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TOXICITY REDUCTION AND SHORTENING PROCESS OF GLUING PLYWOOD AND PARTICLEBOARD BY MODIFYING ADHESIVES

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ABSTRACT

Reducing the toxicity and shortening of the manufacturing process of plywood and particleboard - these are the main tasks for a manufacturer of wooden materials. Modification of urea - and phenol-formaldehyde resins shungite and aluminosilicates sorbents can solve these problems.

Introduction of these adsorbents in the adhesive compositions reduces formaldehyde emission by absorbing the latter and accelerates curing of the adhesive by the action of alkali metal oxides.

Key words: plywood, particleboard, gluing, formaldehyde emission

1. INTRODUCTION

One of the actual problems of the industry for production of plywood and particleboard is to develop new low-toxic, fast hardening glues or to improve the existing adhesives with advanced properties, i.e. to change the properties of adhesive resins efficiently by modifying them.

For several years the St. Petersburg Forest Technical University has been carrying out investigations on the use of modified silica powder dispersed, aluminosilicate and shungite sorbents urea - and phenol-formaldehyde resins for gluing plywood and particleboard [1,2]. The most effective of these are shungites. The mineral composition and structure of shungite yields a significant reduction in emissions of formaldehyde of glue, and of finished products and accelerates the hardening of the modified adhesives.

2. METHOD OF INVESTIGATION

For the research we used the phenol - formaldehyde and urea - formaldehyde resins that have modified silica fine powder with a particle size of 0.005-0.01 mm, or aluminosilicates particle sizes 0.2-0.8 mm, or a shungites particles 0.2 - 0.8 mm. The properties investigated were the effect of these modifiers on conditional viscosity, pot life, time of hardening and formaldehyde emission.

Studies were performed using spectral analysis and electronic microscopy. Formaldehyde emission was determined by gas analysis. The electronic microscopy revealed micro-structural features where shungite sorbents determined the size and shape of their cavities and pores.

3. RESULTS AND ANALYSIS

The results of experimental investigations have shown that all used modifiers can reduce the duration of the curing process of the adhesive (see Table 1, 2) and aluminosilicates, whereas schungite sorbents considerably reduce the emission of free formaldehyde of glue (Fig. 1, 2) and of plywood and particleboard. Best results are obtained when using as a modifier schungite sorbents with a particle size of 0.2 mm. The content of free formaldehyde phenol - formaldehyde resins decreases from 0.18 to 0.04 %, urea - formaldehyde adhesive - from 0.18 to 0.03%, curing time is reduced by 6-8 %.

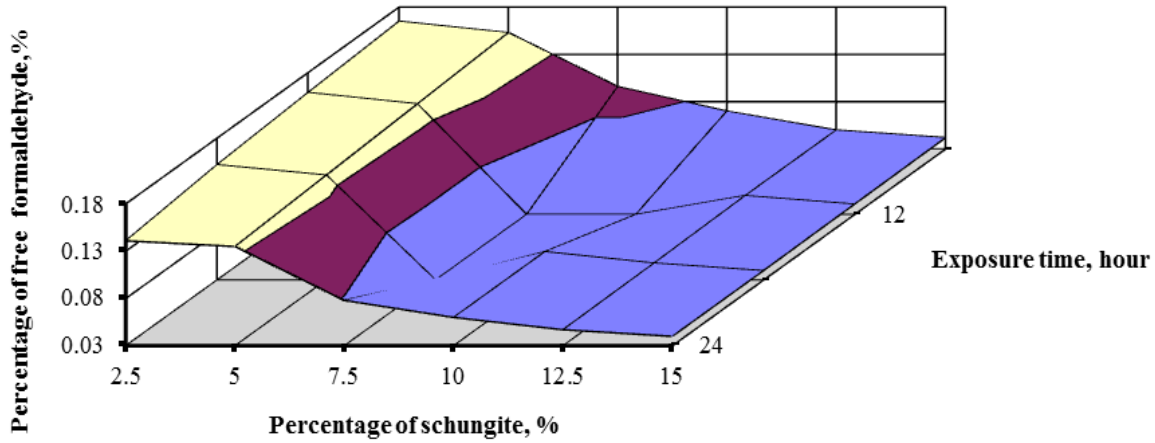

Figure. 1. *Dependence of the free formaldehyde content in phenol – formaldehyde glue on the percentage shungites and the exposure time after preparation*

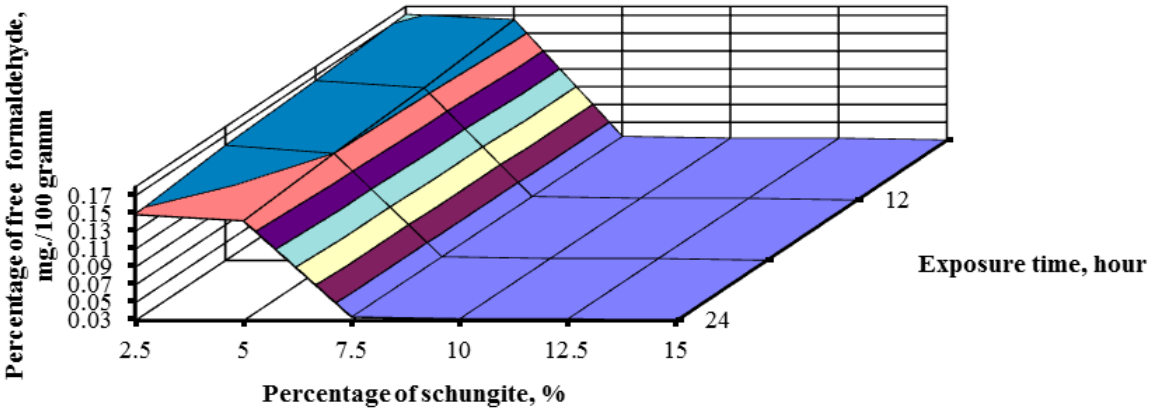

Figure 2. *Dependence of free formaldehyde content in urea – formaldehyde glue on the percentage of shungites and exposure time after preparation*

Use of aluminosilicates and schungite sorbents as modifiers also reduces water absorption of particleboard and increases the strength of plywood.

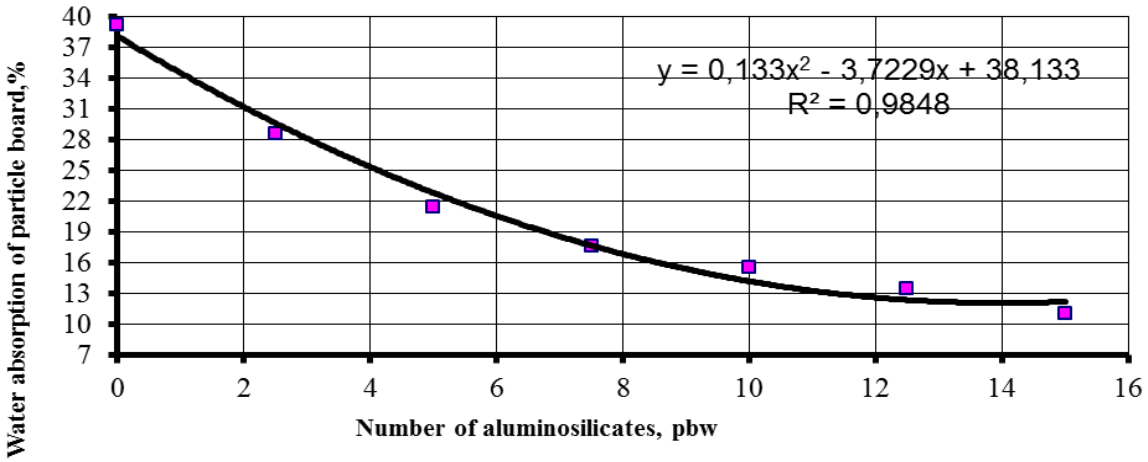

Figure 3. *Dependence of water absorption on the amount of aluminosilicates in urea - formaldehyde glue*

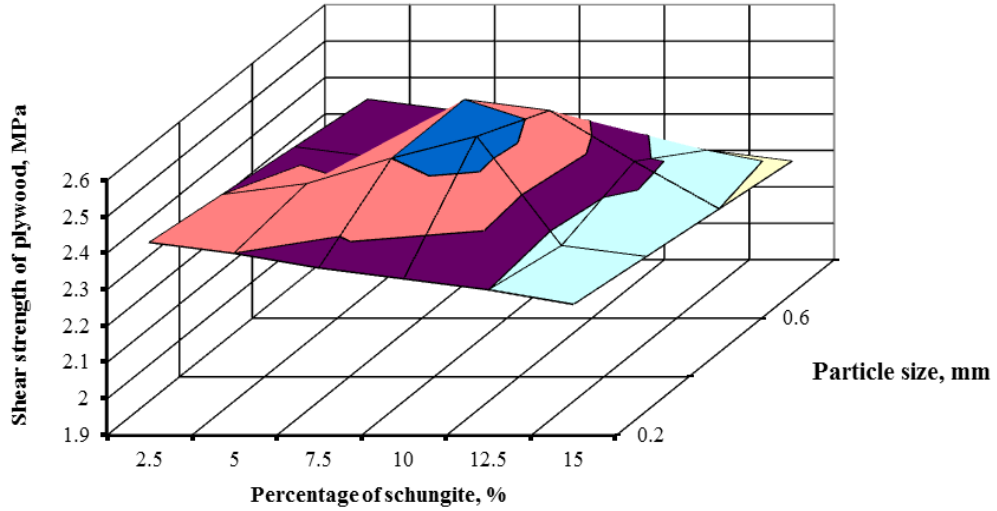

Figure 4. *Dependence the shear strength of plywood on the percentage of shungites in phenol - formaldehyde glue*

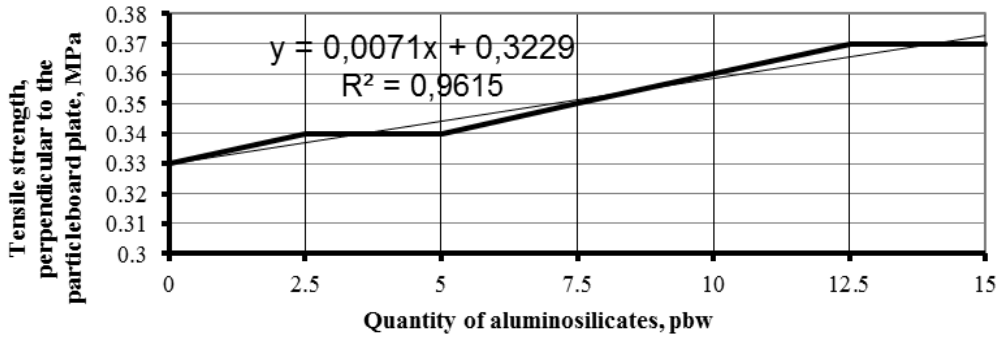

Figure 5. *Dependence of tensile strength perpendicular to the particleboard plate on the amount of aluminosilicates in urea – formaldehyde glue*

The positive effect on the reduction of formaldehyde emission is achieved due, primarily, to the sorption ability of aluminosilicates and schungites representing silicon and aluminum (aluminosilicates) and silicon and carbon (schungites) skeletons which contain free cavities (Fig. 6,7) and are able to absorb free formaldehyde. Schungites give more effect which is enhanced due to its interaction with water to release atomic oxygen, oxidizing adsorbed organic substances to form CO_2 and H_2O [7].

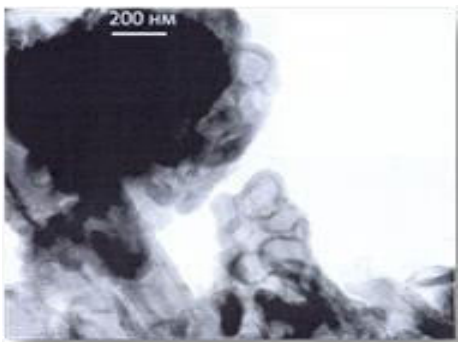

Figure 6. *Cavity (channel) on the shungites surface (magnification 75,000 times)*

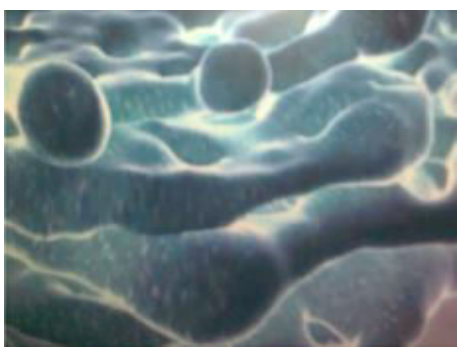

Figure 7. *Channels on the schungites surface (magnification 56,000 times)*

Acceleration of the process of adhesive hardening may be as a result of the catalytic properties of alkali metal oxides and ions of items I and II in the Periodic Table.

Improvement in the strength and water resistance of wood based materials can be explained by an increase in the degree of structuring of the adhesive upon hardening, reducing the amount of hydrophilic methylol groups, increasing the molecular weight of the composition when aluminosilicates or schungites are added to adhesives.

4. CONCLUSIONS

Introduction of the urea-formaldehyde resins as sorbents shungite or aluminosilicates accelerates hardening of the glue composition due to presence of reactive elements.

Use shungites or aluminosilicates as modifiers of urea-formaldehyde and phenol-formaldehyde resins to reduce their toxicity, which is due to the composition, structure and adsorption properties of this natural material.

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