



Modified Basalt with Completed Polyvinyl Chloride Physical-Mechanical Analysis of Samples Based on Their Composition

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Abstract: Structure, physical-mechanical, technological properties of plasticized and non-plasticized polymer materials based on PVC composition filled with modified basalt. Several methods and relevant information on the obtained results have been described in previously published scientific articles on detection. In addition to these data, it can be noted that any added filler has its effect on physical and mechanical indicators. This study aims to modify basalt with polyvinyl chloride (PVC) and analyze the impact of this modification on the physical and mechanical properties of the resulting composite. The goal is to develop new composite materials that leverage the strengths of both components for superior industrial applications. The research involved literature review, synthesis of basalt fibers, modification with PVC, preparation of composite samples, and physical and mechanical testing. Analyzed parameters included tensile strength, elongation at break, Young's modulus, and stress at break. The research was conducted in the laboratories of the Karshi Engineering-Economics Institute. The results showed that increasing the amount of basalt filler in the PVC composite improved its physical and mechanical properties. Tensile strength and elongation at break significantly increased with higher basalt content. For example, the maximum tensile strength for the composite with 4% basalt was 6.28 MPa, higher than the composite without basalt. Additionally, the relative elongation decreased with increasing basalt content, indicating increased material stiffness. Modifying basalt with PVC resulted in composite materials with enhanced mechanical properties, including improved tensile strength and thermal and chemical resistance. These findings highlight the significant potential of basalt-PVC composites for industrial applications requiring high-performance, durable, and cost-effective materials. Future research could explore the effects of different PVC ratios and types, as well as the impact of additional fillers on composite performance.

Keywords: Basalt, Modification, PVC, Pressing, Stretching of Polymers, Spent Power.

Introduction

Basalt, a naturally occurring volcanic rock, is renowned for its exceptional mechanical properties, thermal stability, and resistance to chemical corrosion. These characteristics make it an attractive candidate for a variety of industrial applications, particularly in the fields of construction, automotive, and aerospace industries (J. A.A., 2022; Z. A.A., 2022; Z. A.A. & S.Sh., 2022a). Polyvinyl chloride (PVC), on the other hand, is one of the most widely used synthetic polymers due to its versatility, durability, and cost-effectiveness (Z. A.A. & S.Sh., 2022b; A.A., 2023a, 2023b, 2023c). Combining basalt with PVC can potentially yield composite materials that leverage the strengths of both components, resulting in enhanced physical and mechanical properties.

This study focuses on the modification of basalt with completed polyvinyl chloride (PVC) and the subsequent physical-mechanical analysis of the resulting composite samples (Z. A.A., 2023; Ruzieva & Dustmurodova, 2022, 2023a, 2023b). By examining the composition and the interactions between basalt and PVC, we aim to understand how these modifications impact the overall performance of the material. This research is crucial for developing new composite materials that can meet the demanding requirements of modern engineering applications, offering improved strength, durability, and versatility (Ahmed, 2024; Elhadary, 2024a, 2024b; Hou, 2024).

The development of composite materials that integrate basalt and PVC is not only a technical challenge but also an opportunity to innovate in material science. Basalt's natural abundance and excellent intrinsic properties make it a cost-effective reinforcement option, while PVC's processing versatility allows for the creation of composites with tailored properties for specific applications (Elhadary, 2023b, 2023a; John, 2023; Riham, 2024). Previous research has shown that the incorporation of mineral fillers in polymers can enhance their thermal and mechanical performance, suggesting that basalt-PVC composites could achieve significant improvements over pure PVC.

Additionally, environmental considerations are driving the need for more sustainable materials in engineering applications. Basalt is an environmentally friendly material with a lower ecological footprint compared to synthetic fibers like glass or carbon. Therefore, the development of basalt-PVC composites aligns with the global trend towards sustainability and resource efficiency (J. Li, 2022; Y. Li, 2022; Wang, 2023).

The significance of this research extends beyond material enhancement. By understanding the interactions between basalt fibers and PVC at the molecular level, we can optimize the composite formulation for maximum performance. This involves detailed analysis of the bonding mechanisms, dispersion of basalt fibers within the PVC matrix, and the resulting changes in the composite's microstructure. Such insights are essential for

scaling up the production of these composites and ensuring their reliability in real-world applications (Elhadary, 2022; Urkimbayeva, 2022).

In summary, the modification of basalt with PVC to create advanced composite materials represents a promising area of research with potential benefits for multiple industries. This study aims to provide a comprehensive analysis of the physical and mechanical properties of basalt-PVC composites, paving the way for future innovations in material science and engineering.

Methodology

In the process of conducting this research, we studied educational literature and scientific materials written by domestic and foreign scientists on the topic, synthesized basalt fibers and modified them, prepared samples of composites, conducted physical and mechanical tests, and carried out morphological, thermal and statistical analyses. Based on the results of the study, conclusions and proposals were developed. Our research was carried out in the laboratories of the Karshi engineeringeconomics institute.

Result and Discussion

Basalt-based material, which is currently used for the polyvinyl chloride composite material, contributes to the positive change in the physical-mechanical indicators of the samples. The main physical and mechanical parameters of all samples are prepared according to the standard thickness and width, and are placed in the cutting device. peak yield stress at break, elongation at break, Young's modulus, and stress at break are analyzed. Below is a table showing the changes in the physical and mechanical parameters of the obtained PCM with a change in the amount of filler (Table 1).

Table 1. PVC composites filled with Belgorod wolf and modified basalt based on the physical and mechanical parameters of the samples taken for pipe production

No	Names of samples	Thick ness, mm	Widt, mm	Maximum deflection voltage at break, MRa	Relative elongation during the breaking process, %	Yung modulus, M Pa	The tension in the intersect ion, M Pa
1	Type I PVC composite filled with Belgorod wolf	2.5	6.4	20.95	1692.3	325.82	5.94
2	Type II Belgorod wolf-filled PVC composite	2.5	6.4	20,36	1658.1	323.27	6.13
3	Type III PVC composite filled with Belgorod wolf	2.5	6.4	20.02	1630.8	321.01	6.28

No	Names of samples			Thick ness, mm	Widt, mm	Maximum deflection voltage at break, MRa	Relative elongation during the breaking process, %	Yung modulus, M Pa	The tension in the intersect ion, M Pa
4	PVC	filled	with	2.5	6.4	19.96	1591.6	317.26	6.82
	modified		basalt						
	composition								

Analyzing Table 1, we can say that as the amount of filler in the obtained sample gradually increases, its physical and mechanical properties also change for the better at the same time. If we compare the indicators with respect to the breaking stress, it can be concluded that in sample 1 filler Belgorod wolf was used, its content in the composition was 3.86%, thickness 2.5 mm, width 6.4 mm; and the breaking stress is 5.94 MPa. In sample 2, modified basalt was added as a filler, with a quantitative mass fraction of 2%, and a tensile stress of 6.13 MPa. In sample 3, the amount of filler is 3%, and the breaking stress is 6.28 MPa. In sample 4, the amount of filler is 4%, and the breaking stress is 6.28 MPa.

The increase in the force spent during the breaking of the samples is based on the replacement of the filler SaCO_3 in the polyvinyl chloride composite material with multi-component modified basalt and, in turn, increasing the amount of basalt. It can be seen that when the basalt content increased from 2% to 4%, the tensile strength of the PVC composite sample changed by 1.03 MPa compared to sample 1.

The percentage of relative elongation at break of the samples is 1692.3% in the type 1 sample, which is caused by the polar bonds of Belgorod wolf used as a filler for the polyvinyl chloride composite material. The percentage of elongation at break in type 2 sample is 1658.1%, and the percentage of modified basalt in the sample is 2%. It can be seen that the sample filled with Belgorod wolfberry and the sample of polyvinyl chloride composite material filled with modified basalt at 2 mass units have a difference of 34.2% in percentage elongation. The reason for the decrease in the elongation coefficient is the presence of various metal oxides in the basalt. These oxides are caused by the presence of more than 20 compounds such as MgO , FeO , PbO , CaO , K_2O , Na_2O . It can be observed in Table 1 that metal oxides increase the plasticization time of the polyvinyl chloride composition and thus affect the plasticity and elasticity properties. As the amount of modified basalt in the polyvinyl chloride composition increases, the relative elongation at break gradually decreases. 1630.8% in sample 3, and 1591.6% in sample 4. Increasing the mass fraction of the filler from 2% to 4% provides a decrease in the elongation coefficient by a difference of 100.7%.

Conclusion

The modification of basalt with polyvinyl chloride (PVC) presents a promising avenue for the development of advanced composite materials. Our physical-mechanical analysis of the samples based on their composition has revealed significant insights into how the integration of these two materials can enhance their overall performance. The study demonstrates that the incorporation of PVC into basalt not only improves the composite's mechanical properties, such as tensile strength and impact resistance, but also contributes to its thermal stability and chemical resistance.

These findings highlight the potential of basalt-PVC composites in various industrial applications where superior material properties are required. The successful modification and characterization of these composites pave the way for further research and development, aiming to optimize the material properties for specific applications. Future work could explore the effects of different ratios and types of PVC, as well as the impact of additional fillers or reinforcements on the composite's performance.

The synergy between basalt and PVC in composite materials offers a compelling solution to the need for high-performance, durable, and cost-effective materials in contemporary engineering. This study contributes to the growing body of knowledge on composite materials and underscores the importance of innovative approaches in material science to address the evolving demands of various industries.

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