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Technology of wood impregnation by polymeric compositions

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ABSTRACT

The problem of efficiency of application of special means of improving the quality of impregnation, modification and preservation of wood is extremely important in Russian economy. Economic and environmental efficiency of wood treatment with the aim of increasing its structural and finishing properties is quite obvious, but at the moment there is no single methodology for determining it for different types of impregnating polymeric composite materials and for the method of impregnation. The aim of this study is a detailed analysis of traditional and perspective methods of impregnation, preservation and modification of wood using different types of polymer composite materials, and identifying the most effective methods. The study gives a list of the main methods and means of wood protection, all groups of pests harmful to wood, and forms a list of technologies for the impregnation of wood using different physical peculiarities of the process and equipment according to the critical analysis of the technological equipment of the impregnation plants. One of the important results of the study is identifying criteria for the quality of impregnation of wood and recommendations on labor protection in enterprises, with consideration of environmental aspect. According to the results of the study the following conclusions were formulated. At first, it is extremely advisable to optimize parameters of deep impregnation of the wood with the use of basic available technologies. Second point is that at this time the most promising methods of wood treatment are autoclave method using a vacuum and high pressure, and the method of exposure to wood ultrasonic electromagnetic waves. Finally, the technology ultrasonic industrial impregnations is still not developed, there is no technological scheme and necessary equipment.

Content

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1. Introduction

Protection of wood from destruction by biological agents is a rather complex and time-consuming process because wood is susceptible to rotting, pests, etc. In addition, the wood is very heterogeneous material in its structure, the conditions of its operation and properties are different and depend on many factors. Therefore, the requirements to the means and methods of protection is quite strict.

The knowledge of the specific structure of wood and its physical-chemical properties enables us to define the conditions under which the processes of decay can occur and reveal possibilities of a more rational use of wood in construction. Impregnated with antiseptics and flame retardants wood is widely used in manufacturing of various structures, while its positive structural qualities retain, as it eliminates it from such natural disadvantages, such as rotting, flammability that justifies processing costs.

The problem of obtaining high-quality and durable completed products can be solved by learning causes that create conditions for the development of wood-destroying fungi and insects, and methods of wood protection from destruction by biological disruptors.

2. Literature review

The analysis of available literature shows that the generalizing indicators of the effectiveness of wood treatment are the depth and speed of impregnating composition penetration.

According to [5], the effect is the result obtained in the course of production activities. Efficiency is the ratio of the effect to the cost of its production [10, 12]. Economic and environmental efficiency of wood treatment with the aim of increasing its structural and decorating properties is quite obvious, but at the moment there is no single methodology for determining it for different types of impregnating polymer composite materials [1].

A large variety of technological methods of impregnation, equipment, driving forces of the process and properties of the impregnating liquids makes it difficult to create common classification of impregnation methods. Scientific literature gives different variations [5, 12, 26]

The study adopted a classification, which is the most scientifically sound, in accordance with which all methods of impregnation are divided into three groups – capillary imbibition, diffusion impregnation and pressure impregnation, depending on which of the 3 physical phenomena of the process is crucial [8].

In accordance with [7] the impregnation is introduction into the wood impregnating protective compositions in the form of a liquid or gas, which improve or preserve its natural properties [9]. Wood modification is a deliberate change of characteristic properties of wood [14].

Preservation of wood is a chemical wood protection, which provides treatment by a protective composition and its penetration into the object [6].

The efficiency problem of application special means of improving the quality of impregnation, modification and preservation of wood is extremely important in the Russian economy. A significant contribution to the solution of problems of an estimation and developing indicators of the deep wood impregnation effectiveness made works of such domestic scientists as Gorshin S. N., Rusev A. I., Casarin A. A., Crashin L. P., Shamaev V. A. However, it should be noted that the amount of literature on the feasibility, economic and structural efficiency of application of a method of deep impregnation of wood is small enough; fundamental research on this problem is almost none [2, 3, 4].

3. Goal-setting and the work tasks

Aim of work: to analyze the traditional and perspective methods of impregnation, preservation and modification of wood using different types of polymer composite materials, to identify the most effective.

Objectives of the study:

1. to study methods and means of protection of wood;
2. to familiarize yourself with the types and groups of microorganisms damaging timber;
3. to investigate the methods of wood impregnation;
4. to explore the technology of impregnation, impregnation equipment shops;
5. to examine indicators and methods of quality assessment of protective treatment;
6. to conclude, the most promising method of deep impregnation of wood.

4. The causes of the destruction of timber. Methods and means of protection of wood

Wood being an organic material [11] may be damaged if it is item and facilities are operated in adverse conditions. The destruction of wood can be caused by:

1. Mushrooms:

2. Certain types of insects (beetles, termites), which gnaw through the wood moves, reducing the strength of items and constructions;

3. Some species of mollusks, affecting the wood like insects;

4. Fires. First disadvantage of wood as a structural material – easy flammability and combustibility. The resistance to burning for different species of wood varies;

5. Atmospheric effects coupled with repeated wetting of the wood that can collectively with solar activity cause degradation of the wood;

6. Mechanical effects, leading to abrasion (floors), wrinkling (sleepers, transferable bars), splitting (piers, platforms) etc.

To prolong the service life of wooden structures the protection of wood from the effects of the above factors is needed. From mechanical and atmospheric impacts wood can be protected by proper designing of items and structures, coating with a protective layer (paint, plaster). For fire and biological destroyers' protection chemical methods of protection are used. Chemical wood protection is required in cases when moisture in the process of exploitation is inevitable. Constructions operated in the open air, in the ground, walling of buildings and in other cases, for example, construction of bridges, masts, piles, inevitably atmospherically, groundwater or condensationally moistened [13]. Chemical protection of such structures from rotting is that it is necessary to impregnate or cover them poisonous for fungi substances - antiseptics. The most reliable protection of wood against fire is provided by impregnation by fireproof substances - flame retardants [15]. Depending on the depth of the insertion substances into the wood and timing of action of it distinguish processes:

1. Antiseptization – the process of introducing chemicals into the shallow layers of wood for the purpose of short-term wood protection (in the process of atmospheric drying, the transportation of wood).

2. Conservation - the process of introducing chemicals into the deeper layers of wood with the aim of long-term protection of wood.

To protect the wood from fungi and insects a variety of chemical compounds are applied [16]. These substances are harmful to the pests and prevent their development. Chemical agents used for the protective treatment of wood must meet the following basic requirements:

1. To have a high toxicity – ability to kill the mycelium wood-destroying fungi;

2. To possess a constant chemical properties during storage and after the introduction into the wood;

3. Penetrate the wood well and create a high concentration of the poison;

4. Not to leach from building materials and not to collapse under the sunlight;

5. Not to cause corrosion of metals;

6. To be harmless for human health and animals;

7. Not to have an unpleasant smell and not to prevent further processing;

8. Do not increase the hygroscopicity of the wood and not to reduce its strength; not to worsen its ability to be glued, painted, polished;

9. To be economically viable;

10. For fire protection – the ability to reduce its combustibility and reduce corruption.

Means of chemical protection that meets all the listed requirements do not exist. In each case, the selection of protective substance is determined by the purpose of the product and its operation conditions [17]. Choosing an antiseptic, it is needed as possible provide maximum compliance with the basic requirements considering methods of impregnation, availability of equipment and humidity of the fabricated wood. With the use of protective substances should be kept in mind that the wider range of impacts on the wood has a substance, the more dangerous it is for humans.

5. Traditional and perspective technologies of impregnation

Methods of wood treatment are selected depending on the purpose of the impregnated material, it's service conditions and type of protective compound [18]. On the basis of the physical nature of the impregnating liquid penetration there are three primary methods of wood impregnation: capillary, diffusion, impregnation under pressure.

Capillary impregnation of wood is based on penetration into dry or dried wood liquid under the influence of capillary forces.

Capillary methods include:

1. Impregnation by coating the surface of the wood a fluid of a protective agent using a brush, roller, sprayer [19]. The depth of impregnation for a healthy 1–2 mm and 5 mm for the old, broken wood.

2. Immersion in the impregnation fluid (the duration of a dip is set in seconds or minutes). The penetration of liquid into wood occurs under the action of capillary forces and a small hydrostatic pressure [20]. Depth depends on fluid viscosity, permeability of the wood and time of aging. It's a bit greater than in the previous method.

3. Panel impregnation (figure 1).

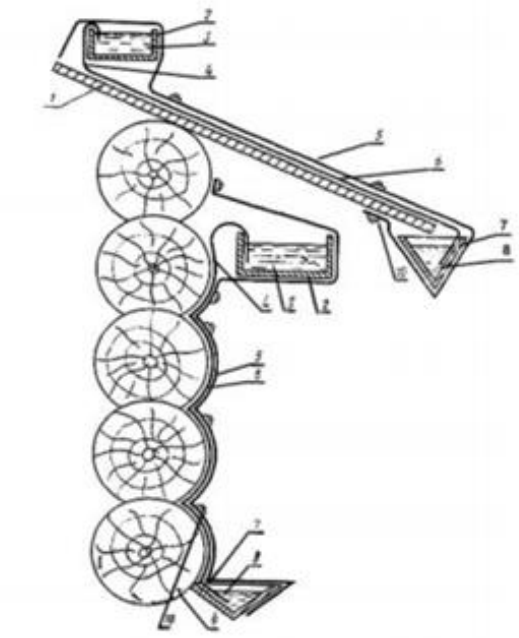

Figure 1. scheme of the panel impregnation of log wall and plank roof [14].
1 – plank roof, 2 – upper tank, 3 - impregnation liquid, 4 – feeder, 5 – outer panel layer, 6 – inner panel layer, 7 – bottom tank, 8 – the surplus of the impregnating liquid, 9 – log wall, 10 – fixation of the panel

The method consists of the imposition of waterproofing panel to the wooden surface and continued transmission of the antiseptic under it. Panel impregnation is used for the protective treatment of unique wooden structures without disassembly.

To a vertical or inclined surface of the processed object is attached penetrating panel, consisting of tightly attached to the wood internal layer (sheets of soft porous material, e.g. filter paper) and the outer waterproof layer. The upper end of the inner layer is dipped into the impregnating fluid of the substance, which is located in the tank above the panel. The fluid moves down from the top of the panel and moistens the wood. Impregnation occurs mainly under the influence of capillary forces. In some cases (when the wood is damp) the phenomenon of diffusion can take place. Sometimes to collect excessive fluid dripping from the panel, under it the reservoir-collector is being additionally set. Time of the panel impregnation depends on the needed depth, condition of the wood (tight, loose), properties of the impregnating liquid and the ambient temperature. On average, it ranges from 15 to 30 days.

Capillary impregnation methods are ineffective, as they provide only superficial impregnation.

Diffusive impregnation is based on the penetration into wood of substances under the action of the difference in their concentrations at the surface and inside the wood.

These include:

1. Impregnation applying the paste. It is used for canning small batches of poles (poles of power lines and communications.) Raw debarked logs are coated on all sides with a paste that contains water soluble antiseptic; then they are placed in a compact package, carefully shielding the waterproofing covers from roofing felt, roofing material or plastic film and kept (in the warmer time of the year) in 2–3 months. Then the bags open, the posts dried in the open air (5–7 days) and send to the consumer.

2. Bandage impregnation. Used for conservation of pillars for various purposes. Its peculiarity is that it occurs during operation. When installing posts in the ground its most prone to decay part (in the area of border ground-to-air), wrapped up by the bandage, i.e., strip of waterproofing material the inner surface of which is coated with an antiseptic paste. The brace is attached to the pole with wire or nails.

3. Impregnation by soaking in a fluid. It differs from capillary impregnation by the initial humidity of the wood and the duration of its exposure in the bath. In the bath with a concentrated antiseptic fluid not dried but raw assortments are downloaded, penetration in which the protective substances occurs due to diffusion. The duration of exposure is determined depending on the required level of protection in accordance with the conditions of service and ranges from 2–3 hours to several weeks. In prolonged exposure penetration of the molecules of the impregnating substance to a greater depth is proved. The productiveness of bath in this method of impregnation is very small, but it provides reliable protection of wood hardly impregnated rocks.

Diffusive impregnation is extremely long and requires a lot of manual labor. In addition, it is possible to use only an inorganic water-soluble impregnating substances.

Impregnation under pressure.

Based on the penetration of the impregnating liquid into the wood under pressure above atmospheric.

1. Impregnation in a bath with a preliminary heating has several technological options. The most common use of two (hot and cold) baths. The package of impregnated logs is heated in a bath of hot impregnating liquid, and then transferred to a bath of cold liquid, exposing in which happens the actual impregnation.

The option of using one (combined) bath is rarely used [21]. After warming up loaded into a bath package hot liquid is quickly replaced by a cold using pumps. The quality of impregnation is somewhat higher than in the first embodiment, due to the lack of contact of the heated wood with air during overload, in which the open cavity cells get air pockets that slow the movement of fluids in wood [22].

Method of hot and cold baths is more effective than capillary methods and was used widely in the past. However, this method due to the small excess pressure does not provide sufficient deep, and especially transparent impregnation.

2. The combination of heating and drying chamber. A stack of lumber or blanks immediately after oven-drying to the required for the impregnation humidity (25–30 %) is placed in a bath with cold impregnating solution. After soaking in the bath a pile is placed again in a chamber and dried to the final (operating) humidity.

3. Autoclave impregnation methods provide ensuring depth of wood penetration by impregnating substances at a low process time and relatively low cost of labor and energy. Method VAD – autoclave impregnation of wood at atmospheric pressure with application of the initial and final vacuum. Method of VDV – autoclave impregnation under pressure above atmospheric with the use of initial and final vacuum. Wood must be dry or dried immediately before impregnation in an autoclave.

Impregnation of wood by the way VAD, VDV using special equipment gives the best result according to the parameters of firebiobarriering.

One of the newest methods of wood treatment is to improve the quality of impregnation with the use of ultrasonic or microwave influence on the assortment [23]. However, this method is poorly understood, there is no technology and methodology of its application. The environmental safety of this technique is not proved [24]. However, this method is an advanced and high-tech, in the future, he might be able to compete with the autoclave method [74, 75, 79].

In all cases the timber must be securely prepared for impregnation. The preparatory operations include sorting, debarking, drying, mechanical processing and pricking. Some of these operations are necessary in all cases, while others are being held only in certain methods of impregnation or in the use of certain breeds of wood.

6. Devices for the preservation of timber

1. Antiseptic installations for spraying lumber, installed in the sorting devices with the transverse movement of the timber.

These installations require a uniform and orderly motion of them through the place and can be recommended only for plants of small capacity or for sorting devices with longitudinal movement of lumber [25].

2. Installations in which the preservation is carried out by immersing the timber in an antiseptic solution.

The main part of such facilities – bath with an antiseptic solution in which the wood is immersed (figure 2).

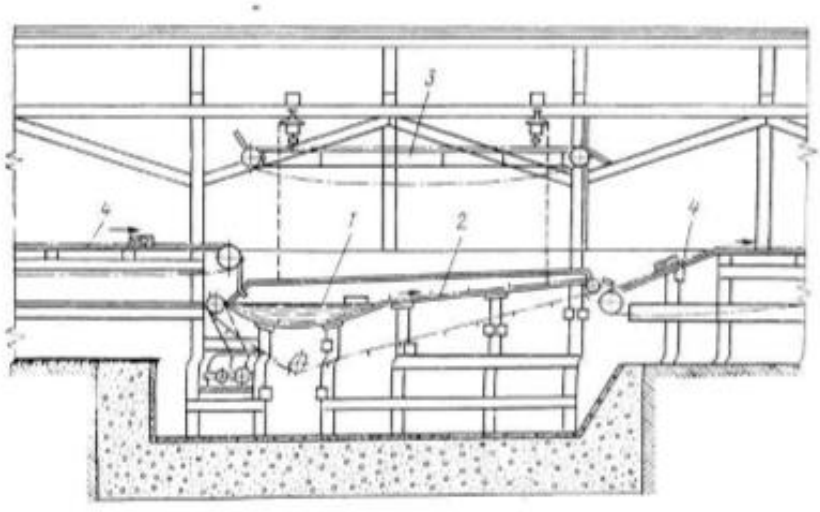

Figure 2. Installation for the antiseptization of timber built into sortblock [14].

1 – bath with a solution, 2 – conveyor chains, 3 – sub-conveyor 4 – conveyor chains of sort site.

The bath is equipped with a conveyor, consisting of 3-4 circuits, the upper branches of which freely sag in the profile of the base [26]. This conveyor brings the timber from the bath into sorting place. Oscillations of the solution occur during the fall of timber contribute to move them after the floating along the bath to the grippers of the conveyor.

The capacity of the bath is determined by the minimum amount of solution required for immersion and removal of timber, with a certain interval coming in the bath [27, 28, 32]. The length of the bath must provide runoff of excess solution from the timber before the release on the sorting place and is usually taken about 12 meters. The place for bath installation is chosen in such a way that all inappropriate for antiseptization pieces of lumber could be selected.

To ensure the smooth operation of the sorting device at a temporary (repair, cleaning) or long (in the winter) termination of the antiseptization it is provided an additional horizontal conveyor mounted on the side walls of the bath in the period when the installation does not work [29,30,31]. During operation of the antiseptization installation the conveyor is raised over the bath and attached to the joists of sorting place.

Antiseptization treatment of lumber on sorting place provides high quality protection, as timber processed directly after cutting and does not require additional operations on sorting place and participation of additional workers [33, 34, 35]. However, the organization meets some difficulties, which include: manual disassembly of wet lumber, the need for an orderly movement of boards on sorting place, etc.

3. Antiseptization treatment of lumber, stacked in the package.

Antiseptization treatment of timber is carried out in tight packages or bags on the strips at short-term immersing them in an antiseptic solution. Figure 5 shows a scheme of the antiseptization installation designed by CSRIMPT in which packages are immersed in a bath of solution with an electric hoist [36, 38].

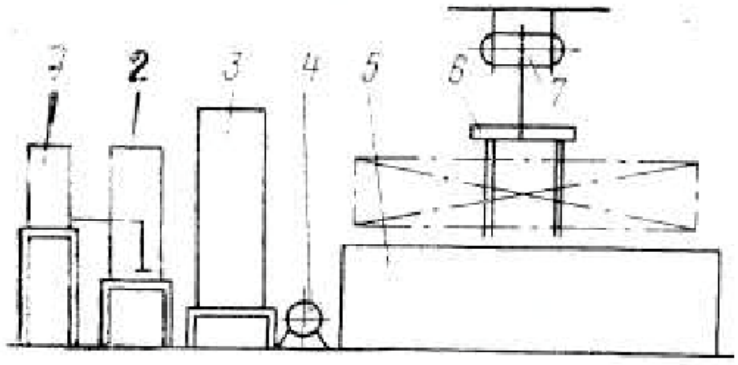

Figure 3. Installation scheme for the antiseptization of timber in packets [14].

1 – tank for solution, 2 – tank for the working solution, 3 – feed tank, 4 – pump, 5 – bath, 6 – gripper, 7 – an electric hoist.

An electric hoist is controlled from the cockpit. Grips due to its own weight load the package into the solution. Using this hoist package is not only immersed in the bath solution, but moves within it [37, 39, 40]. Processed package at first for some time is mounted on the overpass beyond the bathroom, where it drains the excess solution, and then, on the buffer pad, where it is then taken away by timber carrying vessel to the warehouse. Flowing from the package solution passing the filter flows back into the tub. Machine is served by two workers.

Package antiseptization treatment of lumber can be done at sorting place, lumber stock or any other convenient place [41, 42, 43].

4. Bathrooms conveyor systems with forced movement of the impregnated material

These machines are used for the rapid impregnation of assembled joinery (frames, panels, doors) [44, 45, 46]. One of the installation schemes of a conveyor type shown in figure 4.

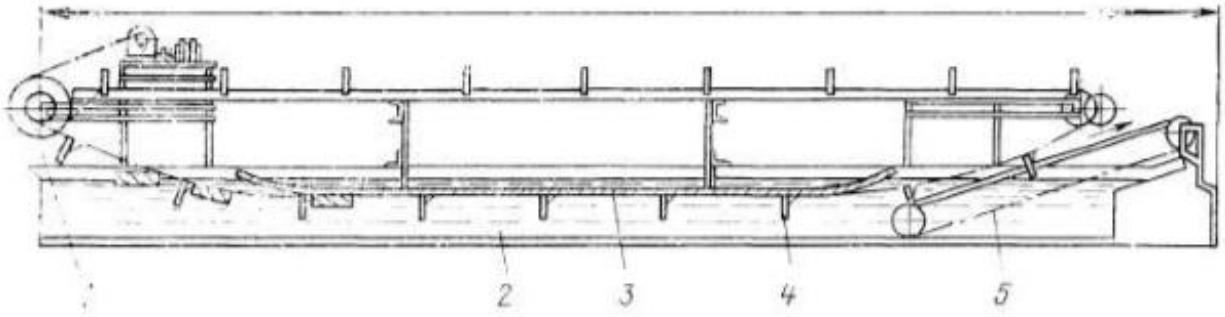

Figure 4. Conveyor belt system for impregnation of joinery [14].

1 – drive, 2 – bath with liquid, 3 –the guide shield, 4 – operating conveyor with stops, 5 – discharge conveyor.

The machine consists of the bath with solution, where working conveyor with stops, the guide shield and the discharge conveyor are located; a drive is in stock.

5. Devices for impregnation of wood with pre-heating.

In technology which presupposes heating and gradual cooling of the wood in a bath with antiseptic, as well as heating and cooling in different baths, the impregnation can be carried out in devices similar to the device shown in figure 5.

For the technology providing heating and cooling in a bath with the change of the liquid used for impregnation the device is shown in the figure 5 [47, 48, 49].

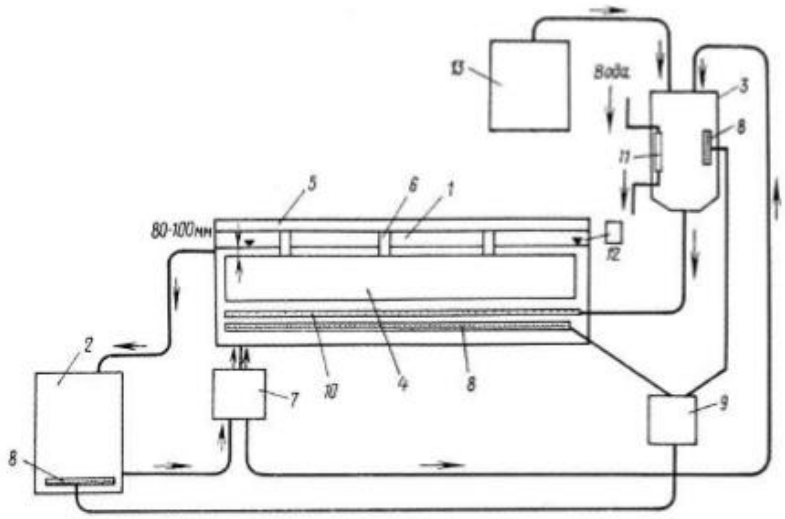

Figure 5. Scheme of the impregnation machine with preheating for the antiseptization and antipyrene-canning of wood [14].
1 – impregnating bath, 2 – tank for hot liquid, 3 – tank for cold liquid, 4 – pack of the material under impregnation, 5 – bath cap, 6 – rests against the floating of the material, 7 – pump, 8 – heater, 9 – panel with thermostats, 10 – perforated pipe for feeding a bath with cold liquid, 11 – cooler (running water), 12 – gauge, 13 – reserve fluid tank.

This installation, designed for the method of hot-cold bath impregnation [50, 51, 52], consists of welded metal bath, tank - reservoir for hot liquid and other equipment. Installation for impregnation of wood by antiseptics can be applied for impregnation by flame retardants.

6. Devices of the autoclave type for wood treatment

Scheme of the device of this type is presented in figure 6.

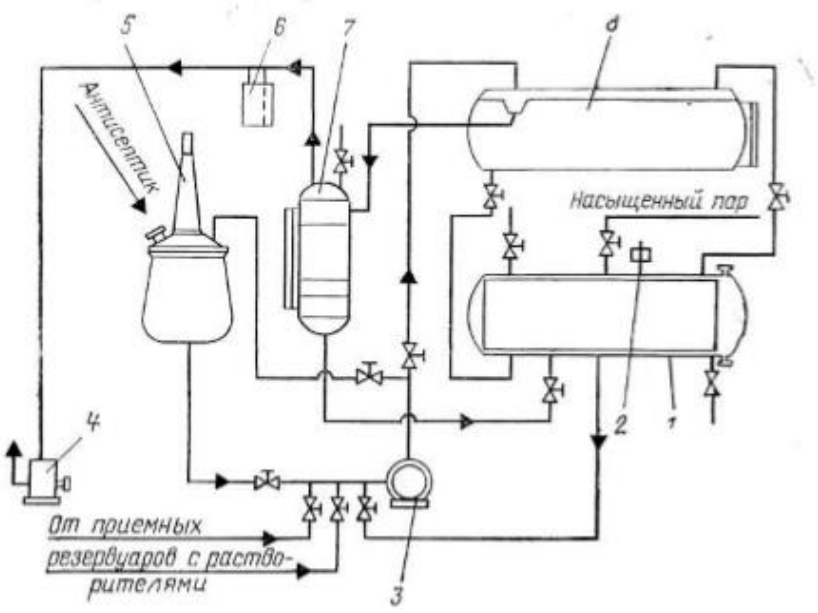

Figure 6. Scheme of the impregnation of wood under pressure [14].
1 – impregnation autoclave, 2 – safety valve 3 – pump, 4 – vacuum pump, 5 – reservoir, 6 – condenser, 7 – dipstick 8 – maneuverable autoclave.

The main part of the installations is the impregnation cylinder or autoclave [53, 54, 55]. Other equipment is of secondary importance and its composition in different machines is somewhat different.

The autoclave is a cylindrical steel tank, which at one end has a spherical bottom [56, 57], and the other end is hermetically closed door. At the bottom of the autoclave railway is laid for rolling trolleys with the material. Parallel to rails are installed special fuses to exclude leaching of the material [58, 59, 60]. Between the rails in the lower part steam coil – heater is mounted. The size of the autoclave depends on the required capacity and dimensions of the processed assortments.

Another important part of the installation – shunting autoclave, which is typically installed horizontally above the impregnation autoclave. With this arrangement, the fluid from the shunting autoclave is poured into an impregnation autoclave by gravity [61]. Normally for two impregnation autoclaves is set one shunting autoclave. Its capacity must ensure the filling with the liquid of the impregnation autoclave, including a fluid absorbed by the wood.

For liquid level measurement the meter is included – it is hermetically closed tank with a device for the measurement [62].

To create a vacuum in the impregnation, autoclave the vacuum pump is installed.

Liquid pump in the unit is designed for pumping liquids [63, 64], but it can also be used to create liquid pressure. The compressor is used to create in the shunting and impregnation autoclaves air pressure, and for pumping liquid from the impregnating autoclave to the shunting autoclave.

Tanks are designed for storage, heating antiseptics and, if necessary, mixing them [65, 66]. They are sometimes equipped with a steam heater and an air or mechanical mixers. Tanks can also be supplied dispensers for mixing liquids, so they are supplied with measuring devices [67, 68].

Auxiliaries include:

1. trolleys for moving and feeding the wood in the impregnating autoclaves;

2. crushers for crushing of solid antiseptics [69];

3. sumps, or separators (centrifuges) for cleaning the impregnation liquids;

4. balances, pipettes and measuring devices (pressure gauges, vacuum gauges, thermometers, etc.).

7. The quality of the protective treatment. Health and the environment

The lifetime of the products largely depends on the quality of the impregnation [70]. It is established that in low doses of antiseptic and in the situation of reduced toxicity fungus grow even more intense than in untreated wood; at the same time the excessive number of introduced antiseptic increases the cost of construction and creates a number of inconveniences in operation [71, 72, 73].

Parameters of wood protection are the amount of absorbed antiseptic, depth and evenness of its distribution in the wood, toxicity and visivamente of the antiseptics.

The depth of penetration of the impregnating substance and its distribution in logs is determined by the color of the wood sampled from control samples [74, 75, 76].

The penetration depth is the distance in millimeters from the outer surface of the sapwood to the boundary layer, which revealed the antiseptic [77].

Samples are taken from the sapwood and the core separately using the drill having an internal diameter of 5-10 mm.

When taking samples, the piece is required not to have knots, cracks or other defects [78, 79]. Drilling should be done strictly according to the radius to the center, drilling part of the original post, and removing unbroken sample from the drill.

In the impregnation by oily and other antiseptics, which color the wood, the depth of penetration of the antiseptic is determined by the dimension of the painted areas of the wood [80]. In the impregnation of wood by colorless antiseptics the depth of the impregnation is determined using chemical indicators.

The depth of impregnation is evaluated in percentage of the drilled thickness of sapwood [81]. Russian State Standard GOST 20022.5-76 provides the depth of impregnation of at least 85 % of sapwood [82, 83, 84]. Sapwood which thickness is less than 40 mm is impregnated completely. The depth of impregnation of the heartwood is up to 5 mm.

The number of samples is determined by the size of the logs and the method of impregnation [85].

The absorption value is determined by the amount of antiseptic impregnated in wood (kg/m^3).

The control of absorption is led in different ways depending on the manner of impregnation:

1. weighing the impregnated segments before and after treatment [86, 87];

2. measuring the consumption of antiseptic in reducing liquid level in the measuring tank or the supply tank [88]. The norm of absorption depends on solubility of the group of protective agents;

3. for oil impregnation liquids in kilograms per 1 m^3 of impregnated timber;

4. for aqueous solutions of salts in kilograms of dry salt or solution of a certain concentration per 1 m^3 of wood.

The rate of flow of the impregnating liquid depends on:

1. the way of impregnation;

2. sort of wood;

3. the purpose of the impregnated segments;

4. moisture content of wood;

5. pre-treatment of the wood before impregnation.

Regulation of absorption in the impregnation is carried out by changing parameters of the process conditions (duration, pressure) or by changing the concentration of the impregnating solution [89, 90].

Visivamente of antiseptics from wood is determined by the method of sequential leaching of the impregnated specimens in the baths. In this method, samples of wood are placed in a bath of distilled water, the amount of washed out antiseptic is determined by analytical method. According to the obtained data, visivamente curves are build [91, 92]. The duration of tests is 30 days. Water is changed after 1, 2, 3, 5, 10 and 20 days. Chemical analysis of washed out water allows you to determine the pace of active components visivamente of the protective liquid and their degree of fixation on wood. The degree of fixation and amount of leached substances is expressed in percent to the original content in the wood after impregnation of the studied component.

Antiseptic toxicity is characterized by the dose limit that represents the minimum content in the wood, in which the development of wood-destroying fungi does not occur.

Evaluation of the toxicity of antiseptics is based on the reaction of wood-destroying fungus on introduction poison to the wood. The marginal dose is defined as the ratio of the mass of dry antiseptic to the mass of absolutely dry wood, expressed as a percentage or in kilograms per cubic meter [93, 94]. For the same kind of antiseptic amount of the limit dose may vary depending on the composition of the nutrient medium, the stamp of the fungus and its devastating activity.

Some of the applied for protective treatment of wood impregnating substances in the situation of careless handling can be harmful to human health [95]. It is important for wood processing shops and sites staff to follow certain safety rules:

1. Use only drugs approved for use by Ministry of health of Russia;

2. The premises must have ventilation and be adapted to wet cleaning;

3. Floors shall be sloped not less than 1/100 for the reliable removal of spilled fluids and wash waters;

4. Work with impregnating substances in protective clothing: rubber boots or leather shoes, overalls, canvas or rubber apron, rubber gauntlets or gloves; for spraying, or spattering of antiseptics mandatory use of protective goggles and respirators;

5. Following rules of personal hygiene [96]. During operation smoking, eating, touching without removing gloves to the open areas of the skin is prohibited. After working a meal is mandatory.

When getting fluids on the skin it should be immediately rinsed with warm water with soap [97]. Using these rules and performing common for all events precautions work at the treatment plants does not pose any danger for staff.

The processes of protection and preservation of wood are of great environmental importance, as, prolonging the service life of wood exposed to decay and destruction by fire in the buildings and reducing the consumption of wood for their renewal, these processes keep from cutting large amount of forest tracts [98, 99].

At the same time, the activities of the wood processing enterprises can harm the nature around these businesses areas, if there are uncontrolled discharges of technology and waste water containing toxic substances into rivers, lakes and other water bodies [100]. That is totally unacceptable. All drains from the main and auxiliary impregnation equipment shall go to water treatment devices. Fulfilling this requirement, the adverse impacts of the processes of impregnation on the environment are completely excluded.

8. Conclusions

Analyzing obtained data, we can draw the following conclusions:

1. A list of the main methods and means of protection of wood is obtained.

2. Identified all groups of pests harmful to wood.

3. Generated a list of technologies for the impregnation of wood using different physical peculiarities of the process and equipment.

4. Critical analysis of impregnating plants process equipment was done.

5. Identified quality criteria for the impregnation of wood and recommendations on labor protection in enterprises, the environmental aspect is worked out.

6. At this time the most perspective methods of wood treatment are autoclave method using a vacuum and high pressure, and the method of exposing wood by ultrasonic electromagnetic waves.

However, it should be noted that the technology of ultrasonic industrial impregnation is still not developed, there is no technological scheme and necessary equipment. It is also impossible to accurately determine the most efficient method of impregnation due to the fact that there is no uniform methodology for comparison. No specific studies to quantify performance indicators ultrasonic and vacuum impregnation was carried out. In conclusion, it should be noted that these data indicate the need to study the application of modern high technologies to improve the quality of wood impregnation and in-depth study and comparison of the vacuum and ultrasonic impregnation.

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Технологии пропитки древесины полимерными композициями

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ИСТОРИЯ

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КЛЮЧЕВЫЕ СЛОВА

Древесина;
пиломатериалы;
пропитка;
полимерные композиции;
сооружение;
здания;
гражданское строительство.

АННОТАЦИЯ

Проблема эффективности применения специальных средств повышения качества пропитки, модификации и консервирования древесины является чрезвычайно актуальной в российской экономике. Экономическая и экологическая эффективность пропитки древесины с целью повышения ее конструкционных и отделочных свойств вполне очевидна, однако на данный момент не существует единой методики определения ее для различных видов полимерных композиционных пропитывающих материалов и способов пропитки. Целью данного исследования является подробный анализ традиционных и перспективных методов пропитки, консервирования и модификации древесины с использованием различных видов полимерных композиционных материалов, и выявление наиболее эффективных методик. В результате исследования был получен перечень основных методов и средств защиты древесины, были выявлены все группы вредителей, оказывающих пагубное воздействие на древесину, а также сформирован список технологий пропитки древесины с использованием различных физических особенностей процесса и оборудования с учетом критического анализа технологического оборудования пропиточных цехов. Одним из немаловажных результатов исследования является выявление критериев качества пропитки древесины и рекомендаций по охране труда на предприятиях, с проработкой экологического аспекта. По итогам исследования были сделаны следующие выводы: во-первых, целесообразно провести оптимизацию параметров глубокой пропитки древесины с использованием основных существующих технологий; во-вторых, на данный момент времени наиболее перспективными методами пропитки древесины являются автоклавный метод с использованием вакуума и высокого давления, и метод воздействия на древесину ультразвуковыми электромагнитными волнами; наконец, технология ультразвуковой промышленной пропитки до сих пор не разработана, отсутствует технологическая схема и необходимое оборудование.

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