

UDC 674.816.3–037.87

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**NATURAL LINOLEUM AS A COMPOSITE MATERIALS BASED
ON WOOD FLOUR AND LINSEED OIL**

The article analyses one of the technologies for wood complex use and outlines the technology for the production of natural linoleum. The paper describes useful properties of one of the components of the referred floor covering (linseed oil) as well as the advantages of natural linoleum over other floor coverings: its bactericidal and antistatic action, wear resistance, fire safety, etc. However, the article points out the following drawback of the described floor covering: high cost, fragility, complicated laying.

Introduction. Economic and social forecasts, both for individual countries, including the most developed economies, and those made on a global level, assume further growth in wood consumption. However, in many countries, forest resources are extremely scarce, and the logging volumes remain at the same level or can even go down. Woodworking industry annually produces a significant amount of wastes. Some of them go back to the production process, another part is used as a fuel, a small amount of 25% is used in various industries, and the rest goes to the dumps. In these circumstances, the rational use of wood wastes is a very urgent issue.

Domestic and international experience shows that wood wastes in the form of chippings, twigs, wood chips, bark, sawdust, flakes represent cheap raw materials for the manufacture of many building materials and products, i.e. so-called new by-products.

This article focuses on the use of wood flour obtained from wood wastes as a filler in the manufacture of natural linoleum.

The object-matter of the article is to show another possible way of using woodworking wastes.

The main part. *Wood flour.* Wood flour is chopped wood, the basic mass of which (95%) goes through a sieve with a mesh size of 1.25×1.25 mm or less. The exact size of the particles of wood flour is not specified, since because of their elongated shape and the possible passing through the diagonal meshes, their linear dimensions, of course, may be greater than the linear size of the sieve clearance.

Woodworking and furniture factories have a grinding shop, in which wood dust is the main wood waste. Wood-grinding dust is a mixture of wood particles of an average size of 250 micron with abrasive powder, separated from the abrasive cloth in the process of grinding of wood material. The content of abrasive material in wood dust can be up to 1% by weight. Fractional composition of wood dust generated by grinding machines, has a range of particle sizes from 40 to 500 micron. The composition of dust formed from the same machine, is not stable and depends on several factors

such as properties of the material, its moisture, grit sandpaper, etc. The dust can be collected using pneumatic or aspiration network and be further used in the manufacture of wood flour.

Natural linoleum. The word “natural” is not quite correct to use for products made from non-synthetic materials. Such materials should be described as “of natural origin”. The two concepts should be clearly distinguished, otherwise any material or product can be called “natural”. For us “natural” means hypoallergenic and harmless to our organisms. But not all natural products meet these requirements.

Today, many people associate linoleum with smooth synthetic floor covering, but originally it was a material produced from natural plant fiber and flax oil. The word “linoleum” is derived from the Latin “oleum lini” – linseed oil.

The main components of natural linoleum are linseed oil, wood flour, pine resin, limestone powder and natural dyes. Jute hessians serve as a supporting basis [1].

The manufacturing process begins with manufacturing linoleum pulp from wood flour, resin conifers chopped lime and linseed oil. This mass matures in special thermal barrels at a constant temperature of about 33°C for a week. Then, organic dyes are added to the mass and the oxidation of linseed oil leads to the formation of colored granules. After mixing the granules of various colors and concentration, the mixture is pressed by a laminating mangle. The resulting one-meter-wide material is cut into strips, put with an overlap onto the jute basis and is again passed through the laminating mangle. As a result, an exceptionally dense structure (mass is pressed to the thickness of 5 mm to 2 cm) is obtained. The obtained strips are placed in the drying chambers, where they mature for 10–14 days and turns into linoleum by the end of the drying process. The covering is treated with a special easy-to-clean system (ETC) which contributes to increasing wear-resistance and usability of the material. After the upper layer has cured, the linoleum cloth is cut to the length of about 30 meters, packed and sent to the warehouse.

Linoleum flour can be used as a filler, which is floured waste of linoleum production. This additive accelerates the linoleum maturation, since binding agents in linoleum waste have already undergone oxidation process. Besides, the use of waste products eliminates the problem of their removal and disposal.

Properties of linoleum. Natural linoleum is distinguished at the market of building and finishing materials by a number of positive features:

- eco-friendly (made only from natural ingredients);
- bactericidal properties;
- high wear-resistance;
- fire safety;
- anti-static;
- strong resistance to chemicals;
- service life of over 20 years.

Natural linoleum has natural antibacterial properties and is easy to disinfect, clean and maintain. So it is widely used in medical, recreational, as well as children's and educational institutions (kindergartens, schools, universities). Bacteriostatic activity (the ability to inhibit bacterial growth) is exerted due to the constituent linseed oil. Linseed oil itself is a therapeutic and prophylactic agent. The most important components of linseed oil are unsaturated fatty acids. These acids actively impede the growth of bacteria and help to reduce the cholesterol level in blood. In addition, they reduce cancer risk and contribute to considerable decrease in allergic and inflammatory reactions, etc. The test results confirm the action of natural linoleum against rainbow *Staphylococcus* bacteria. This property of linoleum is not affected by the impact of water, because the oil is not water-soluble.

According to EN 433, the residual strain is determined at pressing of a flat punch with a given force for 150 minutes and for another 150 minutes after the load has been removed. The mean value of the pressed surface depth for 3.2 mm covering should not exceed 0.15 mm, and 0.2 mm for thicker covers respectively. Due to such small residual strains the natural linoleum can be used in premises where floors are exposed to heavy wear.

In accordance with DIN 4102, defining the fire resistance of construction materials, natural linoleum belongs to B1 class (difficult to ignite).

EN 1399 defines the resistance of elastic coatings against the effects of lit cigarette when pressing it into the material and its smoldering. In the first case the linoleum should be free from any visible spots after being cleaned with abrasive materials, in the second case, however, there can be a slight color change.

Linoleum is resistant to dilute acids, alcohol, fats, but is destroyed by long-term exposure to alkali.

By its nature, linoleum is antistatic and therefore does not attract dust. A floor covering can be described as antistatic, which is charged with maximum 2 kV when walking on it in PVC-sole shoes. Linoleum is charged with maximum 0.8 kV in these conditions. Certain types of linoleum have improved slipping resistance (R10) and are recommended for floors with special slipping resistance requirements.

An important indicator is the level of light resistance (EN 20105-B02). Coverings may have light resistance ranging from 1 to 8 points. The light resistance of linoleum is 6 points.

Linoleum has good heat insulating properties. The level of its heat conduction is directly dependent on its thickness. For example, thermal resistance of 2 mm-covering is 0.012 (m²·K)/W, that of 4 mm-covering is 0.023 (m²·K)/W. (Heat-insulating properties are considered by the example of linoleum produced by Armstrong DLW).

The acoustic properties of linoleum also depend on its thickness. The linoleum glued directly to the ground reduces noise by 3–6 dB. Special sound-absorbing padding or combined cork-based linoleum will reduce noise by 14–16 dB and at the same time will improve heat insulating properties of the floor (sound absorption requirements are specified by DIN 4109).

A so-called “maturation fog” is a specific feature of natural linoleum which is a temporary change in colour of linoleum disappearing under UV exposure. The “maturation fog” occurs with the oils dryout. Depending on the colour of covering the “maturation fog” can be of different colour: blue and gray colours turn into green, white colour into yellow. Some yellow and red coloured coverings do not reveal any “maturation fog”.

Sun light reduces the development of “maturation fog”. This effect can be reduced by 80%, the linoleum being exposed to the midday sun for about one hour in clear weather and for three hours in cloudy weather. It will take a few weeks to achieve the same effect in relatively dark rooms with scattered light. Thus, if the linoleum cloth is cut both outdoors and indoors, different cloth parts will get different color shades. The same effect will occur if the linoleum is laid in bright sunny room and then the work is suspended for the weekend time. Because of a longer exposure to light the material laid earlier will not match the colour of the one laid later in time.

The colour difference in rooms with scattered light will become even very slowly. If, for example, one part (exposed to bright light for longer time) loses its “maturation fog” by 50%, and the other part only by 30%, this difference of 20% will remain as long as both parts completely “lose”

their “maturation fog”. Indoors, this process can take weeks.

The following shortcomings of the floor covering should be taken into consideration:

- High cost.

Natural linoleum is more expensive than any other being as much as one and a half to twice as expensive. In general, this is the main reason why it is less widely used than PVC linoleum. Although, if you compare the cost to the service life, this cost is quite reasonable.

- Fragility.

The material is not to be folded, otherwise it will break.

- Complicated laying.

For the floor covering to have a long service life, it should be laid onto an even surface. The linoleum roll should not be folded or thrown due to the risk of its breaking. It should be left unrolled indoors for at least one day. In the course of linoleum production, hilly strips may occur on its surface, they should be evened with a heavy roller. After

linoleum has been glued, its surface should be left free for the next 5 days, in order to avoid dents.

Conclusion. In view of the foregoing, it can be said that the production of the floor covering is highly promising for the Republic of Belarus, since it is a durable and environmentally friendly product. It should also be noted that this material is import substitution, which is in high demand in Western Europe.

The analysis of the above material resulted in the following tasks:

1. development of reutilizing technology for the linoleum production;
2. defining optimal conditions of production and consumption rates.

References

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Received 16.03.2012