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THERMALLY MODIFIED WOOD: TECHNOLOGIES, TRENDS AND PROSPECTS

Because of the original properties thermally modified wood found widespread use and market dynamic of consumption. The technologies, usually created by the method of "trial and error" and not perfect. To develop effective modes of production thermally treated wood necessary to explore the distribution of moisture and temperature fields and heat treatment process to intensify the search for effective ways to prevent avoid possible ignition of wood that is exposed to thermal modification.

Thermally treated wood, TTW (Thermally modified timber, TMT, Thermally modified wood, TMW) – wood that was treated with heat at high temperatures (180 to 230 °C) [2, 4]. The idea of TTW is to use ordinary undoubted advantages of wood as construction supplies. The absolute advantages of wood are: affordability, environmental friendliness, ease of processing, a wide spectrum of use and virtually inexhaustible supply (recoverability of resources). Using wood associated with a number of significant limitations: poor resistance to mechanical, weather, temperature and biological factors influence, (need replacement or permanent care), lack of artistic and aesthetic expression of inexpensive wood availability and high cost of elite breeds. Almost to the end of the twentieth century the only way to avoid the above-quoted disadvantages – deep industrial chemical or biological processing of wood. Almost to the end of the twentieth century the only way to avoid the above-quoted disadvantages were chemical or biological processing of wood.

At the same time, after such processing wood can no longer be considered an environmentally friendly material. No accident that in 2004 the EU introduced a ban on the use of chemically treated wood in its territory. A similar ban introduced in the U.S., and in the future probably will be introduced globally. By processing in an environment with a temperature of 185-230 °C new method allows to change the molecular structure of wood and fix it biological lesions. Technology of heat treatment of wood on the basis of scientific research began in the 30 years of XX century in Germany and later in 40-e – in the U.S.. Revolutionary solution of this problem was found in the early 90's in Finland – a country with the most advance technologies in the woodworking.

Pilot studies were conducted in 90 years in France, the Netherlands, Italy and Germany. As a result it was found that wood exposed to temperatures 180-230 °C in the biological composition irreversible changes occur that affect the properties of the final product: improved shape stability and resistance to high temperatures, the absolute resistance to biological damage, high moisture (adsorption properties in 3-5 times lower than in normal wood), color uniformity in depth, durability, environmental friendliness, etc. All above mentioned properties of TMW determine latitude areas of application: as a structural material is resistant to atmospheric effects – for external use (street construction, landscaping, construction of bridges, piers, lining of watercourses ...), external and internal facades and premises, furniture, flooring, musical instruments, etc.

The potential scope of TMW as great as the scope of conventional wood: of TMW can be produced components, small architectural, design gardens, one of the priority areas of research is to use TTW as a supporting beams. In particular, solutions found in a composite laminated veneer lumber, which includes slat with a modified and conventional wood.

While the TMW has some drawbacks – the reduction of strength in static bending, reducing the tensile strength, increased brittleness, causing its applications, primarily as a structural material capable of operating as a bearing structure, is rather limited. Partial solution of these problems is possible if the use of thermal modification, which provides acetylation wood using acetic anhydride (technology Accoya ®). Unlike TMW, acetylation wood appearance is not very different from usual. Acetylation process does not lead to significant changes of mechanical properties of wood, except for a slight increase in fragility (similar to the thermal modification). Despite the fact that scientific research level of TTW manufacturing techniques, such as that allowed to get environmentally friendly product with satisfactory physical and mechanical properties and appearance, developed in a long time, in applying it in practice there are some problems limit the possibility of the final quality product. One is the problem to avoid possible ignition of wood exposed to thermal modification, the transition from high-temperature drying stage to the actual heat treatment of wood when the temperature rises to 215-230 °C, and medium to 250-260 °C. In order to prevent the phenomenon of ignition of the material in the volume of inert heat chambers created (protective) environment, using nitrogen, water vapor, vegetable oil, etc. With presently known patented technologies of TMW to avoid ignition of wood, the most common are:

1. Finnish Thermowood ® technology involves a process of heat treatment of wood with the use of water vapor in three phases (fig.1):

- Phase 1. Rising temperatures and drying at high temperature of 100-130 °C.
- Phase 2. Thermal treatment. After high-temperature drying of wood temperature rises to 185-215 °C. On reaching the required level of temperature remains constant for 2-3 hours depending on the destination TMW.
- Phase 3. Cooling and humidity control regime.

Fig. 1. Schedule of the manufacturing process TTW technology Thermowood ® [4]

2. Dutch technology Plato ®. Its feature is a cyclic hydrothermolysis (thermal hydrolysis) of wood at temperatures of 160-190 °C and elevated pressure.

3. Retification ® (NOW New Option Wood, France). This technology provides TTW in the environment of water vapor and inert gas (nitrogen ≈ 2 %) at temperatures of 190-240 º C, the process is modified from 40 to 62 hours.

4. German technology company OHT-process Menz-Holz is based on the process of drying timber in liquid organic substances. In this technology as a protective environment in a different vegetable oils (flax, sunflower, canola, etc.), the process is conducted in four stages.

In recent years, dynamic and other technologies developed by companies including Fromsseier (Denmark), MIRAKO (Austria), Vacuum Plus (Estonia), WestWood (USA), BIKOS-TMT (Russia), etc. In NLTU Ukraine conducted research to develop technologies for production of TMW in the environment of carbon dioxide and conductive by vacuum heat treatment [5]. With the advent of the global market TTW building and finishing products, primarily as a structural material, the tendency to a sharp increase in demand for this type of product, due to its high performance and environmental characteristics.

According to the International Thermo Wood Association and a number of market research, sales TTW and Thermowood ® during 2001-2008 increased by more than 4 times (fig. 2), and demand for this type of product at times still prevails offer.

Leader in TMW is Finland, mainly due to a company incorporated in International Thermo Wood Association, with a total of more than 80 thousand cubic meters per year (fig. 3).

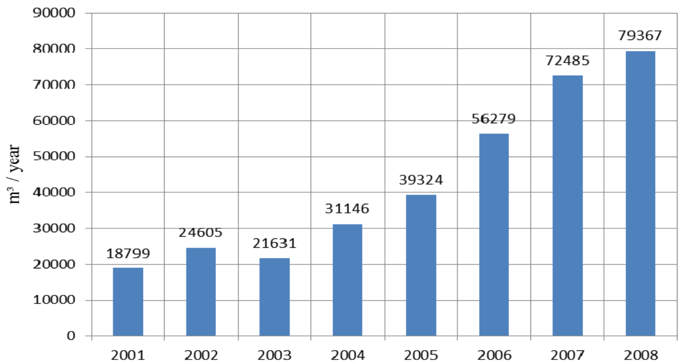

Fig. 2. Dynamics of TMW in the EU [3]

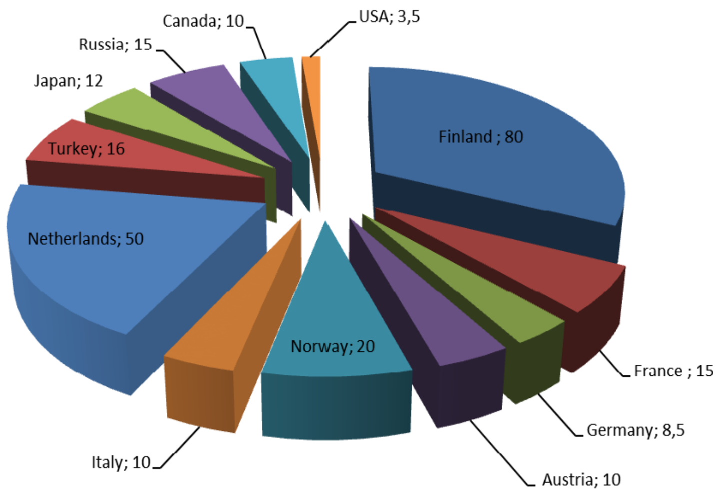

Fig. 3. Production of TMW in 2008,
in thousand cubic meters per year [1]

Conclusions. Because of the original properties TMW found widespread use and market dynamic of consumption (demand exceeds supply in order [1]). The technologies, usually created by the method of "trial and error" and not perfect. To develop effective modes of production TTW necessary to explore the distribution of moisture and temperature fields and heat treatment process to intensify the search for effective ways to prevent avoid possible ignition of wood that is exposed to thermal modification.

References

1. **Antje Wahl.** – Wood market trends in Europe. Special publication, Vancouer, 2008.
2. **Holger Militz**, Professor Dr., Institute for Wood Biology and Wood Technology, University Gottingen, Germany. – Heat Treatment Technologies in Europe: Scientific Background and Technological State-of-Art. (In: Proceedings of Conference on "Enhancing the durability of lumber and engineered wood products" February 11-13, 2002, Orlando. Forest Products Society, Madison, US.).
3. **International ThermoWood Association.** – Production statistics 2008.
4. **Jukka Ala-Viikari, Duncan Mayes** – New generation ThermoWood® – How to take Thermowood to the next level. (In: European Conference on Wood Modification 2009).
5. **Huber Yu.M., Humenyuk Zh.Ya., Il'kiv M.M**. Experimental investigation of physicals and mechanicals properties change the wood of the vacuumcontact thermal process. Collection of scientific and technical works. − Lviv: NUFWT of Ukraine. − 2010, pub. 20.2. − P. 92-99.

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Термічно модифікована деревина: технології, тенденції та перспективи розвитку

Розглянуто історію тенденції та перспективи розвитку термічного модифікування деревини, фізико-механічні та експлуатаційні властивості продукту, короткий огляд технологій. Проведено аналіз динаміки світового ринку споживання термічно обробленої деревини; розглянуті можливі напрямки інтенсифікації процесу розробки ефективних режимів її виготовлення.

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MATHEMATICAL SIMULATION OF SURFACE SHAPE FOR REAL LOG

The features of the mathematical simulation of surface shape for real log were analyzed on the basis of surface shape scanning for log cross sections along its length. The possible shift of the log axis under the scanning relative to its geometric (regressive) axis was taken into account in developed mathematical model.

Key words: log, cross section, scanning, surface shape (form), mathematical simulation, trigonometric polynomial, geometric centre of mass, geometric (regressive) log axis.

Statement of problems and research currency. The significant research work for search the optimal ways of rational logs sawing into sawn timber was performed. Effective solution of this problem requires not only the available the reliable information about size and quality characteristics of logs and sawn timber but also its correct interpretation. The decision concerning direction choice, method and sawing scheme of logs into sawn timber based on information about their size and quality characteristics. This decision is should be also sustained by mathematical and technological calculations. Therefore, information about dimensional characteristics of real logs (mathematical simulation of surface shape of