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SEARCH FOR TECHNOLOGICAL SOLUTIONS TO WOOD THERMO MODIFICATION PROCESS

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Abstract
The paper represents descriptions of wood thermo modification technologies: in flue gases, steam and liquids, as well as the technology of processing by the contact method. Experimental research and industrial tests were the basis to reveal rational use area for the technologies in industry.

Key words: *thermo modification, thermo treatment, thermo wood, flue gas, equipment of heat treatment*

INTRODUCTION

Nowadays, the problem of woodworking industries efficiency ratio as well as the efficiency of wood processing itself is undoubtedly relevant both in Russia and all over the world. It is almost impossible to solve the problem without innovative concepts and technologies of advanced processing though modern high-tech imported equipment is widely used. Technological innovations are demanded to reconsider the use of wood, including low grade quality wood, for the needs of wooden house building and furniture manufacturing.

The production of a new type of goods - thermo modified wood- could be a perspective direction of innovative development of wood processing within difficult market situation. Thermo modified wood is significantly more superior than raw wood by a number of metrics. Research in this field has been conducted for the recent 10-15 years in such countries as Finland, France, USA, Latvia and Germany. However, modern methods of wood thermo modification have significant drawbacks: considerable duration and the high cost of the process; the lack of methods of calculation of the process and the equipment, which leads to experimental search for mode parameters; the results are not optimal; the lack of scientifically well-grounded recommendations on the choice of a technology and equipment for thermal processing as applied to the conditions of the given enterprise. Besides, the data on the characteristics of the thermo modified wood can seriously differ in various research reports because there is no unified approach and thorough research of physical, mechanical and chemical properties of thermo wood.

Therefore, the development of new energy-saving technologies and improvement of existing wood thermo modification technologies and the equipment is an urgent issue

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aimed at reduction of the total cost of the process and improvement of the quality of thermally modified wood.

RESULTS

In this regard, a new approach and improved existing thermo wood technologies are offered:

1. The energy-saving technology of wood thermo modification in flue gases [1] has been introduced at the wood processing enterprise in Minsk (Republic of Belarus, see Fig. 1). It includes the gradual warming of lumber to 180 – 240 C by flue gases resulting from the gasification of wood waste and subsequent burning of synthesis-gas with the excess air coefficient close to 1 and cooled in the heat exchanger to 180 – 240 C. The excessive heat energy allocated when cooling the flue gas is directed to the unit for pre-drying of wood; the gradual phase of wood heating up to the temperature of 160 to 170 C is performed by filing flue gases with high concentration, supported at the level of 95 - 100 % into the unit, and their continuous repeated circulation in the unit; on reaching 160- 170 C the flue gases are directed from the furnace to the heat exchanger; the further heating up to 180 – 240C is performed due to heat transfer between the gas-vapor mixture circulating in the unit, and the flue gases being directed into the heat exchanger; after reaching the given temperature the wood is treated at this temperature; then cooling of wood by steaming processing follows.

2. The energy-saving technology of wood thermo modification in vacuum-conductive machinery implies wood heating up to 200 - 240ºC by the contact method using perforated metal plates on the basis of logarithmic law; seasoning the wood at high temperature and lowering the temperature of the treated wood to 100º C with further loading.

Fig. 1. Industrial equipment for thermal wood modification in flue gases.

3. The technology of thermo modification for hardwoods in liquids [2] involves heating to the temperature of 200 – 240 C and seasoning of the wood at the given temperature in a sealed unit, filled with oil, with flash point above 260 C followed by cooling with oil, vacuuming the wood, steaming with water vapor and re-vacuuming within 2-3 hours.

Energy saving for carrying out the process of cooling is gained by the fact that no additional energy supply to receive water vapor is needed: water vapor is produced by the agent processing (oil) cooling.

4. The technology of lumber thermo modification in superheated steam involves heating to the temperature of 180 – 220 C followed by seasoning at the given temperature in a sealed unit and cooling the wood by repeated vacuuming and steaming. The cooling stage of this kind allows to reduce significantly the "burned" smell of the goods.

5. The technology of thermo modification for high moisture large-sized logs in saturated water vapor [3] has been introduced at the wood processing enterprise in the city of Kirmy (Russia, see Fig. 2). It involves heating to the temperature of 180 C by submission of saturated steam from the steam generator, followed by seasoning the wood at high temperature and vapour pressure within 2-5 hours to thermo modify the wood to the depth of 50 mm, and vacuuming for drying the processed wood.

6. This method avoids the preliminary stage of drying the wood. However, the drawback of this technology is the high pressure in the device (up to 10 ATM) that substantially increases the intensity of the equipment in industrial conditions and, as a consequence, the cost of the process. In this regard, we offer the design of the thermo modification device for round logs for wooden housing construction, where each log is placed in a separate container with a small diameter, which allows to significantly reduce the thickness of the shell.

Fig. 2. Machinery used for lumber thermo modification in superheated steam.

In order to estimate the rational use of the suggested methods of lumber thermo modification experimental research and mathematical modelling of the processes were carried out. This has resulted in the recommendations on the choice of optimum technology depending on the goals of the enterprise and wood assortment. The algorithm of choice of various thermo modification technologies depending on the type of processed wood material, its geometric sizes, initial moisture content and the wood kind, developed. For example, the use of the saturated water vapor is more appropriate in the processing and thermo modification of logs and sawn timber with thickness of 100 mm. Besides, the algorithm provides the choice of optimal variant of treatment, depending on the required production volumes of thermo wood per month.

CONCLUSION

The theoretical and experimental research of the wood thermo modification technologies in various types of process conditions has allowed to identify potential routes of development and intensification of the process. The results of the research imply a number of activities aimed at the development and industrial implementation of the wood thermo modification technology with the use of flue gases, steam and liquids, and the vacuum-contact method. The design and research work has resulted in the development and production of pilot machinery for wood thermo modification in different conditions to be introduced in industrial production at the enterprises of Russia and near abroad.

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