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Towards Preservation of Seasoned Timber against Fungi and Insects Attack

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Authors' contributions

This work was carried out in collaboration between all authors. Author ROO wrote the first draft and contributed in the area of methods of seasoning, methods of applying preservatives to seasoned timbers and ways of preventing insects and fungi attack. While author AMH contributed in the area of wood deterioration, characteristics of timber and typing of the manuscript. All authors read and approved the final copy of the manuscript.

Short Communication

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ABSTRACT

The paper explained how seasoned timber can be preserved against fungi and insects attack. Types of wood and the causes of wood deterioration is also explained in the paper. It discussed Methods of applying preservatives and ways of seasoning timber. Methods of calculating moisture content of timber are also discussed .The most effective chemical substance used for preventing insects was creosote oil. The temperature range for preventing fungi is between 130℉ to 150℉ and above. The moisture content of the timber should be below 20% to discourage insects attack. It is suggested in the paper that timber with so much sap should not be used for furniture and other constructions to avoid insects attack; there is a need for adequate ventilation in every room where timber is used for a particular construction such as furniture, skirting board etc to guide against fungi. Timber should be well seasoned and treated with preservatives before usage.

Keywords: Fung; insect; preservation; season; timber.

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1. INTRODUCTION

Wood like other materials originate from living matters which is composed of an immense number of hollow units known as cells. It has been estimated as observed by (A Nelson, University of Nigeria, Nsukka, unpublished result) that are about 45,000 such cells in an ordinary match stick. There are two types of wood. These are hardwood and softwood. In softwoods, the cells are shaped like tubes with wedge-shaped ends. They are like drinking straws joined end to end and compressed to give the appearance of a honeycomb. These tubes convey liquids from the roots to the leaves and also provide strength to the structure. The liquid pass through the length of the tree from cell to cell in the sapwood through numerous valves in their walls. These valves are called pits which are placed so that liquid pass from one cell to the other in the tree. Each valve is divided into two parts by a flexible and permeable membrane [1]. Soft wood is a nonporous wood. It has no vessels and mainly tracheids. It is also known as gymnosperm while hard wood is a porous wood. It has vessels of uniform or varying sizes. It is also known as angiosperm.

According to reference [2], Wood suffers physical and chemical changes as a result of age. It is an organic material which can support the life of other organisms if the environment is suitable for it and certain conditions can also lead to rapid breakdown of the wood. Though, this depends on wood species. Timber species vary in their structure and chemical constituents. These factors determine the extent to which wood is naturally protected from decay and the ability of protective preservative to penetrate it. The growth of the Wood preservation industry has been one of the most important technical developments within the forest industry. The wide acceptance of preservation as an integral part of wood processing and utilization has been a significant contribution to the use of timber as raw material.

1.1 Wood Deterioration

Timber may be attacked by one or more agents causing degradation. This depends upon the condition of service. Proper design and application of preservatives can eliminate or minimize such attack.

In reference [3], Fungi are classified as a separate kingdom with characteristics of both plants and animals. It is different from plants in that they have no chlorophyll in their structure. They develop from minute spores a germinate in suitable condition. It has filaments called hyphae. These penetrate the wood structure and if suitable conditions exist, break down the wood tissues into simple chemical compounds on which they feed. As the insects attack the timber they create tunnels on it and left powered frass around. The gallery may be stained dark colour. The development of attack can be rapid under favourable condition. Timber which is attacked by fungi is sometimes covered by a mass of intertwined and overlapping hyphae resembling cotton wool called mycelium.

When the fungus is matured and conditions are good, it produces fruiting bodies (mushrooms) which are very different from those of normal garden plants. They can be microscopic or relatively large, either in the form of a fleshy plate standing out on edge from the decayed wood, or as a thick, flat skin covering part of the wood. Fungi spores are produced by the fruiting body in vast numbers and may be carried by air current, animals, birds etc. to considerable distance or to other wood where they will germinate, provided the conditions are suitable. Such conditions include high moisture content, adequate oxygen and availability of enough nutrients.

Reference [3] further disclosed the conditions that encourage the development of fungi as follows:

i. High moisture content of the wood.
ii. Where there is adequate oxygen supply.
iii. A temperature range that suit their life cycle. The temperature that encourages the development of fungi is between 40℉ to 129℉[3].
iv. Availability of adequate nutrients.

Insects also cause damages in timber. These insects are deathwatch bettle, the power post bettle and common furniture bettle. The death watch bettle attack well matured timber. All these insects mentioned attack timbers in tropical countries including Nigeria. There might be no fungi and insects attack if disease resistant timbers are used [4].

2. METHODS OF SEASONING

There are two method of seasoning. They are natural or air seasoning and artificial or kiln seasoning. Seasoning on the other hand is the process of removing excess moisture from the wood. Seasoned timbers are woods that their moisture contents are not more than 20 percent (20%). Reference [5-7] explained that seasoning involves the evaporation of excess moisture. The moisture content should be approximated to that of the atmosphere so that the wood does not split.

2.1 Natural or Air Seasoning

This is the oldest method of drying timber. In air seasoning, the timber is stacked in open shed which protects the wood from sun and rain but permits air to circulate freely. The choice of site is important, hence, it must be in an open, well-drained place/location and the base should be covered with a layer of linker to prevent the growth of weed or fungi attack.

2.2 Artificial or Kiln Seasoning

As the name implies, this is the artificial method of removing moisture from the timber. The kiln is often used in conjunction with air seasoning especially with many of the hard woods which do not dry rapidly in the early stages of seasoning. A preliminary stage of air seasoning is followed by final drying in the kiln, thus, speeding up the process without causing degradation by splitting. The kiln consists essentially of a brick-built chamber in which the timber is stacked. Air of controlled humidity and temperature can be circulated by the use of fans. The timber is piled on bogies or trucks which run on tracks. The operation is done carefully to ensure that the air can circulate freely across all surfaces. The kiln is sealed on the process begun with a preliminary warming up for a short period, after which the circulating air is made very humid by the injection of steams near the heating coils. This is done to prevent rapid evaporation of moisture from the surface which would cause surface splitting by sudden contraction [8]. The equilibrium moisture content of artificial seasoning (kiln) can be controlled manually or automatically. A meter is attached to the kiln which shows the reading of the moisture contained in the timber.

Seasoning is necessary because it reduces the risk of decay or attack by fungi on green or unseasoned timber. Such timber cannot be worked satisfactorily by hand or machine nor takes finishes i.e. paint, varnish or polish. To calculate the percentage moisture of timber

using oven dry method, the dry weight is found by taking a small sample which is first weighted and baked in a special oven at 100℃ until no further loss in weight occurs. The dry weight is used in the equation to determine the percentage moisture content.

$$\text{Moisture content} = \frac{\text{Wet weight of sample X Dry weight of sample}}{\text{Dry weight of sample}} \text{ X } 100$$

For example:

If a 60g sample weighs 40g after drying, then,

$$\text{Moisture content} = \frac{60 - 40}{40} \text{ X } 100 = 50\%$$

Reference [9] revealed another method of calculating moisture content of timber to use of moisture meter. This involves the use of a simple portable electric instrument to give the reading of the moisture. The more the moisture is contained in the timber, the more the current passes through. When the timber contains less moisture due to drying, it resists the flow of current.

3. CHARACTERISTICS OF TIMBER WITH REFERENCE TO ABSORPTION OF PRESERVATIVES

Penetration of preservatives into woods depends on the properties possessed by it such as permeability and durability.

3.1 Permeability

The ability to penetrate wood with chemicals toxic to kill insects or fungi is largely dependent on being able to remove moisture so that the preservative can take its place. Some water soluble chemicals will move by diffusion to penetrate the wood sufficiently to protect it. Most preservatives will not pass through cell wall membranes by diffusion and require pressure to push them deep into the wood. The depth to which penetration is achieved is dependent on density, chemical diffusion within cells, moisture content, cell type, techniques used, etc. Generally, softwoods such as radiata pine are more easily penetrated than hardwoods while Sapwood is more easily penetrated than heart wood [10].

3.2 Durability

Sapwood, irrespective of species, is of low natural durability. It generally has a lower density than the heartwood, has a high moisture content and high starch content, all of which are conducive for fungi or insect degradation. Wood that is kept dry and is naturally durable is able to resist invasion by fungi or insects. Factors involved in providing this durability include carbohydrate and chemical makeup. Heartwood contains cells which have chemical deposits within the cells and has little or no carbohydrates and the moisture content is relatively low [3,10].

Heartwood in some species e.g. sneeze wood, can be highly durable whilst in others e.g. Radiata Pine or Eucalyptus Saligna, durability is low. Durability may be increased by the addition of chemicals that are toxic to fungi or insects.

4. METHODS OF APPLYING PRESERVATIVES TO SEASONED TIMBER

Preservation of wood means protecting wood against wood destructive agents. The destruction can be caused by fungi, insects and mold etc. Wood preservation can be done through natural or artificial means. The artificial means refer to the use of chemicals. It is advisable to treat wood with chemicals before using it for any construction, it can be impregnated or soaked with antiseptic liquid; coal-tar e.g. creosote oil etc [11]. The wood should be well seasoned (dried) before using it for any construction. Reference [12] stressed that wood workers should use durable timber for construction and with proper woodwork practice and maintenance; the effects of fungi and insects on wood will be minimized.

Fungi and insects can be killed by poisoning the wood with a toxic liquid. Before applying preservatives, the wood should be well seasoned to allow penetration of preservatives. It is important to apply preservatives by using correct method. Preservatives can be made ineffective by incorrect application such as use of brush and spraying. Reference [11] disclosed that wood preservatives can be divided into three main groups:

i. Tar-oil e.g. creosote oil (it is mostly used)
ii. Water solution e.g. sodium fluoride, zinc chloride
iii. Organic solvent type e.g. copper napethenate in white spirit.

These chemicals don't change the colour of the wood especially when small quantity is applied through empty cell process [13-15].

These preservatives can be applied by two methods i.e. non-pressure processes and pressure processes.

4.1 Non-Pressure Processes

These include application of a preservative by brushing, spraying, steeping and dipping. [13,14] Argued that these methods are ineffective especially brushing and spraying, unless they can be renewed every three years to preserve the wood for a long time. Two or three coats are necessary when applying preservatives and each coat should be allowed to dry before the next coat is applied.

4.1.1 Dipping

Dipping is another process. It is the submerging of wood in a preservative tank for a short time (a day). The size of the tank is governed by the size and shape of the wood units to be dipped. After dipping, the units are placed on a draining rack usually of corrugated sheet.

4.1.2 Steeping

It consists of submerging wood in a tank of either hot or cold preservatives for a period of two to four hours. The seasoned timber is placed in the tank to cover the timber and is generally heated to 94℃. After being maintained at this temperature for one to three hours,

the heat is turned off and the preservative is allowed to cool. The liquid is then pumped back to the storage tank and the wood removed.

4.2 Pressure Processes

Pressure processes include full cell process and empty cell process. Pressure processes are the most effective for applying preservatives. They are generally used for treating large quantities of timber. Special pressure cylinders are used which are built to withstand vacuum and liquid pressures. The cylinders vary in sizes from 15 to 30m long and 1.8 to 2.1m in diameter. According to reference [14,15], the following methods of applying preservatives are effective.

4.3 The Full Process

The wood is loaded into the cylinder and the doors sealed. A vacuum is created in the cylinder and sustained for fifteen minutes to one hour. This helps to withdraw air and any moisture on the wood since it obstructs the penetration of preservatives. The preservatives are introduced at a temperature of 60℃ to 82℃. When the cylinder is full, pressure is applied at 6,890 to 12,402mbar. The pressure is maintained for a long time to force the required amount of preservatives into the wood.

4.3.1 The empty cell process

The wood in the cylinder is first subjected to an air pressure of about 2,756mbar. With this pressure maintained, the hot preservative is pumped in and the cylinder completely filled. An additional air pressure of about 690mbar is applied for a short time. This causes the preservative to enter the wood cells. The pressure is then released so that the compressed air within the wood can expand and as it does so, a quantity of preservative is removed from the cells by the air pressure being reduced with a pump. Some amount of preservative is now left in the wood. It is effective and the wood treated is clean to handle. The process is comparatively cheap because small amount of preservative is used.

The difference between the full cell process and empty cell process is that, in full cell process, the pressure is usually maintained for a long time to force the required preservative into the wood while the empty cell process, small amount of preservative is required so it doesn't take much time like full cell process.

5. WAYS OF PRESERVING TIMBERS AGAINST FUNGI AND INSECTS ATTACK

It is essential woodworkers preserve seasoned timbers for its effective utilization. Below are ways woodworkers can preserve their timbers against fungi and insects attack.

i. The conditions that encourage insects and fungi attack are poor ventilation and dampness. To prevent it, provision of good ventilation is essential. When the temperature is between 4℉ to 129℉ and moisture content is below 20% it encourages fungi and insects attack [3].
ii. Any wood infected by fungi and insects should be removed and the parts infected should be replaced with sound wood treated with preservatives.
iii. To destroy the eggs of insects, the surface of such wood may be treated with propriety solution which will kill the larva as it emerges from the wood during the

spring and summer periods. Some woodworkers use sodium fluoride, zinc chloride and copper napethenate to kill the egg of insects and equally treat the surface of the wood with the same chemical or use creosote oil.

iv. Wood should be properly seasoned before usage. A seasoned timber of 20% or less moisture content is less likely to be infected by fungi.

v. Avoid wetting floors where timbers or wood products are kept. Do not pour water on seasoned timbers.

vi. Timber with so much sap should not be used for furniture and other constructions to avoid insects attack.

6. CONCLUSION

It has been observed that wood used for furniture and other constructions are infected by fungi and insects. This is may be attributed to high moisture contained in the timber or due to lack of preservatives applied to the timber before usage. It should be treated with preservatives to guide against fungi and insect attack. Timber with so much sap should not be used for furniture and other constructions to avoid insects attack. It is observed that pressure processes of applying preservatives are not mostly used by wood workers. Two methods of seasoning are commonly used. These are natural and kiln seasoning. Wood workers should endeavour to use any of the methods mentioned above to dry their timber before usage. Application of preservatives should be repeated within two to three years to guide against wood destructive agents. A temperature between 130℉ to 150℉ and above should be maintained to discourage fungi attack while moisture content of the timber should be less 20% to prevent insects attack. Chemical substance such as creosote oil should be used on timbers to prevent insects attack.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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