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To cite this article: D O Chernyshev *et al* 2019 *J. Phys.: Conf. Ser.* **1177** 012002

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# Innovative material based on wood waste for application in special purpose vehicles

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**Abstract.** The article presents innovative composite wood material «DS-1» with a powder binding, which is used in special purpose vehicles. Vehicles for transporting radioactive waste for its recycling and disposal, and radiodiagnostics mobile complexes intended for conducting massive X-ray have been considered. The composition of material «DS-1» has been revealed, experiments have been listed and a table with physical and mechanical properties has been given. Relying on experimental analysis data it can be concluded that implementation of innovative composite material «DS-1» with a powder binder using barium sulphate helps solve the problem of lead replacement with lighter environmentally friendly material and contributes to complex use of wood raw materials Using a low-toxic binder in the material obtained makes its production innocuous and environmentally friendly and solves a number of economic and energy-saving problems.

## 1. Introduction

At all times transport has been of great importance for any nation. Nowadays, there is practically no state that can manage without motor transport. Recently, careful attention has been focused on the development of special-purpose vehicles. Innovative technologies for updating technological elements and mechanisms are being developed and introduced in transport industry. Due to the market development, vehicles production and new technological structure shaping present an urgent demand for speeding-up the motor transport development. This fact puts innovative modifications in the forefront as a crucial factor in long-term automobile industry development. [4]

Special purpose vehicles are widely used for a variety of jobs, practically, in all major industries. In order to increase special vehicles' efficiency, service life and improve their performance specially designed and manufactured modern materials are used.

Design, technical characteristics, overall dimensions and other parameters of a vehicle depend on the task to be completed.

Freight service is a sector of economy in demand. It is proved that the growth of the market is accompanied by motor transport development. As production is growing, the amount of waste is increasing. Transporting, disposing and recycling of waste are vital problems nowadays. To transport radioactive waste for processing and long-term storage, special purpose vehicles are used. To ensure the safety of the driver and the passenger, a barrier in the form of a lead sheet is installed on the rear



wall of the cab under the trimming. On the front of the body from its outside, a protective wall of sheet lead is installed. [7]

A multi-section isothermal van is used In mobile radiodiagnostics complexes for mass X-ray examinations, lead plates are mounted on its walls under the trimming (Figure 1).



**Figure 1.** A multi-section isothermal van.

The lead is known to be a naturally toxic metal. Human exposure to lead always have consequences. Inhalation of lead particles when processing secondary raw materials causes great harm to the human body. Special expensive disposal is required for products made of lead. Lead is a heavy metal, its density ( $11,34 \text{ g / cm}^3$ ) exceeds that of iron by 1,5 times, 4 times that of aluminum. This makes special purpose vehicle heavy.

Since in today's world careful attention is confined to keeping human life and health safe, a matter of concern is how to substitute lead for lighter, environmentally friendly material. There is a way to develop an innovative material based on wood waste for special purpose vehicles. [1-3]

## 2. Experimental results

In this paper, we present our material - the «DS-1» plate which is a finely dispersed composite wood material with a powder binder. To obtain this material, the following works have been carried out:

- production technique development;
- obtaining low-toxic material;
- laboratory samples tests to determine basic physical, mechanical, protective and other properties;
- preliminary assessment of its production and application reasonability

We have devised a formula (percentage of components) for a wood-glue composition of material «DS-1» and developed its production technique. The new material «DS-1» has X-ray protective properties. The composition of the material is the following: sawdust particles less than 2 mm, dry glue powder and barium sulphate powder. [6] The production technique for the material resembles the technique for woodchip board manufacturing. [5,9,10] Experiments were conducted in compliance with standard procedures: determination of density, tensile strength in static bending, thickness swelling, toxicity, Brinell hardness, impact toughness, radiation attenuation rate (performed with hard beam radiation), cutting force value. The influence of wood-adhesive composition components number on the chemical formula and material microstructure has been revealed. The experiment results have been processed with mathematical methods. Physical and mechanical properties of a new composite material are given in table 1.

**Table 1.** Physical and mechanical properties

| Index   | DS-1                      |
|---|---------------------------|
| Toxicity, E<br>(free formaldehyde emission)                                     | E0.5 (up to 5 mg / 100 g) |
| Density (kg / m <sup>3</sup> )  | 1100-1200                 |
| Humidity (%)  | 2-3                       |
| Strength at static bending (MPa), for thicknesses<br>from 10 to 14 mm inclusive | 15-19                     |
| Hardness (MPa)  | 70-80                     |
| Impact strength (J / m <sup>2</sup> )   | 20000-50000               |
| Swelling (%)  | 8-13                      |
| Average lead equivalent, Pb, (mm)   | 0,3-0,9                   |

Table data indicates that composite material obtained «DS-1» has high performance characteristics.

The material obtained :

- practically non-toxic;
- has high heat insulation;
- has high fire resistance;
- easily sawn;
- protects against radiation of different types (for example, Y radiation, X-rays, electromagnetic radiation, etc.);
- has density of 1,15 g / cm<sup>3</sup> (10 times lower than the density of lead).

To refine its appearance the material can be painted, varnished, or coated with paper-resin films, paper-laminated plastics, natural veneer.

## 3. Conclusion

The economy development of the requires new materials with various qualities. Such materials are to be environmentally friendly and safe for the consumer. The implementation of innovative composite material «DS-1» helps solve the problem of lead replacement with lighter environmentally friendly material and contributes to complex use of wood raw materials. Using a low-toxic binder in the material obtained makes its production innocuous and environmentally friendly and solves a

number of economic and energy-saving problems. The material is advisable for cabs of special purpose vehicle intended for transporting radioactive waste for recycling, and for multisectional isothermal vans of mobile radiodiagnostics complexes intended for conducting mass X-ray examinations, as well as for X-ray rooms' walls, floors, ceilings, screens, door blocks, etc. Comparing the scientific and technological level of our work with the best achievements in this field, we can claim that the obtained composite material has no analogue in the world. The innovative composite material «DS-1» is competitive with lead.

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