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INSULATING MATERIAL ON THE BASIS OF BARK FIBRE OF THE OLIVE PALM TREE

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The relevance of use of bark fiber of the oil palm tree for the production of effective heat-insulating materials is justified. Compounds of heat-insulating plates on the basis of bark fiber are picked up. Results of the research of the main physico-mechanical characteristics of the developed heater are given.

Cultivation of the oil palm tree on an industrial scale began in the XX century. At that time companies manufacturing soap and margarine were engaged in the production of oil from palm fruit. Large-scale cultivation of the palm tree began in Indonesia in 1911, in Malaysia – in 1919. During that period the areas with landings of olive palm trees in the African countries began to be expanded [1].

In the last decades in connection with the world growth of consumption of palm-oil in the food and cosmetic industries the landing areas of plantations of olive palm trees have significantly increased. The leading position in production of palm-oil is taken by Malaysia. However, today, Malaysian producers of oil face the problem of recycling of a large number of the cut-down old palm trees. It should be noted that separate parts of the olive palm tree are used quite variously: fibers of young leaves are used for the production of ropes, dry leaves are used for weaving mats and curtains, and roofs for huts, stalks are used for spin baskets. Quite tasty young escapes are applied in food (palm cabbage), from juice of the palm tree wine is produced. As a rule, trunks of the cut-down trees decay, or are burned on plantations. Bark of an olive palm tree easily is removed from a trunk and has fibrous structure. 10–15% of the mass of a trunk of a palm tree fall to the share of bark. As a result, it is annually necessary to utilize about 210 thousand tons of bark [2].

At the beginning of the XX–XXIst century the relevance of use of vegetable waste has got the new reconsideration caused by ecological purity of materials and fast renewability of raw materials. In this regard, today much attention is paid to scientific research on rational recycling of crop production. Vegetable raw materials, as the main component of construction materials, have been used in the construction of various objects for hundreds of years, as they have valuable properties, such as, availability and prevalence, low density and low heat conductivity, low cost. The listed positive characteristics provide a demand and great opportunities for application of vegetable raw materials in construction [3].

For example, the natural heater "Bauplit Cocos" consisting for 85% of coconut fiber and for 15% from polyester fibers as a binding component is manufactured in Russia. The material is applied for warming of external walls, internal partitions, floors and interfloor overlappings. Moreover, "Bauplit Cocos" possesses high sound-proof characteristics. The main distinctive feature of material is high moisture resistance, thanks to the high content of lignin in coconut fiber. The lignin interferes with the emergence of mold and the destruction of fibers. "Bauplit Cocos" is capable of absorbing moisture with the subsequent return, but at the same time the structure of a heater remains former. This heat-insulating material possesses good physical characteristics: a density of 30 kg/m^3, a heat conduction coefficient of 0,038–0,042 Watt/(m·°C), its vapor permeability rate is 0,59 mg/(m·h·Pa), but at the same time it is a combustible material – group of combustibility G4 [4].

For the countries with warm climate, including Malaysia and Indonesia, the presence of thermal insulation materials in enclosing structures is also important to keep cool inside and prevent the heating of buildings, which saves on the air conditionings.

The purpose of the conducted research was to establish a possibility of use of bark fiber of the oil palm tree for the production of effective heat-insulating material. Fibers of bark of the palm tree were the main components in the heater; liquid sodium glass performed the function of binding. For increase in water resistance of liquid sodium glass additives from plaster and lime in quantity of 8% of the mass of binding were used. The quantitative structure of the components of heat-insulating plates is brought in table 1.

Table 1 – Quantitative compound of components of heat-insulating plates

Composition No.	Expense of components per 1 m^3, kg			
	Bark fiber	liquid glass	lime	gypsum
1	2	3	4	5
1	66	17	1,6	1,6
2	94	17	1,6	1,6
3	122	17	1,6	1,6
4	150	17	1,6	1,6

Table 1 Conclusion

1	2	3	4	5
5	178	17	1,6	1,6
6	66	34	3,2	3,2
7	94	34	3,2	3,2
8	122	34	3,2	3,2
9	150	34	3,2	3,2
10	178	34	3,2	3,2
11	66	51	4,8	4,8
12	94	51	4,8	4,8
13	122	51	4,8	4,8
14	150	51	4,8	4,8
15	178	51	4,8	4,8

The rresearch of physico-mechanical characteristics of the received samples has been conducted. The average density and coefficient of heat conductivity were determined on sample plates 25×25×3 cm. Durability on compression at 10% of deformation was investigated on sample cubes 10×10×10 cm. The results of the research are given in fig. 1–3.

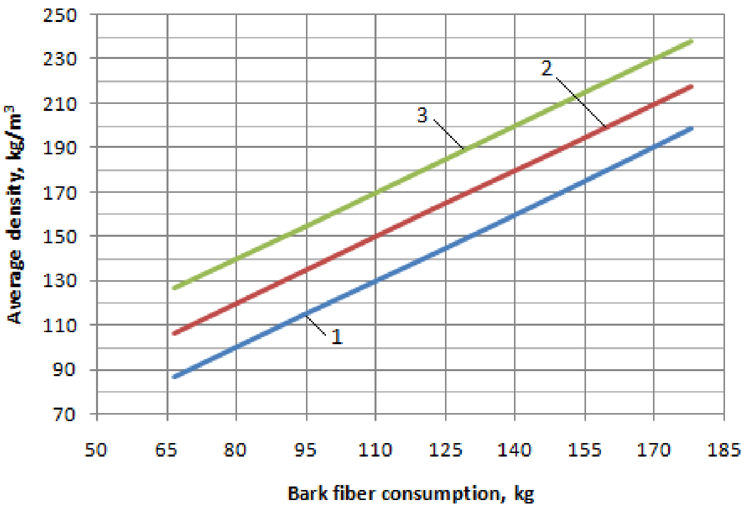

Fig. 1 – Dependence of average density of a heater on a consumption of fibers of bark:
1 – for compounds 1-5; 2 – for compounds 6–10; 3 – for compounds 11–15

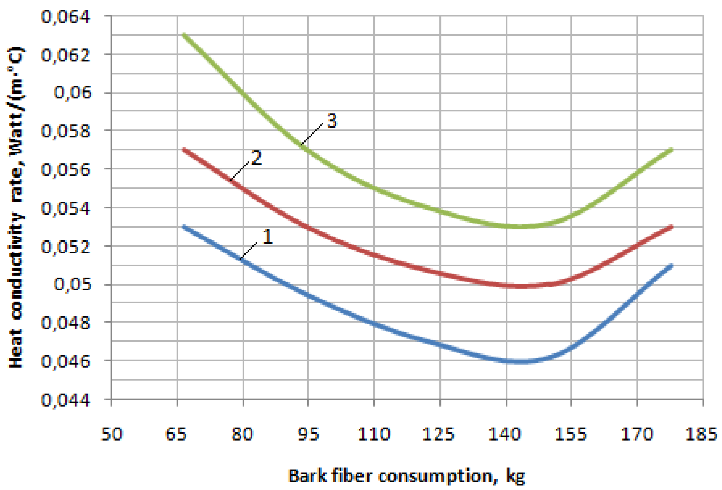

Fig. 3 – Dependence of heat conductivity rate of a heater on the consumption of bark fibers:
1 – for compounds 1–5; 2 – for compounds 6–10; 3 – for compounds 11–15

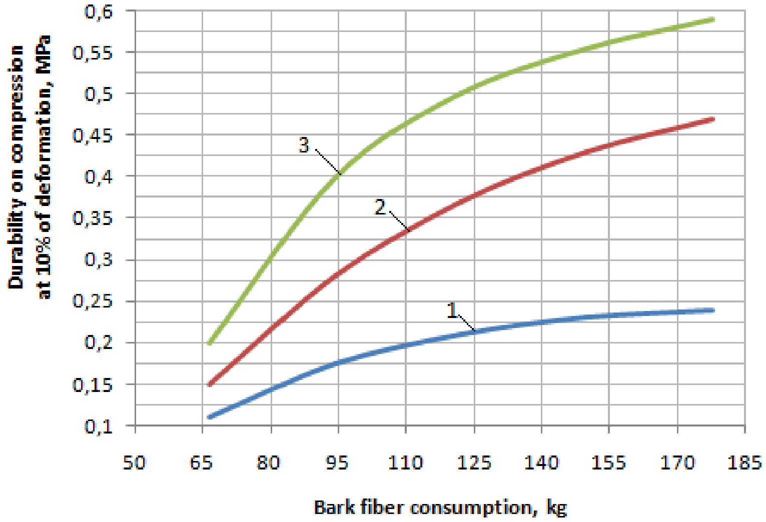

Fig. 3 – Dependence of durability on compression at 10% of deformation of a heater on the consumption of bark fiber:
1 – for compounds 1–5; 2 – for compounds 6–10; 3 – for compounds 11–15

From the obtained dependences (Fig. 1) it follows, that the variation in the amount of fibers of bark, binder and additives allows to obtain a material with an average density from 87 (compound 1) to 238 kg/m^3 (compound 15). The change of mass of fiber from 66 to 178 kg (compounds 1–5), at the fixed amount of additives leads to increase in an average density by 2,3 times up to 198 kg/m^3. For compounds 6–10 the minimum value of average density of 107 kg/m^3 corresponds to the consumption of 66 kg of aggregate, and at the maximum consumption of 178 kg of bark fiber an average density increases twice and makes 218 kg/m^3. Similar dependence is established for compounds 11–15. With the fixed amount of bark fiber, for example 178 kg per m^3 (compounds 5, 10, 15), increase in the consumption of binding and additives causes increase in an average density by 1,2 times from 198 to 238 kg/m^3. Thus, the quantitative content of bark fiber, liquid sodium glass with additives as part of a heater has significant effect on the size of average density, and allows reaching a wide range of change of this indicator.

The analysis of the received dependences (Fig. 2) allows to draw a conclusion that increase in the amount of bark fiber up to 143 kg per 1 m^3 independently on the consumption of binding and additives leads to reduction in heat conductivity rate, and further increase or reduction in the consumption of aggregate causes increase in the studied parameter. For example, at the consumption of 178 kg of aggregate per 1 m^3 for compound 5 heat conductivity makes 0,051 Watt/(m·°C). Reduction of the consumption of aggregate by 20 per cent causes decrease in coefficient of heat conductivity up to 0,046 Watt/(m·°C). Further reduction of amount of bark fiber causes increase in heat conductivity by 15 per cent up to 0,053 Watt/(m·°C). At the consumption of 66 kg of aggregate per 1 m^3 for compound 6 heat conductivity makes 0,057 Watt/(m·°C). Decrease in coefficient of heat conductivity up to 0, 05 Watt/(m·°C) happens at increase in the consumption of aggregate by 2,15 times. Further increase in amount of bark fiber leads to increase in heat conductivity rate up to 0,053 Watt/(m·°C). For compounds 11–15 the minimum value of heat conductivity rate of 0,053 Watt/(m·°C) corresponds to the consumption of 143 kg of aggregate of per 1 m^3. At the reduction of the consumption of aggregate (compound 11) it is established, that heat conductivity rate increases by 19 per cent up to 0,063 Watt/(m·°C), and at increase in amount of bark fiber (compound 15) there is an increase in the studied parameter up to 0,057 Watt/(m·°C). It is also established what with a constant mass of the aggregate, increase in the consumption of binding and additives causes increase in heat conductivity rate. For example, when using 66 kg of aggregate (compounds 1, 6, 11) the gain of heat conductivity rate makes 19 per cent. In the considered ranges of expenses of components, heat conductivity rate of a heater changes from 0,046 to 0,063 Watt/(m·°C).

The received dependences of durability (Fig. 3) demonstrate that increase in the consumption of bark fiber binding and additives leads to increase in durability at 10% of deformation from 0,11 to 0,59 MPa. For compound 5 the indicator of durability reaches the greatest value of 0,24 MPa that exceeds the indicator of compound 1 2,2 times. At the consumption of 66 kg of aggregate per 1 m^3 for compound 6 the durability on compression at 10% of deformation makes 0,15 MPa. Further increase in the consumption of bark fiber causes increase in durability by 0,32 MPa (compound 10). At the maximum consumption of 178 kg of bark fiber per 1 m^3 (compound 15) the value of durability is equal to 0,59 MPa, i.e. increases by 2,9 times in comparison with the indicator of compound 11. It should be noted that at the consumption of 66 kg of fiber of per 1 m^3, the difference between the maximum and minimum indicator of durability makes 0,09 MPa, and at 178 kg of aggregate per 1 m3 there is an increase in an interval between extreme values of durability up to 0,35 MPa.

Conclusions. Compounds 3 and 4, characterized by an average density of 142 and 170 kg / $m^{3,}$ have the best heat conductivity rates of 0,046 and 0,047 Watt/ (m·°C). Compounds 14 and 15, at the average density of 170 and 198 kg/$m^{3,}$ have the highest indicators of durability of 0, 55 and 0, 59 MPa at 10% of deformation. Thus, the composition of insulating material on the basis of bark fiber of the palm tree is selected according to the required physic-mechanical parameters of a heater.

The conducted research has confirmed the possibility of using bark fibers of the olive palm tree to obtain effective heat-insulating materials. The heater produced on the basis of this aggregate including liquid sodium glass, lime and plaster is environmentally friendly and safe for people. The use of bark fibers of the olive palm tree allows Malaysia, Indonesia and also other regions of Asia and Africa to solve the problem of recycling of vegetable waste and produce effective natural heater from local natural raw materials.

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