always a first large cylindrical roller followed by conical rollers of reduced diameter which press the edge to the panel. The pressure applied by the rollers can be spring or pneumatic, adjusted accordingly the thickness of the edge. For edges up to 1 mm an indicative pressure of about 3 bar is applied, while for edges with a thickness greater than 2 mm the indicative pressure is about 5 ÷ 6 bar. Even with solid wood strips, a pressure of more than 5 bar is applied.

The pressure for thick edges (greater than 1.5 mm) can be reduced to 3.5 ÷ 4 bar if the temperature of the glue line immediately before the pressure roller is at least 20°C higher than the softening point (Ring & Ball) of the adhesive used. In case of double shoulder machines, pressures even higher than the nominal 5 bar can be used.

5.6.1.4 End trimming unit

It is a working station consisting of one or two motors, with respective blades, for cutting the excess front and rear edge. The blades are able to cut both roll edges and solid wood of various thicknesses.



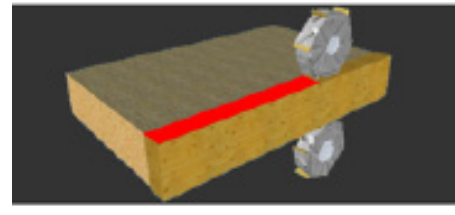
CHARACTERISTIC PARAMETERS OF THE END TRIMMING PROCESS

Table 30

Side of the panel	Edging material		
	Thin edge	Thick edge	Solid wood
Long side	Blade inclination angle = 1 ° approximately Flush cut (no excess edge)	Blade inclination angle = 1 ° approximately Flush cut (no excess edge)	Blade inclination angle = 1 ° approximately Flush cut (no excess edge)
Cross side	Blade inclination angle = 15 ° approximately Flush cut (no excess edge)	Indifferent blade inclination angle Cutting with excess edge (material is needed for next process with rounder)	Blade inclination angle = 1 ° approximately Flush cut (no excess edge)

5.6.1.5 Rough trimming unit

The working station carries out a rough trimming process in the case of the application of roll edges and a finishing process in the case of solid wood edges. The trimming unit consists of two horizontal motors equipped with specific tools capable of removing the excess of the upper and lower edge.

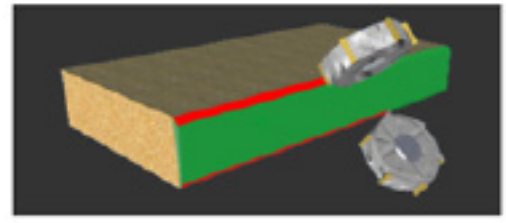


The amount of residual material depends on the edge:

- Solid wood edge: finishing panel processing → top edge overhang = bottom edge overhang = 0 mm (practically nil)
- Edge in coil: processing with top and bottom edge excess → top edge overhang = bottom edge overhang = approx. 2 mm

An excess of 2 mm can be considered an optimal value for the next process carried out by the fine trimming station.

5.6.1.6 Fine trimming unit



This unit, placed immediately after the rough trimmer, performs a finishing process in the case of thin edges (normally up to 0.5 mm thick) while with thicker edges (normally from 0.6 m to 3 mm) the finishing process is carried out afterwards by the edge scraper unit.
The fine trimming unit consists of two motors with specific tools capable of removing the top and bottom edge excess. The quantity of residual material must be the optimal one, that is 0.2 mm, for the subsequent processing carried out by the edge scraper unit.

CHARACTERISTIC PARAMETERS OF THE PANEL EDGING PROCESS

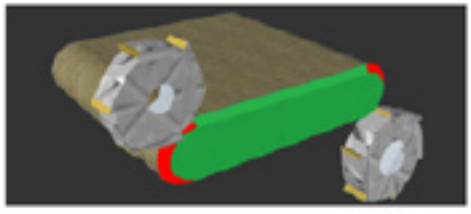
Table 31

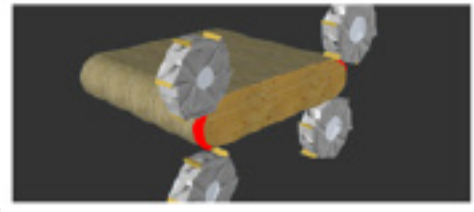
Parameter	Property	Nominal reference value
Number of tool cutting edges (Z)	Minimize the size of the hammering effect (cutter marks) caused by tool during the cutting process.	Z3 for feed rate ≤ 12 m/min Z3/Z4 for feed rate 12 < v ≤ 25 m/min Z6 for feed rate > 25 m/min

The cutting edge can be made of Widia (Wie Diamant) which consists of hard particles of tungsten carbide embedded in a metal or diamond matrix.

Widia cutting edges are usually inserts. When worn, the cutting edges are replaced with new ones, always using the same cutter body. The diamond cutting edges are brazed and, when worn, can be re-sharpened by the tool maker.
The number of times a cutter can be sharpened depends on the amount of diamond it contains.
Normally the edge quality of a tool with diamond brazed cutting edges is better than a tool with Widia insert cutting edges.
The duration of the sharpening of a diamond tool is also longer than that of a Widia tool.

5.6.1.7 Corner rounding unit





The unit carries out a finishing process with edges in coils. The corner rounding unit can consist of one, two or four motors with dedicated cutters that remove material at the four corners of the panel, in the area of the sharp edge of the tape which is therefore rounded at the end of the processing.
All polymer edges can be processed with one or two motors. In order not to chip the material, the wooden edges need to be worked with four motors, one for each corner and the direction of rotation is what tends to push the material towards the panel.

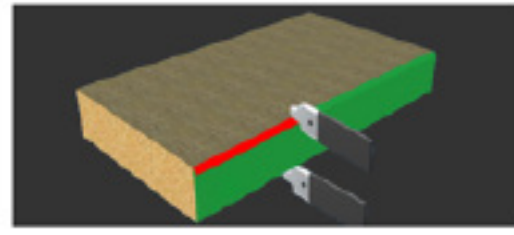
CHARACTERISTIC PARAMETERS OF THE PANEL ROUNDING PROCESS

Table 32

Parameter	Property	Nominal reference value
Number of tool cutting edges (Z)	Minimize the size of the hammering effect (cutter marks) caused by tool during the cutting process	Z3 for feed rate ≤ 12 m/min Z3/Z4 for feed rate 12 < v ≤ 25 m/min Z6 for feed rate > 25 m/min

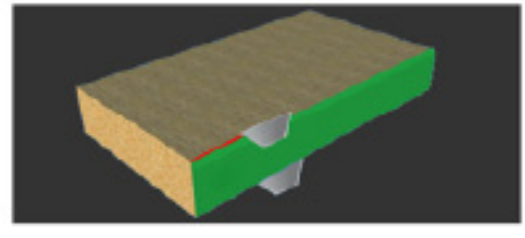
The cutting edge material can be Widia or Diamond.
Widia cutting edges are usually inserts. When worn, the cutting edges are replaced with new ones, always using the same cutter body.
The diamond cutting edges are brazed and, when worn, can be re-sharpened by the tool maker. The number of times a cutter can be sharpened depends on the amount of diamond it contains.
Normally the edge quality of a tool with diamond brazed cutting edges is better than a tool with Widia insert cutting edges.
The duration of the sharpening of a diamond tool is also longer than that of a Widia tool.

5.6.1.8 Edge scraper



The edge scraper unit performs a finishing process, in the case of edges in coil. It consists of two small knives capable of scraping the top and bottom edge excess previously left by the fine trimming. At the end of the processing, the surface of the scraped edge will be radiated and perfectly smooth and there will be no more edge excess than the panel.
As a negative effect, the edge scraper knife tends to "whiten" the edge during cutting (working flush with the panel).
The "radius" is the profile that the knife creates on the edge.
The radius is the result of the relative position between the lateral copier and the tool.
By moving the position of the lateral copier, it is therefore possible to create narrower or wider radii.
The cutting edge can be made of Widia or Diamond.
The duration of the sharpening of a diamond tool is longer than that of a Widia tool.

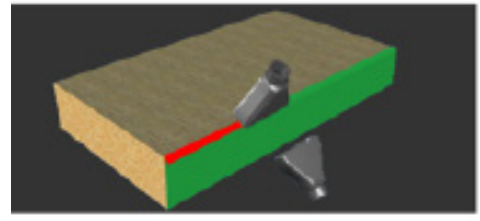
5.6.1.9 Glue scraper



The unit carries out a finishing process in the case of roll edges application. It consists of two slats (flat scraper) capable of removing the excess adhesive present at the top and bottom panel-edge joint.

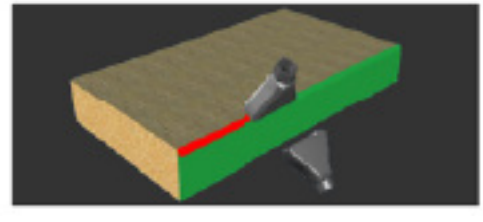
5.6.1.10 Buffers

The group carries out a finishing process, in the case of the application of roll edges. It consists of two motors equipped with special brushes which, combined with the cleaning liquid, clean and polish the surfaces machined by the previous working units.



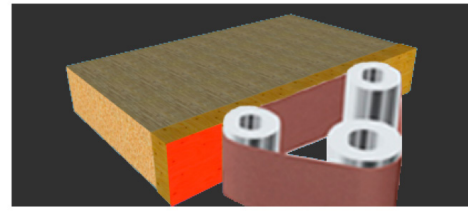
5.6.1.11 Hot air blower

The unit carries out a finishing process in the case of roll edges made of polymeric material. It is characterized by two heating elements, typically with hot air, which through heat revive the colour of the edge and tend to minimize the whitening effect possibly caused by the edge scraper.



5.6.1.12 Sanding unit

The group carries out a finishing process on the wooden edges. The unit consists of several motors and abrasive paper to smooth the front surface of the edge.



6 Quality control on edged panels

The test methods and related requirements prescribed for the evaluation of the bonding of the finished product are listed below. They are divided in two types: those that can be directly used in production and those that can be only performed in specialized laboratories.

6.1 Evaluation of the bonding strength at the end of the line

There is no standardized method for evaluating the bonding of edges at the end of the line.
The most used method, even if empirical, is a simple visual assessment which allows, in some cases, to assess the performance of the bond after a forced removal of the edge from the panel.
As already mentioned, the evaluation is visual and is essentially based on the amount of wood removed from the panel. Obviously, this assessment is possible only with some types of panels (for example particleboards) and edges (for example plastic edges).
The following figure presents three different cases resulting from the use of this methodology. The figure on the left shows an insufficient bonding, the one in the centre can be considered as a sufficient result and the last on the right reveals an adequate bonding.

Figure 38. Visual assessment of the gluing: not sufficient (left), sufficient (centre), adequate (right)

In the case of non-reactive hot-melt adhesives or edges that can be applied by reactivation with laser/hot air technology, this manual assessment is generally carried out by pre-conditioning the specimens at 23°C, 50% relative humidity for 24 h.
On the other hand, in the case of reactive hot-melt adhesives, it is advisable to carry out a first test at the end of the line, to estimate of the initial setting, and a second test at the end of the crosslinking reaction involving the adhesive (generally after 3 - 7 days), conditioning the specimens at constant temperature and humidity conditions (23°C, 50% r.h.).
A second more sophisticated method that can be

Figure 39. Portable dynamometer for the peeling test

directly used in production, provides quantitative results using a portable dynamometer, as shown in the following figure. The bonding strength is measured applying a progressive force to a flap of the edge previously detached and positioned at 90° with respect to the panel. There is currently no reference value, also because this data greatly depends on the type and characteristics of the panel, as well as on the edge type.

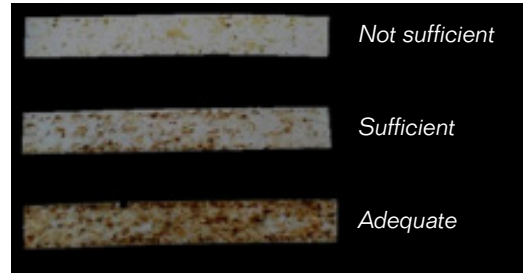


Figure 40. Visual assessment of the removed wood particles after the peeling test

This peeling method can be used as quality control, for the selection of raw materials and for the setting up of the production processes. For this last purpose it is possible to compare the results deriving from the test, varying one parameter at a time considering both the materials (for example: edges, adhesives or panels) and process parameters.

6.2 Evaluation of the bonding with laboratory tests

6.2.1 Adhesion test (UNI 9240)

To check the strength of the edge to the panel or, in other words, the adhesive and cohesive strength of the bonding performed, a pull off test can be performed verifying the force required to detach the edge from the panel.

Figure 41 and 42. Pull-off test - UNI 9240 standard

The test is performed by initially bonding specific metal cylinders (called dollies) to the surface under test.
Afterwards these cylinders are subjected to a traction force with a dynamometer, until they are pulled from the panel.
There are no official reference values but, generally, the result is considered positive with load values of at least 1.2 N / mm2. In addition to this established force, the effect caused by the pull-off stress on the bond is also evaluated. Where the adhesive detaches completely from one of the two surfaces, the actual effectiveness of the adhesion must be carefully considered. On the other side, the removal of wood particles, although minimal,

is normally considered as a positive result, especially in the case of particleboards.
This type of test can also be combined with a preventive aging cycle (conditioning in hot and cold environments) of the specimens.

6.2.2 Peeling test

To evaluate the bonding strength of an edge to the panel, it is possible to use the peeling test, even if there is no specific technical standard for edging. In any case, by analogy, it is possible to use the method described in the EN 28510 standard "Adhesives - Peel test for a flexible-bonded-to-rigid test specimen assembly - Part 1: 90° peel".

Adhesion test, peeling at 90°

Figure 43. The peeling test

Figure 44. Plastic edges after the peeling test

The peeling test can be effective, especially in the case of edges made of plastic material. The methodology is similar to that already described in point 6.1, provided that adequate laboratory instruments are available.
Obviously, the test must be performed only after the adhesive has completely set which, in the case of isocyanate-based ones, can last even several days.
The result of the peeling test can be considered positive with a value of at least 1 N/mm. As in the previous test, the presence of wood particles on the back of the edge that is torn during the test is considered a positive index in the case of particle board.

6.2.3 Resistance of the edges to heat according to UNI 9242 standard

The method consists at first in placing the test sample inside a ventilated oven at 40°C for 4 hours. At the end of this period, the bonding is visually examined and, if there are no alterations, the test continues by raising the temperature of the oven by 10 degrees.
The test method establishes to proceed up to the maximum temperature of 90°C or to interrupt it at the temperature at which a gluing defect is observed.

Figure 45. Samples after the heat resistance test

This handbook establishes that the heat resistance test is satisfied if at least 70°C is reached without observing any defects in the bonding of the edge to the panel (rating 5 at 70°C).

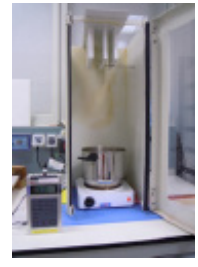
6.2.4 Resistance of the edges to water according to UNI 10460 standard

This standard defines a method to evaluate the effect of the occasional contact of water with the edges applied to the panels. The procedure establishes that the edged surface of a panel is placed in contact, for a certain time, with sponges soaked in water. At the end of the testing period, any alterations in the sample such as swelling and detachment are assessed. This handbook prescribes that the tested sample must reach, or exceed, the 60-minute test without showing any defects (level 3).

Figure 46. Resistance to water test

6.2.5 Edge resistance to water vapor AMK-MB-005 Mod. 1

Apart from for specific methods directly established by some internal company specifications, there are currently no specific standards providing for this type of solicitation. This handbook therefore takes as a reference the specifications of the German association AMK (Arbeitsgemeinschaft Die Moderne Küche) regarding kitchen doors.
The AMK-MB-005 Mod. 1 method provides for the exposure to water vapor of the edged samples under certain test conditions.



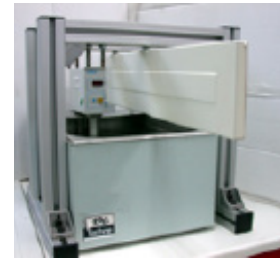


Figure 47. Amk test MB-005

Figure 48. Test according to the specifications of a furniture manufacture

This handbook establishes that, for furniture to be used in humid environments such as bathrooms and kitchens, it is advisable to carry out a test that includes 3 consecutive cycles of 30 minutes each, according to the procedure defined by this German specification, without the evidence of any kind of defect at the end of the test.

6.2.6 Edge resistance to climatic variations AMK-MB-005 Mod. 5

As there are currently no specific standards that provide for this type of solicitation, this handbook takes as a reference the specifications of the German association AMK (Arbeitsgemeinschaft Die Moderne Küche) regarding kitchen doors. The AMK-MB-005 Mod. 5 method establishes to expose the samples to a specific hygrothermal cycle inside a climatic chamber defining, for each of the 3 steps established for each cycle, the duration and the climatic conditions (temperatures and relative humidity). This handbook establishes that, for furniture to be used in humid environments such as bathrooms and kitchens, it is advisable to carry out a test that includes 10 consecutive cycles, with no evidence of defects at the end of the test.

7 Problems associated with the edging process

The problems associated with edging processes can be many. Both traditional systems and the most innovative energy transfer gluing systems can be subject to problems due to incorrect use and/or maintenance.

7.1 Traditional gluing system

7.1.1 Cleaning and servicing of the gluing unit

Traditional gluing systems generally consist of a premelter and/or an adhesive tank/head.

Premelter

The premelter can usually be the subject of the following problems:

- Adhesive char
- Possibility of chip contamination (chip removed by premilling)
- Worn or burnt adhesive
- Exhausted non-stick treatment for premelters with HM PUR adhesive

Figure 49. Example of an uncleaned premelter

What to check after the maintenance

After servicing the premelter, it is good practice to check the real melting temperature of the adhesive, by using immersion probes.

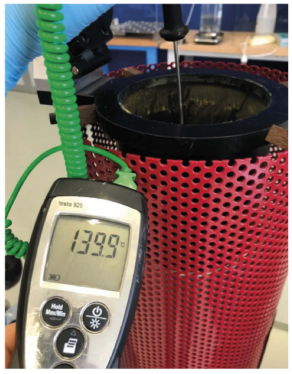


Figure 50. Immersion probe *Figure 51. Premelter control panel*

The adhesive temperature measured by the probe must correspond to the software parameters that can be viewed on the premelter control panel and/or on the machine control interface.

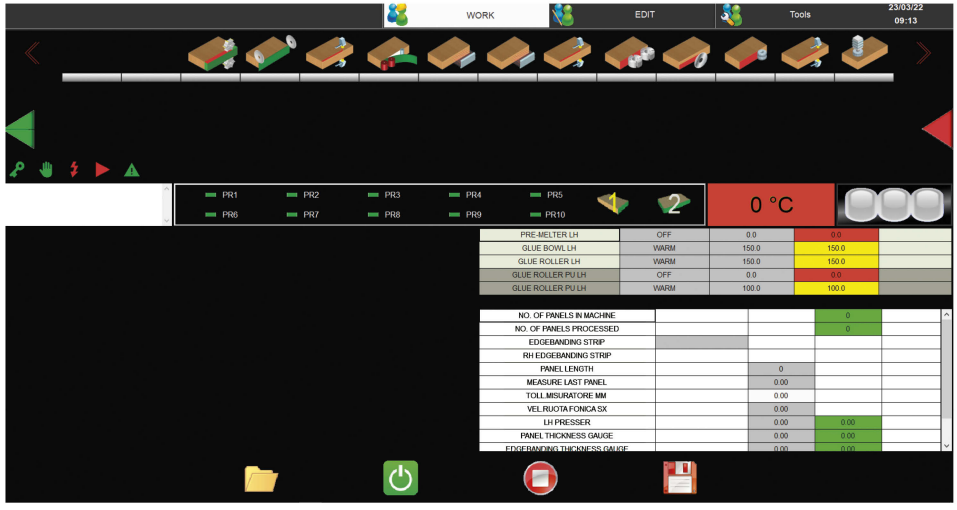


Figure 52. Melting parameters on the control of the edgebander

As an alternative to the immersion probe, special infrared thermometers or more sophisticated thermal imaging cameras can be used.
With these tools, however, the real temperature of the adhesive is not measured, but the temperature of the areas where the melting takes place (melting grid, resistors).

Figure 53. Infrared thermometer on the adhesive head

Procedure for using a laser pointer thermometer

The infrared thermometer detects the temperature on an average of the surface according to the distance of the sensor from the surface to be detected (25 @ 100 means that at a distance of 100 mm the temperature of a circular area with a diameter of 25 mm is detected).
The thermometer is also equipped with a laser indicator, which does not always correspond to the detection area (read the instructions for correct use).

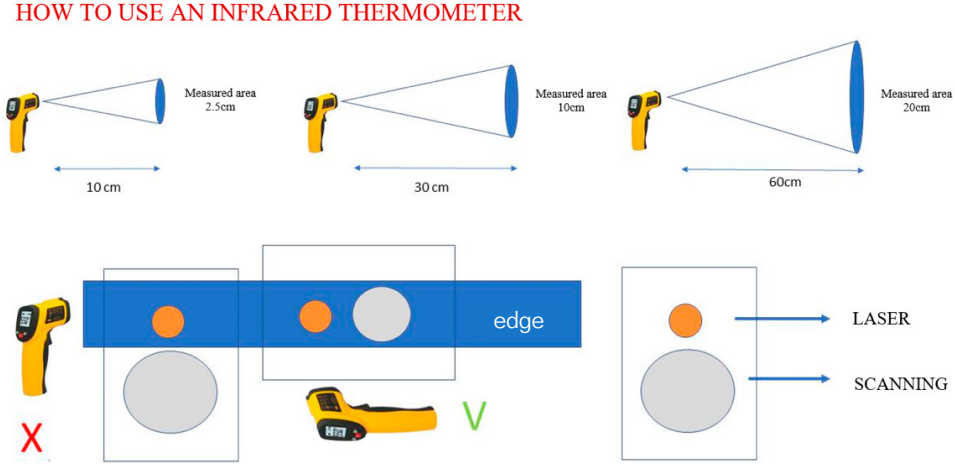


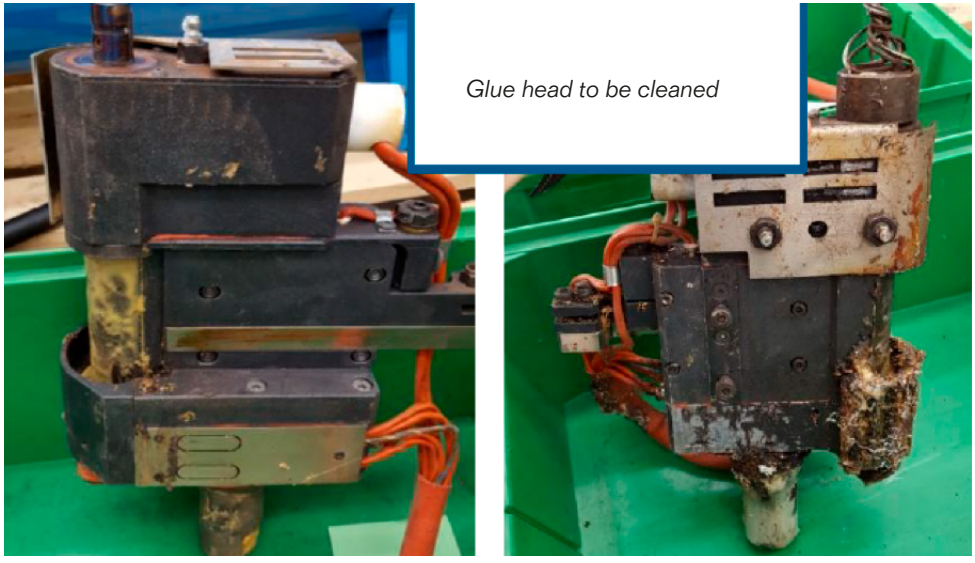
Figure 54. Procedure for using a laser pointer thermometer

If the temperature of the adhesive inside the pre-melter is too high, there is a risk of changing the adhesive's bonding properties, up to its burning point.
On the other hand, if the temperature of the adhesive is too low, there is a risk that the pre-melter will not be able to feed properly, the tank/head roller.

Glue pot/Glue head

The glue tank / glue head can usually be subject to the following problems:

- Adhesive char
- Inclusion of chip removed from premilling
- Worn or burnt adhesive
- Exhausted non-stick treatment



Glue head to be cleaned

What to check after the maintenance

After servicing the glue tank/ glue head it is good practice to check the real melting temperature of the adhesive. It can be done using immersion probes. The adhesive temperature measured by the probe must correspond to the values observed on the machine control interface.

Figure 55. Immersion thermometer for temperature control of the melted adhesive

Figure 56. Infrared thermometer for surface temperature control (not suitable for depth checks)

Figure 57. Set temperature

Figure 58. Detected temperature: difference between immersion thermometer and infrared thermometer

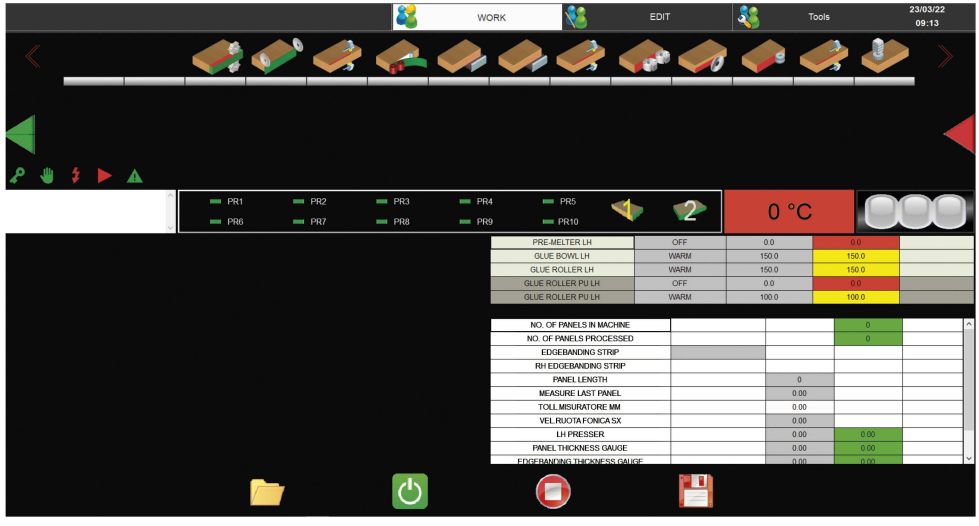


Figure 59. Edgebander control panel

If an immersion probe is not available, special infrared thermometers, or the most sophisticated thermal cameras can be used.
With these instruments it is possible to measure only the surface temperatures of the adhesive inside the glue tank or those on the glue head and on the applicator roller.

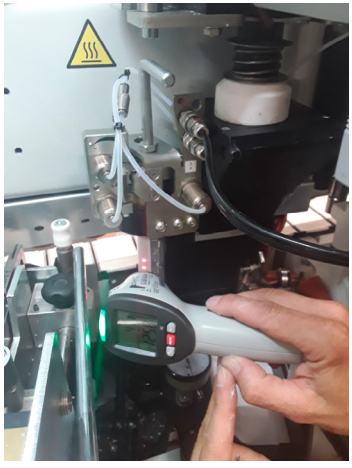


Figure 60. Infrared thermometer on the applicator roller

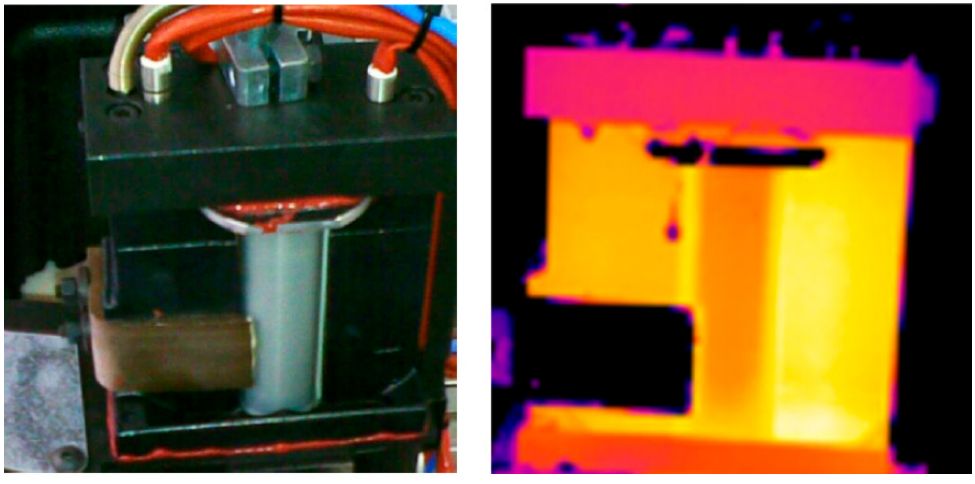
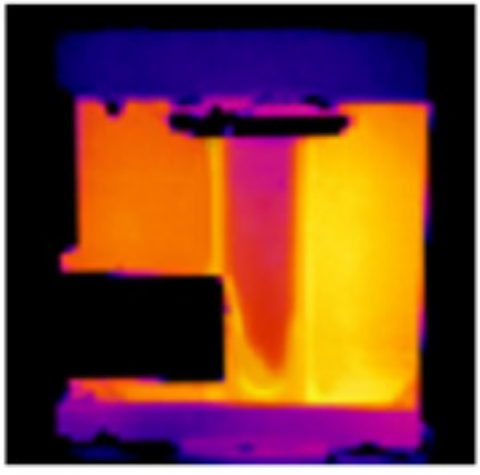


Figure 61. Image of the roller: left in grayscale; right thermographic

If the temperature of the adhesive inside the glue tank or glue head is too high, there is a risk of altering the adhesive bonding properties or even burning it.
On the other hand, if the temperature is too low, there is a risk that the roller will not be able to transfer the adhesive to the panel along its entire height and length, with consequent detachment of the edge.

Figure 62. Correctly fed applicator roller

Below two thermal images relating to two applicator rollers, one in perfect working conditions and the other not properly working.



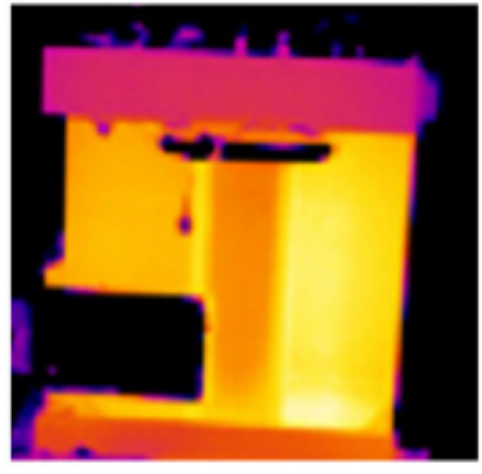


Figure 63. Thermal image of an applicator roller with incorrect software parameters or a non-functioning heating elements

Figure 64. Thermographic image of a properly functioning applicator roller

7.1.2 Other associated issues

7.1.2.1 Applicator roller alignment

To apply the adhesive correctly over the entire height of the panel, the roller must be perfectly square with the panel itself.
It is good practice to check this parameter especially in case of panels with thickness higher than 40 mm.

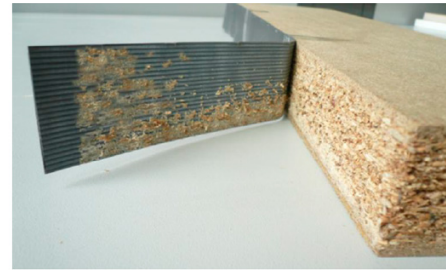


Figure 65. Example of an incorrect gluing with applicator roller not properly squared

7.1.2.2. Adhesive quantity adjustment

The quantity of adhesive spread on the panel is fundamental for a correct bonding.
An excessive or insufficient quantity can compromise the bond strength and create problems of an aesthetic nature (adhesive line too evident on the product).
To minimize the thickness of the adhesive line, we tend to use the least possible amount of adhesive, without compromising the bond strength.To optimize the quantity of adhesive, it is good practice to refer to the tewchnical data sheets and follow what is written in paragraph 6.1 of this handbook.

7.1.2.3. Pressure adjustment of the pressure rollers

The pressure applied by the pressure rollers must be properly adjusted to ensure what is called the "gluing closure". If the pressure is too low, the gluing closure is not sufficient and the edge could result partially separated from the panel.
If the pressure is too high, the bonding closure is guaranteed, but the edge can be excessively crushed with consequent plastic deformation.

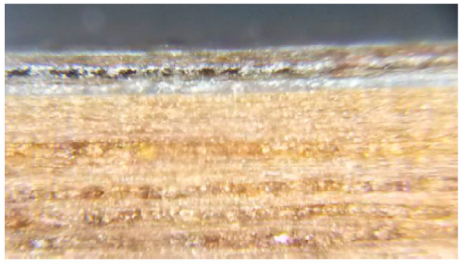


Figure 66. Insufficient pressure, adhesive line not closed

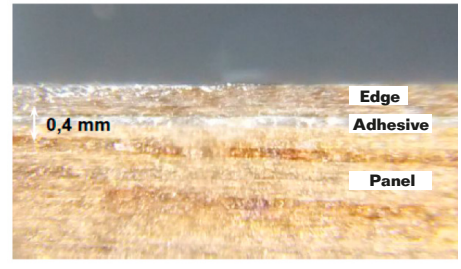


Figure 67. Correct pressure, adhesive line closed

7.1.2.4 Stability of the adhesive after long periods of inactivity

The time the adhesive can be left inside the glue head without cleaning operations is a determining parameter, especially when working with a polyurethane adhesive. If the idle time is long enough to trigger crosslinking, the glue head must be serviced.

Figure 68. Examples of glue heads with cross-linked polyurethane adhesive

As a rule, with the polyurethane adhesive it is recommended not to exceed a period of inactivity of three days (weekend). For longer periods, a cleaning agent must be used to inhibit crosslinking.
Three days is an average reference value and it depends a lot on the external conditions of temperature and humidity which are very variable in different areas and periods of the year.
It is therefore good practice, during inactivity, to place the glue tank / glue head inside the appropriate nitrogen tank.

Figure 69. Nitrogen tank to inhibit the cross-linking of the adhesive

7.2. Energy transfer gluing system

The energy transfer gluing systems have been developed with the aim of eliminating the glue line and, at the same time, reducing the maintenance required for traditional gluing systems.
However, energy transfer bonding systems can also be subject to problems.

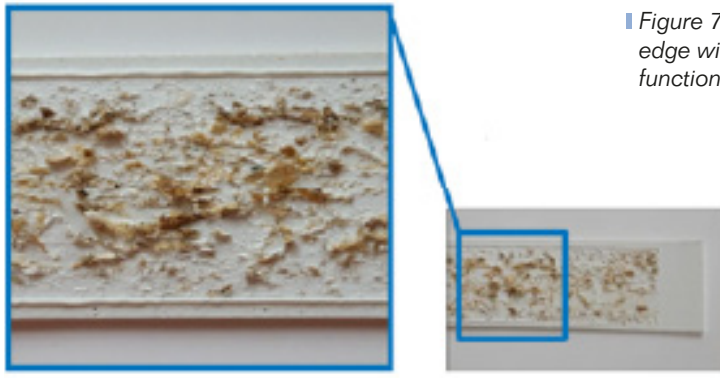


Figure 70. Example of an edge with a correctly cast functional layer

7.2.1 Too low energy

When the fusion energy is too low, the functional layer is not completely melted, and the polymer does not penetrate the panel. Consequently, the tear resistance is not good.
In most cases, bonding can be considered as good if the minimum tear strength value (peeling 90°) is 30 N/cm.

7.2.2 Too high energy

When the fusion energy is too high, the following problems can arise:
> Partial burning of the functional layer
> Detachment of the functional layer (delamination)
> Plastic distortion of the edge

Figure 71. Example of a delaminated functional layer

What to check

- Software parameters that regulate energy transfer
- System cleaning:
  > Control of the overall cleanliness of the system
  > Cleaning the cooling system
  > Check the condition of the cooling system
  > Cleaning the optics
  > Cleaning of tools and pressure zone
  > Use of antistatic liquids
  > Use of cooling liquids
  > Use of cleaning liquids (see paragraph 5.5)

7.3 Related processes

7.3.1 Hogger and premilling

The removal of chips by means of a hogger and/or premilling is essential for proper bonding, as it prepares the surface of the panel for the next application of the adhesive.
The main issues related with such process are listed below:

Blunt tools

Figure 72. Example of worn premilling tools

When the tools are not sharp the possible effects on the process are:
- Damaged "cutting line"

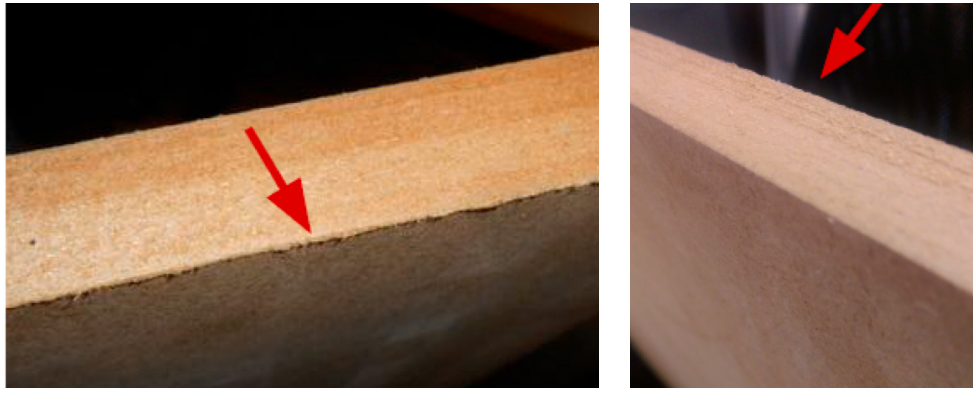


Figure 73. Example of a panel with a damaged cut line due to a worn tool

- "Step" on panel thickness change
  The step is the typical defect that occurs when some cutting edges are more worn than others. This happens when thin panels are processed for a long time and then we move on to work thicker panels.

- Orange peel in the case of thin edges

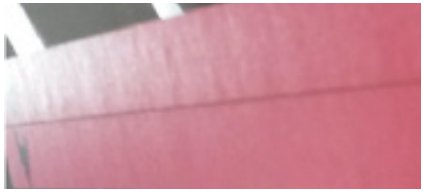


Figure 74. Orange peel effect

To reduce the orange peel effect, in addition to checking the sharpness of the tools, the pressure of the pressure rollers must be checked, which should not be excessive and the feed speed of the panel should be reduced. In addition, it may be useful to use a premilling tool with a greater number of cutting edges.
It is of fundamental importance to know the correct procedures to be performed following the replacement of tools.

The main ones are listed below:

> Check of the vertical square

Check of the vertical square to avoid:
- Gluing problems on thick panels
- Insufficient seal
- Imperfections on the finishing

Figure 75. Example of a 45 mm thick panel premilled with perfectly squared cutters

Figure 76. Example of a 45 mm thick panel premilled with non-squared cutters

> Check the alignment of the two premilling tools

If the two tools are not perfectly aligned, there is a lack of homogeneity in the material removal and the consequent defects are:

- Edge detachment
- Aestetichal imperfection

Figure 77. Example of premilled panel with perfectly aligned cutters

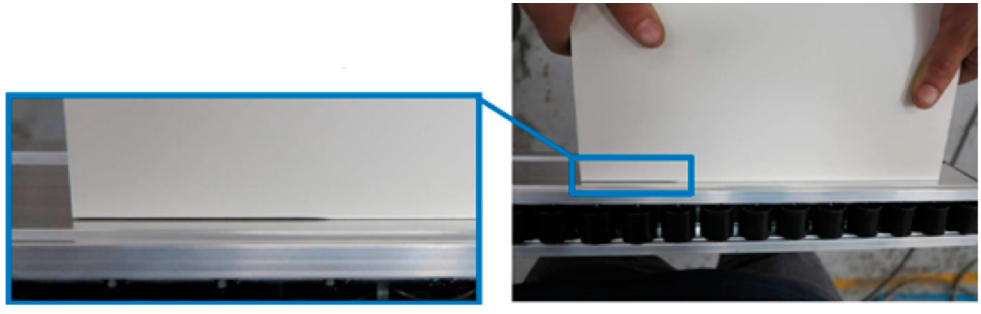


Figure 78. Example of rectified panel with not aligned cutters

> Check of the "working line"

The working line is the main feature of the edge banding machines and is the distance between the side surface of the panel and the track support. The working line can be measured with a caliper.

The copying (compensation) of the working groups is adjusted after the working line of the machine has been adjusted.

If the working line varies, the copying (compensation) of the groups varies accordingly. To have a constant finish of the machining it is essential to have a constant copying of the working groups. Knowing how to find the working line after the replacement / sharpening of the premilling tools is therefore fundamental.

- Poor copying (compensation): The front copier cannot follow the profile of the panel.
- Excessive copying (compensation): the front copier impacts excessively with the edge, causing crushing defects called “whiskers”.

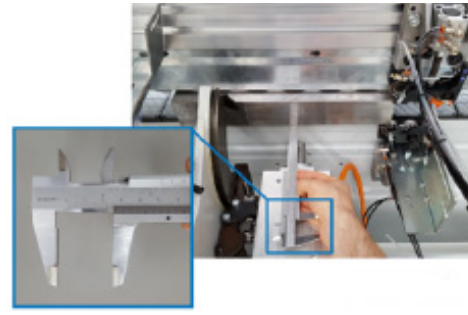


Figure 79. Example of measurement of the working line: distance between the side surface of the panel and the track support measured with the caliper

7.3.2 Finishing units (fine trimmer, corner rounder and radius scraper)

The correct gluing of the edge to the panel can be nullified by the incorrect processing of the finishing units for edge trimming, rounding and edge scraper.
The following are the main issues regarding the finishing units.

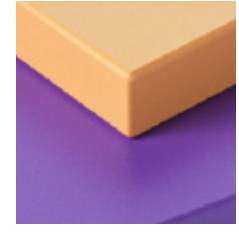
> **Worn tools**

> Excessively worn tools lead to:

- Low quality of the profile made on the edge
- Excessive "beats" (cutter marks of the fine trimming cutter) that the edge scraper is unable to remove during the scraping phase.

Figure 80. Example of correctly sharpened tools

Figure 81. Example of a perfectly worked edge without “beats”



The correct procedures after replacing the tool are related to checking the setting of the working units:

- Edge overhang adjustment
- Tool radius adjustment
- Adjusting the copying (compensation) of the copiers
- Check the alignment of the knives

7.3.3 Unsuitable suction

The quality of the chip extraction system can heavily influence the machining quality of the operating units.

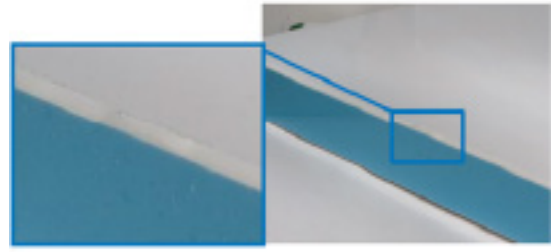


Figure 82. Example of profile irregularities due to chips under the vertical tracer

The consequences of incorrect suction can be:

> Low quality process
If the chip not properly sucked is deposited between the vertical copier and the panel, the copying process is distorted and the quality of the machining is consequently compromised.

> Insufficient edge / panel adhesion
If the premilling chip is not properly sucked, it remains attached to the panel and does not allow proper adhesion.

7.3.4 Materials with high gloss finish

High gloss edges, often covered with protective film, are more difficult to machine than standard edges.
The main problems are:

- The front copiers can remove the edge film and scratch it
- The film, if removed, risks to affect the quality of the process if it remains between the knife and the edge surface and/or between the copier and the panel surface
- The edge, after being scraped, loses its glossy appearance and bleaches

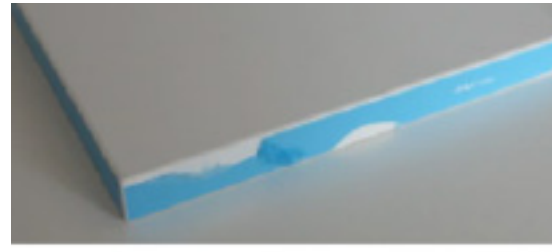


Figure 83. Example of edge with the protective film removed from the front copiers of the corner rounder

The possible solutions are:

> Use the anti-whitening edge scraper knives
> Use hot air blower to revive the colour
> Reduce the feed speed of the panel
> Choose a machine with belt presser and not with wheels
> Use sliding liquids (see paragraph 5.5)

Annex 1

Method for determining the edge thickness

Instrument

The instrument suitable for measuring the thickness of edges in paper, plastic material, aluminum or wood is the micrometer with a cylinder reading surface and 0.01 mm precision. In addition to the analog ones (see photo) there are also others with reading in digital format.

Method

The procedure for checking the thickness of an edge is as follows:

- Perform at least 3 measurements on the edge being tested in different positions.
- Estimate the arithmetic average between the different measurements
- Compare the result with the value declared in the manufacturer's technical data sheets

When measuring it is important that the edge is straight and has no curvature.

(+) Follow the recommendations of the manufacturer of micrometer for tool calibration and for cleaning the contact points.
Keep the instrumentation calibrated and clean.

Annex 2

Method for determining the edge width

Instrument

The tool suitable for measuring the height of edges in paper, plastic, aluminum or wood is the caliper with 0.01 mm precision. In addition to the analog ones there are also others with reading in digital format (see photo).

Method

The procedure for checking the width of an edge is as follows:

- Estimate the arithmetic average between the different readings
- Compare the result with the value declared in the manufacturer's technical data sheets

It is important that, during the measurement phase, the edge is straight and has no transverse curvature.

(+) Follow the recommendations of the caliper manufacturer for tool calibration and for cleaning the contact points. Keep the instrumentation calibrated and clean.

Annex 3

Method for the determination of the longitudinal distortion

Instrument

The instrument suitable for measuring the longitudinal distortion of edges in paper, plastic material, aluminum or wood is the caliper with precision 0.01 mm. In addition to the analog ones there are also others with reading in digital format (see photo).

Method

The procedure for verifying the longitudinal distortion of an edge is as follows:

Place the 1-meter-long edge in a flat position, approached at the extreme points to a straight line. Longitudinal distortion is the range (H) of the edge from the straight line

- Perform the measurement on 3 different edge pieces, one meter long, of the same coil being tested.
- Estimate the arithmetic average between the different readings
- Compare the result with the value declared in the manufacturer's technical data sheets

(+) Follow the recommendations of the caliper manufacturer for tool calibration and for cleaning the contact points; keep the instrumentation calibrated and clean.

Annex 4

Method for determining the edge convexity

Instrument

The instrument suitable for measuring the convexity of edges in paper, plastic material, aluminum or wood is the caliper with a resolution of 0.01 mm. In addition to the analog ones, there are also others with reading in digital format (see photo). The edges that may be difficult to bond due to convexity problems are, normally, those thicker than 0.7 mm.

Method

The procedure for checking the convexity of an edge is as follows:

- A Compliant
- B Compliant
- C Compliant providing that:
  - > Perform at least 3 measurements (see procedure below) on the edge being tested, in a different position
  - > Estimate the arithmetic average between the different readings
  - > Compare the result with the value declared in the manufacturer's technical data sheets

MEASUREMENT: initially measure the nominal thickness of the edge, using the caliper and applying enough force to make it flat (see image 1). At the same point, carry out, subsequently, an overflow reading of the edge always with the same caliper (see image 2). The difference between the two values is the convexity data.

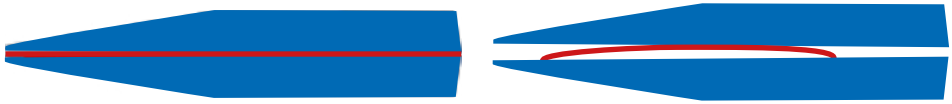


Image 1. Edge made flat between the two planes of the caliper

Image 2. "Overflow" measurement between the two planes of the caliper

In case of doubts or in any case of need to perform the measurement of the convexity of the edge with greater reliability, other methods can be used. One of these involves the use of advanced vision systems (optical microscope), with suitable measurement software.

The determination is carried out on the appropriately recorded image, by drawing a line (a) between the two extremes of the edge and measuring the distance (b) between this line and the center of the edge itself (see image).
Also in this case it is advisable to perform three measurements on different positions, obtaining the result as an average value.

(+) Follow the recommendations of the caliper manufacturer for tool calibration and for cleaning the contact points. Keep the instrumentation calibrated and clean.

GLOSSARY

A

ABS:
acrylonitrile-butadiene-styrene is the most widely used thermoplastic polymer for edges production. Its main features are its easy workability, its lightness compared to other polymers and its impact resistance. It is a product that can be recycled.

ABS-PMMA:
the edge is obtained from the coextrusion of ABS (acrylonitrile-butadiene-styrene) as a support and PMMA (Polymethylmethacrylate) on the surface. The characteristics are the high transparency and gloss. The surface is easily scratched if not protected with an appropriate coating material.

C

Corona treatment:
is a high-frequency electrical discharge to a surface. The purpose of this treatment is to add chemical bonds to materials to increase their wettability (surface energy measured in mN/mm). It is normally used in plastics to increase their surface energy, which is usually very low.

E

Edgebanding:
is the lamination operation of the side surfaces of panels. It is carried out at industrial level, using automatic and semi-automatic plants, called edgebanding machines, with edges of various materials (plastic, wood, cellulose, metal) bonded with hot melt adhesives or applied with other technologies.

Edge bonding:
it is the assembly process aiming to laminate the side surfaces of panels by using an adhesive

Extrusion (co-extrusion):
extrusion is the industrial process used to produce the plastic base used for the manufacture of edgings. This is done by melting the polymer and then extruding it from a die that determines its dimensions. Co-extrusion is a variant of the extrusion process that allows the use of different materials that come out of this process perfectly matched without the use of glues.

K

Knurling:
is a production process that consists of knurling a metal surface. Knurling is generally carried out on a lathe, using a tool called a "knurling wheel", which simply cuts lines on the workpiece without removing the chip. There are also cut knurling wheels that can be used with a wider range of materials, allowing a better finish.
In the edgebanding process, knurling is used for knurling the adhesive coating roller. The knurling pitch varies according to the adhesive to be processed by the coating roller. There are coating rollers for EVA adhesives (typically with knurling pitch (1.2-1.5 mm) and coating rollers for PUR adhesives (typically with knurling pitch (0.8 -1mm).

M

Mineral fillers:
are naturally occurring inorganic substances in powder form of various particle sizes which are added to adhesives as fillers.

N

Nesting:
in the wood sector, nesting is a panel cutting process that allows the total surface area of the panel to be processed to be exploited. The cutting shapes can be rectangular and/or square (as in the cutting process of nesting), but also shaped. As the panel is stopped by a vacuum, milling or vertical holes can also be made in the panel.

NW:
is the generic term to indicate an industrial product called "non-woven fabric". Generally obtained from pure cellulose fiber, it is used as a support in the production of single-layer wood edges. Its coupling with vinyl or polyurethane glues allows the edge itself an easier and safer workability.

P

Pawls:
the pawl is the mechanical element used in the squaring module of edgebanding machines. The pawls are a system of adjustable mechanical stops that allows the panel to be fed into the edgebander to create the squaring ratio through the removal of chips by the grinder and/or the double cutter.

Plasma treatment:
the plasma technique also called APP, Atmospheric Pressure Plasma is another technique used to improve the surface energy of materials. In a nutshell, these devices ionize gas inside a special chamber due to the high potential difference between two electrodes. The plasma thus generated is then pushed outwards by the pressure of a gaseous jet and directed towards the surface to be treated.
In addition to air, APP systems can also use other gases, allowing the effects of treatment to be modified and balanced.

PVC:
polyvinyl chloride is a very stable and safe polymer at room temperature. It is extremely dangerous if burned or heated to high temperatures and in plants not suitable for its treatment. This is causing its gradual abandonment in use for the production of edgings.

PET:
polyethylene terephthalate is a thermoplastic polymer. In the furniture industry it is mainly used for the production of surface materials. Not often used in edging products.

PP:
is a thermoplastic polymer called Polypropylene. It is a product that is slowly developing in the production of edging products. It has excellent surface chemical resistance even without being protected by coating. On the other hand, since it needs to be used with a high amount of mineral fillers, it has a high specific weight.

PS:
polystyrene. Thermoplastic polymer in the past less expensive than ABS but much more fragile.

Acknowledgements for outstanding cooperation in writing the handbook:

Alberto Barbina – FANTONI S.p.A.
Marco Bernardini – DURANTE ADESIVI S.p.A.
Alberto Bottoli – GRUPPO MAURO SAVIOLA S.r.l.
Andrea Bracci – BRATEK S.r.l.
Gianluca Brocchieri – PANGUANETA S.p.A.
Franco Bulian – CATAS S.p.A.
Claudio Caon – CATAS S.p.A.
Maurizio Carrer – TAKA S.r.l.
Alberto Casari – SITECH S.r.l.
Fabio Chiozza – VINAVIL S.p.A.
Giovanni Costa – GRUPPO MAURO SAVIOLA S.r.l.
Giorgio Cristofori – ALPI S.p.A.
Matteo De Carli – PLASTIVAR S.r.l.
Stefano Dissegna – TAKA S.r.l.
Lorenza Farina – ALPI S.p.A.
Patrizio Marozzi – GIPLAST S.p.A.
Stefano Monti – CLEAF S.p.A.
Franco Moroni – H.B. FULLER S.r.l.
Lorenzo Munaro – TAKA S.r.l.
Stefano Orio – BVR S.p.A.
Marco Pacini – BIESSE S.p.A.
Fabio Padoan – DURANTE ADESIVI S.p.A.
Carla Perugini – RIEPE GmbH
Luca Pevere – RIEPE GmbH
Stefano Romagnano – DURANTE ADESIVI S.p.A.
Daniele Setti – PLASTIVAR S.r.l.
Paolo Tirelli – CATAS S.p.A.
Ezio Valente – H.B. FULLER S.r.l.

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Assunta Tralongo – Federchimica Avisa
Roberta Lusiardi – Federchimica Avisa

For the photographic archive we thank the companies

- BIESSE S.p.A.
- BRATEK S.r.l.
- BVR S.r.l.
- CATAS S.p.A.
- DURANTE ADESIVI S.p.A.
- PCE ITALIA S.r.l.
- RIEPE GmbH & Co. KG
- TAKA S.r.l.
- URAI S.p.A.

Layout by Studio ABC Zone (Milan -Italy)

January 2022