The Austrian Journal of Technical and Natural Sciences, No 9–10
ISSN 2310-5607

PREMIER Publishing
ppublishing.org

Section 2. Materials Science

DOI:10.29013/AJT-23-9.10-32-36

SOLUTIONS TO LIMIT THE ABILITY TO SPREAD FLAMES ON THE SURFACE WHEN THE MATERIAL IS PLACED VERTICALLY OF WOOD MATERIALS IN VIETNAM

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Cite: *Nguyen Nhu Dung. (2023). Solutions to Limit the Ability to Spread Flames on the Surface When the Material is Placed Vertically of Wood Materials in Vietnam. Austrian Journal of Technical and Natural Sciences 2023, No 9-10.* https://doi.org/10.29013/AJT-23-9.10-32-36

Abstract

The study aims to propose solutions to limit the possibility of flame propagation on the vertically placed surface of wood materials used in Vietnam. In order to come up with solutions, it is necessary to understand the factors that affect the ability to spread flame on the surface of the vertically placed wood material. Experimental methods according to ISO 5658–2:2006 are used to determine the degree of influence of each factor on the ability to spread fire, including: Humidity, material thickness and heat source capacity. The study has shown the effect of increased humidity, wood material thickness and heat source capacity on the ability to spread flames on vertically placed wood surfaces.

Keywords: *fire spread, heat source capacity, humidity, material thickness*

Introduction

Wood materials are commonly used in Vietnam due to their high aesthetics, mainly used as tiling materials or decorative partitions. Besides, the disadvantage of natural wood materials is that they are flammable, easy to spread fire on the surface of the material. The change in the characteristics of wood under fire conditions as well as fire protection measures for wood materials have been focused on research. However, studies focus mainly on issues such as the thermal decomposition process of wood under fire conditions, the fire hazard properties of wood materials such as ignition, smoke and toxin capacity, and the ability to spread flames on the surface of wood materials. The current published studies on flame propagation on the surface of wood materials mainly focus on evaluating the degree of fire propagation to classify materials according to fire hazard. Meanwhile, factors affecting the ability to spread fire on the surface of wood materials vertically under use conditions in Vietnam have not been specifically studied. The article aims to provide a method to determine the fire propagation

on the vertical surface of some popular wood materials in Vietnam, including: natural wood and MDF artificial wood. At the same time, the parameters affecting the ability to spread fire on the surface of the vertically placed material of wood materials under fire conditions are determined.

Experimentally evaluate the ability to spread flame on the surface of vertically placed materials of natural wood and MDF artificial wood

Natural and artificial wood materials are commonly used in Vietnam, when using wood materials, they also take advantage of locally available materials. Each year, planted timber provides about 25 million m^3 for the construction industry (Vu Huy Dai, Ta Thi Phuong Hoa, Vu Manh Tuong, Do Van Van, Nguyen Tu Kim, 2016). In addition, due to the gradual depletion of natural wood resources, the demand for wood products is increasing, artificial wood is a product with a rapid development rate. Commonly used artificial wood boards in Vietnam include plywood, particleboard and fiberboard (MDF wood).

The effect of moisture content, material thickness and heat source capacity on the ability to spread flame on the surface of wood material vertically is determined according to the experimental survey method based on the test procedure specified in ISO 5658–2 : : 2006. Test measurements were performed on natural and artificial wood with variations in moisture content, material thickness and heat source capacity.

Each sample group of wood materials for testing is randomly selected from natural wood in Vietnam and MDF artificial wood, including 03 samples with a width of 155 mm and a length of 800 mm, nourishing samples in room conditions to a constant volume. The test to determine the effect of the thickness of wood materials includes 03 sample nests with a thickness of 7 mm respectively; 18 mm and 25 mm. The test to determine the effect of humidity consists of 03 sample nests with humidity of 7%, 12% and 18% respectively. The test to determine the effect of the heat source capacity consists of 03 sample sets with a thickness of 18 mm, humidity of 12% tested with heat source capacity of 20 kW/m^2, 35 kW/m^2 and 50 kW/m^2.

The test procedure for determining the ability to spread fire on the surface of materials vertically complies with the procedure specified in ISO 5658–2 : 2006. The test equipment is composed of three main parts, including: an open flame heating element and thermal radiation, a sensor unit that records heat flux and a synchronous computer with the manufacturer's IMO Soft software installed. Thermal radiation heaters have adjustable radiation intensity up to approx. 62 kW/m^2, surface temperature up to approx. 750 °C.

The ability to spread fire over a material's surface vertically is classified according to the critical surface heat flux intensity (Ministry of Construction (2022). In addition, to evaluate the influence of factors on the ability to spread fire on the surface of the material vertically, the length of the burnt sample and the rate of fire propagation on the surface of the wood material in the vertical direction are also noted.

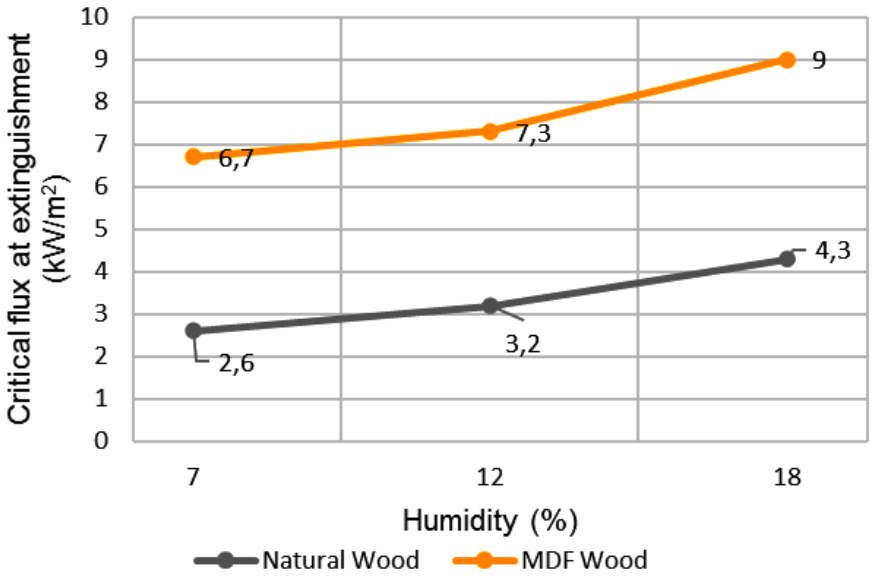
Results and discussion

The test results show that the correlation between moisture content, material thickness, heat source capacity, and ability to spread fire on the surface of the material is indicated through the critical heat flux intensity. The greater the humidity and thickness of the wood material, the increase in critical heat flux intensity corresponds to the reduced ability of fire propagation on the surface (Figure 1, 2). Conversely, the more the heat source capacity increases, the lower the critical heat flux intensity corresponding to the increased ability to spread fire on the surface (Figure 3).

Research published in Russia shows that the test results on coniferous wood are similar to the types of wood being used in Vietnam. When the moisture content of the wood is changed from 1.6 ÷ 13%, the thermal radiation intensity of the flame decreases from 29.4 ÷ ÷ 21 kW/m^2 and the flame propagation velocity decreases from 2.66 ÷ 0.91 mm/s (equivalent to a decrease of nearly 3 times) (Androsov A.S., Begishev I.R., Saleev E.P., 2007). Increased humidity, reduced heat flux intensity due to increased heat losses for heating evaporate the water contained in the wood material out of the layer the surface of the material, due to which the velocity of thermal decomposition

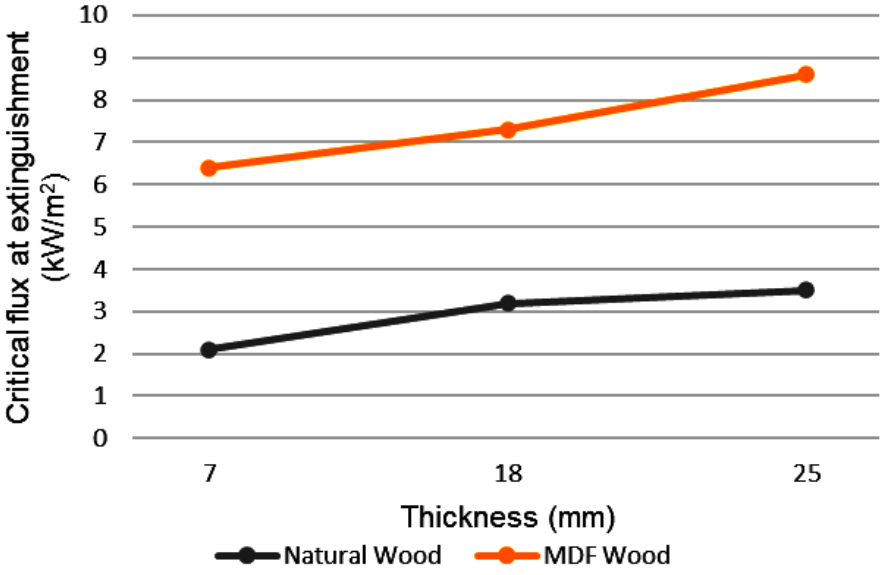
is reduced. In addition, water vapor in natural convection currents enters the combustion zone, reducing the temperature of the flame, the likelihood of radiation is reduced.

Figure 1. *The effect of moisture on the ability to spread flame over the surface of the material vertically (Nguyen Nhu Dung, Dinh Cong Hung (2023)*



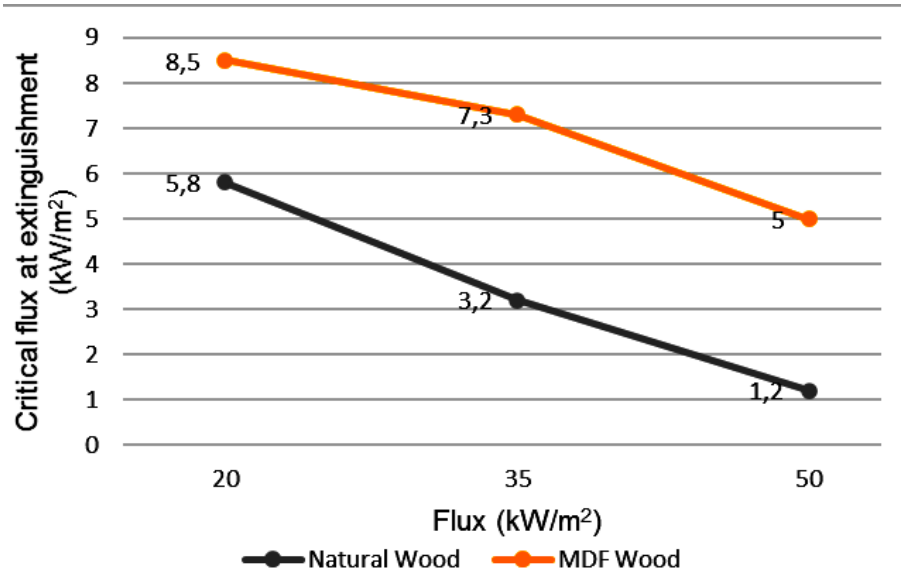
Research shows that with an increase in thickness, the rate of flame propagation decreases. As the thickness of the solid combustible substance sample increases, the flame propagation velocity decreases mainly due to the increased amount of heat and cost to heat in depth (Figure 2).

Figure 2. *The effect of material thickness on the ability to spread flame over the material surface vertically (Nguyen Nhu Dung, Dinh Cong Hung (2023)*



The smaller the heat source capacity, the greater the heat loss, the flame propagation rate slows down gradually, and the flame can be extinguished (Figure 3). The spread of flame on the surface of wood material follows the general law of flame propagation. In particular, the heat supply to create a fire reaction zone plays a major role. The heat to create the combustion reaction zone depends on the heat source capacity and heat loss from this zone to the outside.

Figure 3. *The effect of heat source capacity on the ability to spread flame over the material surface vertically (Nguyen Nhu Dung, Dinh Cong Hung (2023)*



Experimental results show that moisture, material thickness and heat source capacity have a certain effect on the ability to spread flame on the surface of vertically placed materials. From there, some solutions are proposed to limit the possibility of spreading fire on the surface of vertically placed materials as follows:

— For production: To limit the possibility of spreading fire, technical measures should be taken to limit moisture changes over a wide range. Current methods include wood drying and chemical wood preservation. For wood storage, it is necessary to classify and arrange by humidity with a safe distance for fire protection (including fresh wood, dried wood). In addition to wood drying, chemical wood preservation methods can be used to limit the impact of the environment on changes in moisture content of wood materials. For wood with a thickness of less than 5 mm such as sawdust, packaging and cardboard, wood scrap needs to focus on sorting and arranging materials in a neat warehouse with moderate density and the distance between other sorting areas is large enough to prevent fire from spreading when a fire occurs. Use thermal sensors at large material storage areas to detect fire early. In addition, flame propagation decreases when the heat source capacity or ambient temperature in a fire decreases. To reduce the ambient temperature in a fire, cooling measures should be taken to reduce the ambient temperature in the fire. The main cooling measure in Vietnam is to equip automatic fire extinguishing systems. In addition, for warehouses, wood factories need to be equipped with an automatic alarm system to detect fire early when the heat source capacity is small.

— For use: Finished wood materials put into civil use have a moisture content of 8–14%. When environmental conditions change, prolonged heat, dry weather, moisture content in wood materials decreases, increases the risk of fire spread (Androsov A. S., Begishev I. R., Saleev E. P., 2007), measures must be applied to limit the risk of fire and explosion such as strict management of heat and fire sources; use ventilation, air conditioning to limit the change in humidity in wood materials ... When using finished wood materials, it is necessary to pay attention to the thickness to limit the spread of fire on the surface of the material. Materials with a thickness greater than 5mm have the ability to limit the spread of fire on the surface of the material, and the spreading flame tends to extinguish itself gradually as the thickness of the material increases.

Conclusions

The article has proposed measures to limit the spread of fire on the vertically placed surface of natural wood and MDF artificial wood according to influencing factors including: moisture content, material thickness

and heat source capacity. At the same time, the research results found that MDF materials have the ability to limit the spread of fire on the surface better than natural wood materials due to surface treatment with flame retardant materials. To limit the spread of wood materials, artificial wood materials can be used with surface treatment with a thickness of 5mm and moisture content of 12% or more.

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submitted 22.08.2023;
accepted for publication 20.09.2023;
published 8.10.2023

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