Use of irretrievable waste flax and cotton for production of heat-insulating plates

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Abstract. In the article the method of utilization of irrevocable waste of spinning of a flax and cotton is considered. It is offered to use waste as filler for production of heat-insulating composite plates. The difficulties of use of irreparable dust-like waste as filler of composite plates are caused by considerable damage of vegetable fibers, increase in absorbency binding in filler, a big specific surface of particles. The composite materials from dust-like vegetable waste are produced by the technology of fiber boards of a wet way of production. As binding phenol formaldehyde resin is used. Increase in a share of additive of pitch leads to the increase in durability of material. At all modes of production and any share of additive binding stronger are composite materials from dust-like waste of processing of a flax. The mass fraction binding in composite material doesn't exert significant impact on the coefficient of plate heat conductivity.

1. Introduction

Processes of spinning of vegetable fibers are followed by formation of a significant amount of waste as returned in production, and irretrievable, burned or sent to a dump. The fact that the volume of the waste going for burial decreases ten times [1] is considered the main advantage of burning of waste. However, by data the Greenpeace, emissions of the toxic substances in the atmosphere which are formed when burning garbage lead to such diseases as cancer, diseases of respiratory and cardiovascular systems, violations of immunity, growth of number of allergic reactions and congenital anomalies [2]. Conclusions of many researches concern generally old technologies of burning of waste [3-7], however, and the modern technologies which are put into operation in the last several years continue to do harm to health of the person [8]. Even use of the technologies reducing emissions of toxic substances in the atmosphere can't prevent return them to the environment from places of burial of ashes and slags [9,10]. The waste disposal share on grounds for garbage has around the world increased. Now goes to burial up to 60% of the waste made in EU countries, and growth of their volumes in 2010 was 20% in relation to 1995 [11].

The negative impact of growth of waste on the biosphere causes relevance of works on development of ways of recycling by return to the production sphere.

2. Discussion of results
In processes of production of textile fibers (in particular, cotton and linen) a number of waste is formed. Waste is subdivided on returnable (used and not used in production) and irretrievable. Used in production waste which can be consumed by the enterprise for production of production of the main or auxiliary production [12] are considered as returnable.

Not used in production waste which can be consumed by the enterprise only as materials, fuel, for other economic needs are considered as returnable or are realized on the party. Waste which can't be used at this condition of the equipment, and technological losses are considered as irretrievable: waste, shrinkage, volatilization, etc. At the same time irretrievable waste isn't subject to assessment.

According to the Interstate standard 30772-2001 "Resource-saving. The address with waste. Terms and definitions" are understood as irretrievable waste (losses) production wastes which are impossible, inexpedient to be reused (inefficiently) or inadmissibly. All initial quantity of the useful components which are contained in raw materials can't be processed into the final product of production as irretrievable waste and technological losses which have no cost category in connection with low contents in them useful components are result of production activity.

Use of fine waste as filler of composite slabby materials is possible. A problem in development of such materials is creation of steady structure from vegetable filler and a matrix – binding. The Russian and European researchers note that properties binding exert significant impact on indicators of composite materials [13-18]. The greatest number of composite slabby materials in the European industry is made urea-formaldehyde resin (UF) – 90 … 92%, phenol formaldehyde binding (PF) – 92 … 95 % [19].

According to this classification the dust-like waste of spinning of a flax and cotton utilized by burning or directed to a dump belongs to irretrievable waste. The researches directed to processing of this type of waste aren't found in literature.

Dynamics of growth of volumes of waste and ecological consequences of processes of warehousing and burning force to look for new methods of their utilization. The possible direction of utilization of irretrievable dust-like waste of spinning of a flax and cotton is their use in production of heat-insulating composites.

3. Experimental part
Difficulties of use of irretrievable dust-like waste as filler of composite slabs are caused by considerable damage of vegetable fibers, increase in absorbency binding in filler, a big specific surface of particles. About it it is possible to judge by the photos of vegetable waste received during the researches with use of a microscope of MS of 20.1 (figure 1, 2, 3).

**Figure 1.** Change of structure and the sizes of vegetable filler at cotton fiber processing.  
**Figure 2.** Change of structure and the sizes of vegetable filler when processing fiber of waste of processing of cotton.
In laboratory of department of Logging and woodworking productions (LDP) of the Kostroma State University (KSU) the way of receiving construction composite plates from irrevocable waste of textile productions is developed.

Analog for development of composite material are fiber boards (fibreboards) of a wet way of production. The most power - and a fibreboard of a wet way, labor-intensive in the course of production, are operations of grind of wood raw materials on fiber. Use of dust-like waste of cotton and flax as filler of composite plates allows to lower costs of production of material significantly.

Composite material of heat-insulating appointment was made average density of 275 kg/m$^3$. Samples of material dried at 100 °C. As binding it was used phenol-formaldehyde resin (PF) with a different expense (%). The mass fraction of binder varied for ensuring durability of plates necessary for heat-insulating materials.

Results of definition of physicomechanical indicators and coefficient of heat conductivity of materials are presented in table 1.

![Figure 3. Flax processing waste.](image)

**Table 1.** Physicomechanical indicators of composites

| Binder consumption, % (above the line for cotton slabs, under the line for flax plates) | 2     | 4     | 8     | 12    | 16    | 20    | 24    | 30    |
|---------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Density $\rho$, kg/m$^3$         |       |       |       |       |       |       |       |       |
| 267                             | 264   | 265   | 268   | 271   | 272   | 270   | 268   | 266   |
| 273                             | 272   | 275   | 267   | 269   | 270   | 268   | 274   |
| Bending strength $\sigma$, MPa  | 0.32  | 0.35  | 0.38  | 0.41  | 0.43  | 0.45  | 0.47  | 0.49  |
| 0.47                            | 0.48  | 0.49  | 0.50  | 0.52  | 0.54  | 0.58  | 0.63  |
| Swelling on thickness $P_b$, %   | 20.5  | 19.5  | 18.4  | 17.4  | 16.4  | 15.3  | 14.4  | 13.6  |
| 14.0                            | 13.4  | 12.6  | 11.4  | 10.1  | 9.2   | 8.7   | 7.5   |
| Water absorption $W$, %         | 215   | 208   | 200   | 191   | 182   | 171   | 162   | 150   |
| 197                            | 189   | 180   | 169   | 160   | 152   | 144   | 130   |
| Coefficient heat conductivity $W / (m\cdot K)$ | 0.083 | 0.084 | 0.085 | 0.086 | 0.087 | 0.088 | 0.089 | 0.09  |
| 0.050                           | 0.051 | 0.052 | 0.053 | 0.054 | 0.055 | 0.056 | 0.058 |

4. Conclusions

Increase in a share of phenol-formaldehyde resin additive leads to increase in durability of material, and at all modes of production and any share of additive binding stronger are composite materials from dust-like waste of processing of a flax.

Plates from dust-like waste of processing of a flax conform to standard requirements for durability at a share of additive of 2-30% on weight, from cotton at additive of binding over 12% on weight.
The mass fraction binding in composite material doesn't exert significant impact on coefficient of heat conductivity of plates. The obtained experimental data allow to recommend as utilization of irrevocable dust-like waste of spinning of linen and cotton fibers use them as filler of composite slabby materials. Slabby materials are intended for use as a heat-insulating element of building constructions.

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