(57) The invention relates to a process for gluing sheets of veneer in multiple layers one above the other and one behind the other to form LVL or plywood panels by curing the glue that is applied between the individual layers in a pressing process in a heated press. The invention consists of gluing and pressing the exterior layers of a layered package with high-temperature glue and the interior layers with low-temperature glue to form LVL or plywood panels, so that the heat applied to the layered package decreases from the exterior to the interior.
Abstract

The invention relates to a process for glueing sheets of veneer in multiple layers one above the other and one behind the other to form LVL or plywood panels by curing the glue that is applied between the individual layers in a pressing process in a heated press. The invention consists of glueing and pressing the exterior layers of a layered package with high-temperature glue and the interior layers with low-temperature glue to form LVL or plywood panels, so that the heat applied to the layered package decreases from the exterior to the interior.
Process for glueing plywood or LVL panels

Field of the Invention
The invention relates to a process for glueing plywood or LVL (long veneer lumber) panels.

Background of the Invention
LVL and plywood panels consist of sheets of veneer from 0.5 mm to 6 mm thick. Normally, phenol-formaldehyde glue is applied to the sheets of veneer, which are then layered and subsequently pressed together in a hot press where the glue is temperature-cured. Phenol-formaldehyde glue is a high-temperature glue that cures by condensation reactions in approximately 1 minute after reaching 110 °C. With temperatures lower than 110 °C, the condensation reaction takes a considerably longer time and is limited. Therefore, this kind of glued joint is less strong than when cured above 110 °C. If the curing reaction is controlled properly, the phenol resin conglutination results in a water resistant bonding which resists even boiling water. The plywood and LVL thus manufactured is weather resistant and can be used in structural areas. This glue is inexpensive compared to other glues with which these attributes can be achieved. Therefore, phenol-formaldehyde is almost always used for plywood and LVL that is destined to be used in structural areas.

Normally, plywood and LVL panels are up to 45 mm thick. The sheets of veneer and the glue are heated solely by conductance in the hot press. The heat is conducted by the pressure plates through the exterior layers into the interior layers. The heating time, i.e. the amount of time until the core of the panels reaches 110 °C, increases exponentially with increasing thickness of the panel due to the low conductivity of wood. For instance, if the panel’s initial temperature is 30 °C and the pressure plates’ temperature is 160 °C, the heating time is 5 minutes for panels 20 mm thick, 20 minutes for panels 40 mm thick and 120 minutes for panels 80 mm thick.

Various suggestions have been made about how to produce panels thicker than 45 mm in an economically viable time. Increasing the temperature of the pressure
plates to above 160 °C was shown to be disadvantageous because the wood is thermally degraded at temperatures above 160 °C and an application time in excess of 20 minutes. The strength of the panel decreases considerably through thermal disintegration.

In a known discontinuous production process, the panels are heated by high frequency in single or multiple level presses. The pressure plates are designed in such a way that they can be simultaneously heated and used as condenser plates. In this process, the temperature of the pressure plates is approximately 110 °C. The sheets of veneer are deposited on the lower pressure plate, pressed and subsequently heated by high frequency across the whole section of the mat. Numerous safety measures are required to operate a facility such as this. The press must be shielded. Transmission may only be carried out at certain frequencies. In addition, trained personnel are required during operation. Since the efficiency of the electrical energy is approximately 50 %, this type of heating results in high energy costs. Furthermore, if the local humidity of the veneer sheets is too high, electrical punctures and carbonization of the wood may occur. High frequency cannot be used for heating in a continuous production process, since continuous hot presses cannot be equipped with high-frequency heating.

According to DE 197 18 772, in a continuous production process, the veneer sheets are heated across the whole mat section by means of microwave radiation before going into the hot press. Several disadvantages are connected with the production of very thick panels by means of this process. Since the microwave is located several meters in front of the hot press, the glue may undergo precuring during transportation of the sheets of veneer from the microwave to the hot press. The precuring results in a weakening of the glued joint. Since the production speed decreases with increased thickness, this precuring also increases. Production stops can result in a considerable amount of precuring in the veneer sheets between the microwave and the hot press, which then become waste.
Up to a certain temperature and humidity combination, the wood is softened with increasing temperature and humidity. With a normal veneer humidity of approximately 8 – 10 %, the wood softens considerably at temperatures above 100 °C, whereby the softening can be increased up to approximately 140 °C. During the curing of the glue, the veneer sheets must be subjected to a minimum pressure of approximately 1.5 N/mm² in order to achieve contact over a large surface. The thickness of the veneer sheets is reduced due to the pressure during the pressing process (pressure shrinkage). With increasing temperature of the sheets of veneer, from a temperature of 100 °C, pressure shrinkage increases exponentially. With normal hot pressing of LVL and plywood panels the pressure shrinkage is approximately 10 %. Pressure shrinkage is normally undesirable, since more material must be used for a product of the same size. Another problem is the fact that in the finished panels, the compressed veneer sheets spring back somewhat due to swelling and contraction processes. This back springing causes uneven thicknesses in the panels and, in extreme cases, warping.

Another disadvantage of the conventional process is that during hot pressing, the temperature increases to over 100 °C, water evaporates and steam pressure builds up between the sheets of veneer. The steam pressure increases with the increasing humidity of the veneer sheets. If the steam pressure between the veneers sheets after leaving the press is greater than the strength of the glued joint, the panel will split open and becomes waste.

This splitting usually occurs in the core of the panel, since this layer is only heated at the end of the pressing process and has therefore had the shortest curing time and has the lowest bonding strength. Furthermore, in the exterior layers some of the steam can flow off through the panel surface after leaving the hot press, so that the steam pressure is reduced there.

**Summary of the Invention**

It is an object of the invention to efficiently produce thick LVL and plywood panels in such a way that supplementary heating by high frequency or preheating, for
instance, in addition to the conductive heating in the hot press, is no longer necessary.

In accordance with one aspect of the present invention there is provided a process for glueing sheets of veneer in multiple layers one above the other and one behind the other to form LVL or plywood panels by curing the glue that is applied between the individual layers in a pressing process in a heated press, characterized in that the glueing and pressing of the exterior layers of a layered package is carried out with high-temperature glue and the interior layers with low-temperature glue to form LVL or plywood panels, so that the heat that must be applied to the layered package decreases from the exterior to the interior.

**Detailed Description of the Invention**

According to the invention, the exterior layers of a layered package are conglutinated and pressed with high-temperature glue, and the interior layers with low-temperature glue, to form LVL or plywood panels, so that the heat applied to the layered package decreases from the exterior to the interior.

The advantage of this process is that it permits the production of thick LVL or plywood panels without heating the layered package completely through. Different glues are applied to the veneer sheets of the panel: a high-temperature glue is applied to the veneer sheets of the exterior layers, and a low temperature glue to the interior layers. The pressing time is selected in such a way that the core of the LVL or plywood panel is no hotter than 60 °C after leaving the hot press, or was heated no more than 40 °C.

At room temperature, low-temperature glue cures in approximately 20 to 60 minutes, at temperatures around 60 °C it cures in just a few minutes. Per square meter of surface, the price of these glues is about 3 to 6 times that of the high-temperature glue phenol-formaldehyde. The highly reactive polyurethane glue has been shown to be particularly suitable for glueing veneer sheets at low temperatures. However, melamine-formaldehyde glues or resorcinol glue can also be used. By
using low-temperature glue, the pressing time for thick panels is considerably reduced, since heat need only be applied to the exterior layers of the package, which consist of veneer sheets with high-temperature glue. Therefore, thick panels can be pressed in approximately 20 to 30 minutes. Since the inexpensive high-temperature glue phenol-formaldehyde is used in the exterior layers of the layered package, the manufactured product can be produced at less cost than using only low-temperature glue.

The process according to the invention also offers the advantage that with the hot-pressing process, only the exterior layers are heated, thereby reducing the pressure shrinkage to approximately one third of the usual amount. Therefore, the reduction in pressure shrinkage permits savings in material and the dimensional stability of the panel is increased in the event of swelling and shrinking.

Another significant advantage of the process according to the invention is that production safety during the hot-pressing process is considerably increased.

With the process according to the invention, the temperature during hot pressing does not exceed 100 °C in the core of the panel and steam pressure does not build up. Then a higher veneer humidity can be set during the pressing process. The panels have a humidity that is closer to moisture content equilibrium. Therefore, climatization of the panels can be shortened and later, when the panels are used, there are fewer dimensional changes and there is less warping. Since the panels are not completely heated through, energy is also saved (thermal and electrical).

It can also be of advantage that, when manufacturing particularly thick LVL or plywood panels, in the construction of the layered package from the exterior to the interior, i.e. from the exterior layers to the core of the panel, not two, but three or more temperature glues with graduated curing times are used.

Further advantageous measures and embodiments of the object of the invention are described in the following description with the drawing.
The drawing shows the construction of a layered package 1 as used for manufacturing LVL or plywood panels by the process according to the invention. The sheets of veneer 2 are laid one above the other in multiple layers, whereby high-temperature glue 3 has been applied to the surfaces of the exterior veneer sheets 2, and low-temperature glue 4 has been applied to the interior veneer sheets.
List of reference numbers

1. Layered package
2. Sheets of veneer
3. High-temperature glue
4. Low-temperature glue
Claims:

1. A process for gluing sheets of veneer in multiple layers one above the other and one behind the other to form LVL or plywood panels by curing the glue that is applied between the individual layers in a pressing process in a heated press, characterized in that the gluing and pressing of the exterior layers of a layered package is carried out with high-temperature glue and the interior layers with low-temperature glue to form LVL or plywood panels, so that the heat that must be applied to the layered package decreases from the exterior to the interior.

2. A process according to Claim 1, wherein the glue applied between the exterior layers of the layered package is phenol resin and between the interior layers the glue applied is phenol-resorcinol, polyurethane or melamine-formaldehyde.

3. A process according to Claim 1 or 2, wherein the temperature in the core of the layered package is raised to approximately 60 °C.

4. A process according to Claim 1, 2 or 3, wherein between the layers of veneer sheets of the layered package several glues (from high-temperature glue to low-temperature glue) with graduated curing times are applied from the exterior layers to the core of the panel.