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Physical and Mechanical Properties of Roll Materials Made of Local Raw Materials

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ABSTRACT: The article presents the results of experiments on the development of coiled insulating material based on gossypol resin bitumen and provides indicators of physical, mechanical and technological research.

KEYWORDS: gossypol resin, basalt fabric, secondary polyethylene, conditional strength, porosity, moisture absorption, elasticity, thermal analysis.

INTRODUCTION

The production of rolled roofing material is a costly process, the cost of cardboard, bitumen and fillers are 80-85% of the total production costs. Improving the exploitation properties and reducing the cost of this type of material can be achieved by modifying the bitumen binder or using non-conventional bitumen and choosing the right fillers.

To this day, despite the diversity of the names of companies that produce roll materials, the structure of the products they produce, the bases used in the composition and the binding materials are almost the same. They use petroleum bitumen as binders in the amount of 70-80% of the total mass. When choosing a technical solution for roofing and repair work should take into account not only the initial cost of the work and roofing materials, but also its physical and mechanical properties, and most importantly long-term durability, ie they require at least 20 years of service [1].

PROBLEM STATEMENT

The creation of a new generation of roll materials, which is free from the existing shortcomings in the roll materials used to this day, is a pressing issue. In this article, the competitiveness of this type of products high-efficiency, low-cost, easily accessible raw materials, based on the waste of fat-oil combinant was proved by a comparative study of physical and mechanical properties.

RESEARCH METHODS

The research used chemistry, analytical chemistry and modern physicochemical methods.

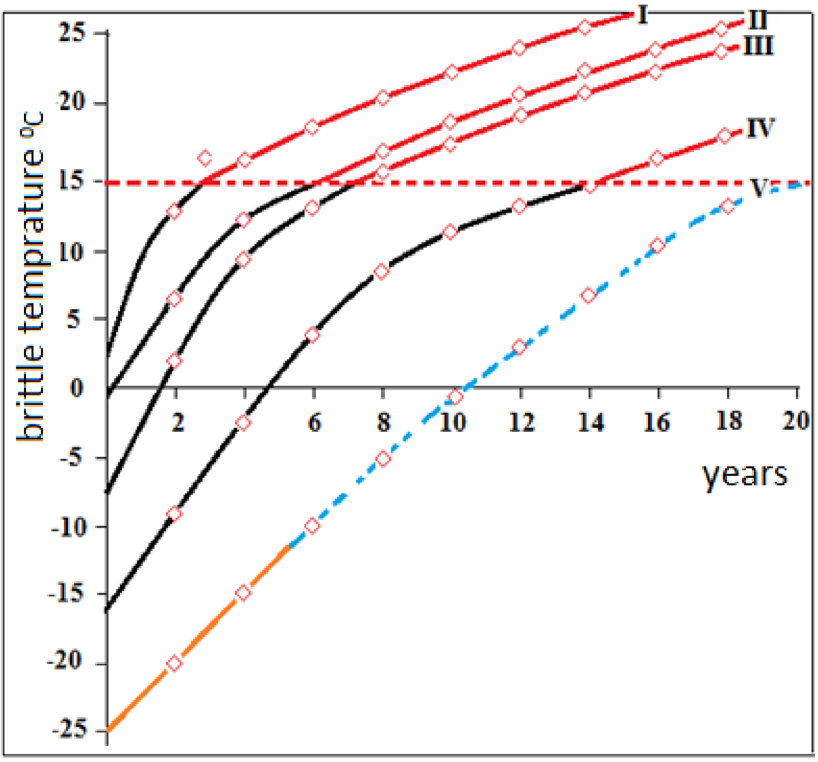
THE PURPOSE OF THE RESEARCH

The purpose of this scientific work is to test the physical and mechanical properties of roll materials based on industrial waste and local raw materials in modern methods.

PART OF RESEARCH

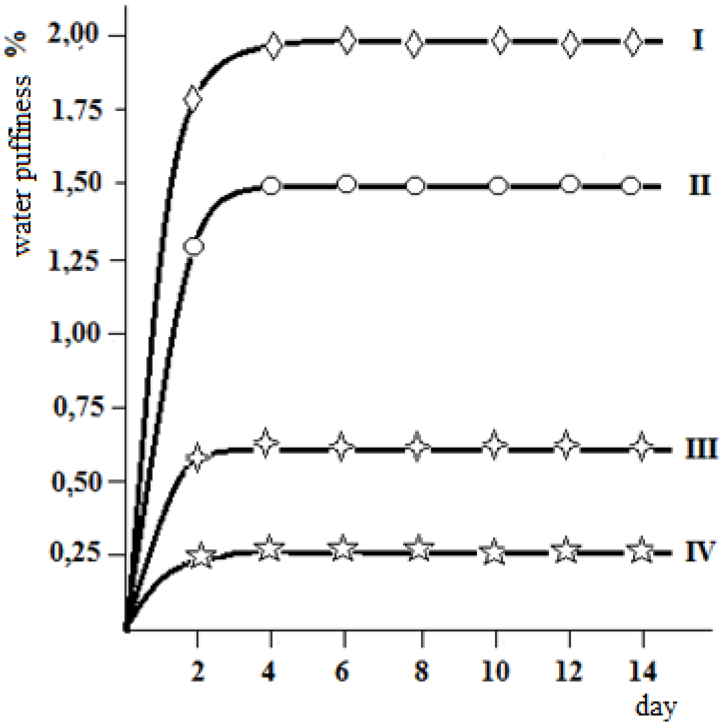
In the production of a new generation of roll materials used non-traditional materials gossypol resin-based bitumens, basalt fibers, secondary polyethylene and other resources. The main object in determining the physical and mechanical properties of the new generation of roll material is the following of the composition in percentage - bitumen based on gossypol - 80.0; rubber resin (0.1mm) - 5.0; basalt fiber- 3.0; secondary polyethylene - 7.0; talc-5.0, was tested.

The brittleness temperature is one of the most important factors in any roll materials. It is known that the material is considered unusable when this value exceeds 15 ^{0}C. We began the first series of our research with a comparative study of the change in brittleness index of the composition created over the years. This is because the wear of the resulting composition under the influence of heat is directly related to the service life. In a comparative study of these indexes, 1-ruberoid, 2-synthetic fiber roll material, 3-glass fiber composition, 4-asbestos fiber and 5-basalt fiber roll materials were tested. The results are shown in Picture 1. According to the results of the comparative study, the superiority of the brittle properties of the new composition over other analogues and its compliance with all standards was scientifically and practically justified.



Picture 1

In the later stages of the study, we tested the water puffiness of the above materials relative to the above analogues. The results are shown in Picture 2.



Picture 2

The main parameters of the created compositions were determined in subsequent resears in given in the requirements of GOST 2678 comparison with ruberoid. The results of the study are presented in Table 1.

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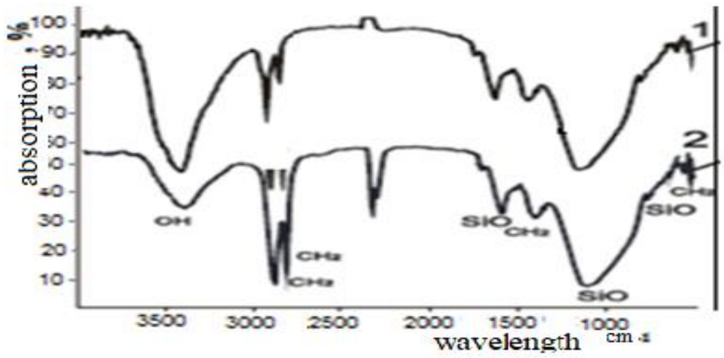
Table 1. Comparative physical and mechanical properties of bituminous roll materials based on ruberoid and gossypol resin

Material	Conditional strength	In stretching delay power H	Flexibility R=20 мм ^0C	Strength in bonding with concrete MPa, not less	Bending in the temperature range	water puffiness in 24 hours, %	Water conductivity during 72 hours 0,001MPa	Service life, year
Ruberoid	5.6	220 - 340	5	0.45	15,0	5,0	2,0	5
Gosizol	7,8	600-650	0	0,61	-55 +100	2,0	not swallowed	30

The presence of bitumen matrix and basalt fibers (length 15-20 mm) in the roll materials provides a certain degree of elasticity. The irregular arrangement of these fibers ensures smooth physicochemical performance throughout the material. IR spectra of the constituents of the obtained composition were studied in the range of 400-4000 cm $^{-1}$. The samples being tested were crushed on an agate stupa and placed between NaCl and KBr plates. Hexachlorobutadiene was used as an immersion fluid in the recording of high-quality spectra in the 4000-2000 and 1500-1300 cm $^{-1}$ regions, and Vaseline oil was used in the 2000-1500 and 1300-400 cm $^{-1}$ regions.



Picture 3. IR spectra:

1- basalt fiber; 2 - polyethylene + basalt fiber.

As can be seen in the figure, the valence oscillations of the silicon-oxygen chain Si-O in a wide-density feldspar of length 1145 cm $^{-1}$ are repeated in the anorite $CaO \bullet Al_2O_3 \bullet 2SiO_2$, albite $Na_2O \bullet Al_2O_3 \bullet 6SiO_2$ and the solid solution $[SiO_3]^{2-}$ $[SiO_4]^{4-}$ one, two, three, four, five, seven tetrahedral chains are distinguished. The main active groups are Si-O, AI-O bonds and Si-O-Si and O-Si-O silicon-oxygen bridges. Basalt contains a nosymmetric compound $2MgO \bullet SiO_2$ - $2FeO \bullet SiO_2$, the component of which is an isolated $[SiO_4]^{4-}$ tetrahedron. The heterogeneity of the distribution of the Si-O bond and other bonds in the basalt composition is very weak at a distance of 800 cm^{-1}. The oscillations of the Si - O bond are characteristic of the hydroxyl oscillations of the lowest maximum N3O $^+$ ions at a maximum of 1750 cm $^{-1}$.

For basalt fiber-polyethylene samples, the maximum intensity of the assimilation range of vibrations of CH_2 groups is 2 times more than 2922 cm $^{-1}$ and 2852 cm $^{-1}$. This is also explained by the presence of secondary polyethylene in the samples. However, no shift in these maxima was observed in the IR spectra of all samples. This means that the interaction of polyethylene films with the active centers of the basalt fiber surface does not affect the strength of -C - C - C - and - C - H - compounds. But there is a deformation of these relations. All levels 1466 cm $^{-1}$ and 1469 cm $^{-1}$, which is caused by vibrations, showed the presence of polyethylene in the IR spectra of the samples. At a maximum height of 1375 cm $^{-1}$ vibration of CH2 groups occur.

The thermal stability of the obtained materials was also assessed by the thermogravimetric analysis method. Samples of composite material obtained under laboratory conditions are characterized by low mass losses up to 300 ° C (Table 2).

Table 2. Differential thermal analysis of roll material based on basal fibers and secondary polymers

Composition	The main stages of destruction		Weight loss at a temperature of °C., %						E_{akt}, KJ / mol
	T_n-T_k, ^0C / T_{max}	M_n-M_k, % M_{max}	100	200	300	400	500	600	
Polyethylene + Basalt layer	160-240 200 330-540 390;470	0-4 2 10-37 18;35	0	2	7	20	37	37	32,95

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Thermo gravimetric analysis showed that the mass loss for basalt fiber modified materials was 24% less. When secondary polyethylene was used to obtain the roll material, the mass loss was reduced according to the TGA compared to the primary polyethylene-based sample and was 30-37%, respectively. This indicates the emergence of structural processes in the processing of polyethylene and leads to a high level of heat resistance, however, it reaffirms the effectiveness and expediency of using secondary polyethylene to obtain layered materials.

Basalt fibers, unlike common glass fibers, have high crystallization ability and high heat and chemical resistance. High-pressure polyethylene consists of polymers containing crystals (40-60%) and amorphous regions.

The created compositions were tested in HCl and H_2SO_4 solutions in aggressive environments. The acid resistance of this composition is based**.**

CONCLUSION

- For the first time, a new type of bitumen-based roll technology has been developed for gossypol resin. For the first time, a new type of roll material (based on bitumen from gossypol resin) technology has been developed. In order to solve the problems of quality and prolongation of service life of the tested materials in the developed technology, petroleum bitumen was replaced by bitumen obtained from gossypol resin with the addition of various local components. The use of basalt fibers and secondary polyethylene in the formation of roll materials was demonstrated for the first time.
- The presence of bitumen matrix and basalt fibers (length 15-20 mm) in the packaging materials provides a certain degree of elasticity. The irregular arrangement of these fibers ensures smooth physicochemical performance throughout the material.
- Bitumen based on gossypol resin, secondary polyethylene (industrial waste) has been proven to be effective and expedient when using basalt fiber for the formation of roll materials superior to its bitumen and fiberglass-based analogues in terms of physical-mechanical and chemical properties.

Thus, the combination of basalt fiber with polyethylene allows the wrapping material to have high mechanical properties, as well as the efficient use of secondary polymers and low basalt fibers as a polymer matrix.

THE RESULTS OBTAINED AND THEIR DISCUSSION

Based on the above, it can be concluded that the technology of roll materials based on oil-free bitumen, basalt fiber and secondary polyethylene was developed for the first time, it has many advantages compared to industrially produced petroleum bitumen roofing materials and is inexpensive.

Using modern methods, it was found to be distinguished by its physicochemical and mechanical properties, heat resistance, chemical resistance, water resistance and cold resistance. The created compositions have high strength, heat and sound resistance, sufficient flexibility and cold resistance, high resistance to moisture, chemical environment analogues, simple production technology, high efficiency of the obtained products, low cost.

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