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Research Article

Polyethylene Foam in Seamless Insulation Systems

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ISSN: 2770-6613

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Submission: March 07, 2022
Published: April 18, 2022

Volume 3 - Issue 2

How to cite this article: Karapet Ter Zakaryan and Aleksey Zhukov*. Polyethylene Foam in Seamless Insulation Systems. Polymer Sci peer Rev J. 3(3). PSPRJ. 000565. 2022.
DOI: 10.31031/PSPRJ.2022.03.000565

Abstract

The use of rolled polyethylene foam is promising in terms of the material's properties and the possibility of forming seamless insulating shells. The use of foamed polymers as one of the components of insulating shells makes it possible to solve the issues of energy saving and the formation of optimal operating conditions for structures. The formation of seamless insulating shells, on the one hand, significantly increases the heat-shielding properties of the structure by minimizing cold bridges and eliminating leaks in the connection of individual insulating elements and on the surfaces adjoining structures. On the other hand, it creates practically impenetrable vapor and water barriers along the perimeter of the insulated structure.

Keywords: Insulating shell; Slab thermal insulation; Polyethylene foam; Lock connection; Thermal resistance; Frame building; attic

Introduction

Figure 1: Formation of a seamless shell: a - mechanical fastening of the insulation sheet; b - welding of joints of rolled polyethylene foam.

The main criteria for the energy efficiency of any building are the factors of heat conservation, maintaining the required microclimate in the premises, protection of structural elements, ensuring their durability. Gas-filled plastics have the best thermal performance. An additional advantage of polyethylene foam products is the possibility of obtaining a seamless welded joint during installation [1]. The formation of seamless insulating shells, on the one hand, significantly increases the heat-shielding properties of the structure by minimizing cold bridges and eliminating leaks in the connection of individual insulating elements and on the surfaces adjoining structures. On the other hand, it creates practically impermeable vapor and water barriers along the perimeter of the insulated structure [2]. The installation technology of seamless insulating shells is based on solutions [3]. Firstly, a group of products based on polyethylene foam (mats, roll material) with a thickness of 3 to 200mm (layered homogeneous and products with ventilated interlayers) has been created and commercially produced. Secondly, a method has been developed for individual interlocking sheets and welding them with hot air to obtain an insulating shell without seams (Figure 1).

Materials and Methods

The classical technology provides for the use of layered products with close-fitting layers that are welded to each other during the manufacturing process (Figure 2a). Products can be made with a heat-reflecting layer (aluminum foil or metallized film) or without a coating. Previous tests [1,2] showed that the tensile strength of products made of polyethylene foam is 80-92kPa, and that of a welded joint is 29-32kPa. Compressive strength at the 10% strain is a function of the load application area and varies from 70kPa to 260kPa for areas greater than 100m2. Polyethylene foam with an average density of 18-20kg/m3 has a thermal conductivity of 0.032-0.034W/(mK); water absorption by volume when completely immersed in water for 28 days 0.96%. The material practically does not change its properties when cooled to minus 60 °C and under conditions of long-term alternating temperature changes. The study of the experience of using polyethylene foam products led to the creation of a new line of Air Layer materials (RF patent No. 199048) [4]. These are heat-insulating multilayer materials containing flat layers of foamed polyethylene (polypropylene or rubber) interconnected by seams with air gaps between the layers (Figure 2b). Layers can be made with or without a heat reflective layer. Such a system has a lower thermal conductivity than laminated materials, and insulating shells have better thermal performance.

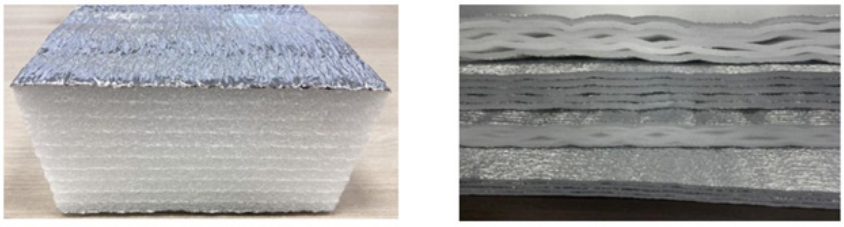

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Figure 2: Products made of polyethylene foam: a - layered products; b - products of the Air Layer line.

Experimental & Results

The purpose of the research was to study the possibilities of creating insulating shells for buildings and structures: insulation systems for walls, ceilings, roofs and floors, as well as to evaluate the properties of insulating shells in buildings in operation. An important direction is also to reduce the flammability of foamed plastics, which is achievable by chemical modification of the polymer matrix, the introduction of finely ground mineral fire retardants into the matrix, and the replacement of a flammable foaming agent with inert ones and, in particular, with CO2. It is possible to use products in which the core of combustible polyethylene foam is protected by a film of non-combustible modified polymer with flame retardants introduced. To assess the heat-shielding qualities of the outer wall of a building with a wooden frame and an insulating seamless shell of rolled polyethylene foam at an object that has been operating for 5 years, the resistance to heat transfer was determined, and the density of heat fluxes passing through the building envelope was measured. The results of field tests showed that the thermal resistance of the outer frame wall, insulated with rolled polyethylene foam (50mm thick) according to seamless technology, is 2.96m2 °C/W, and the heat transfer resistance is 3.12m2 °C/W.

Humidity measurements of pine lining (interior decoration) and pine frame timber with an express moisture and thermal conductivity meter. Humidity by weight averaged about 14%. No putrefactive or biological damage to wooden elements was found. The evaluation of the flammability of samples of modified polyethylene foam was carried out by a standard method. The flue gas temperature was 220-230 °C; the duration of self-smoldering was 15-20min; the sample damage length was 10-14%, the weight loss was 10-15%; the formation of a burning melt was not recorded. Studies to assess the degree of flammability, as well as other normalized properties: flame spread over the surface, smoke-generating ability and toxicity of combustion products will continue in certified laboratories. The use of seamless insulation systems with polyethylene foam products is carried out in almost all areas of the construction segment. When insulating residential frame buildings or in facade heat-insulating composite systems, as well as when insulating floors on the ground, the implementation of these insulation methods can significantly reduce heat loss and provide a comfortable microclimate. In the insulation systems of the frame and frameless warehouses, storage facilities, production facilities, these systems allow you to effectively control the internal microclimate and technological requirements for temperature and humidity conditions. These systems are also involved in cold storage facilities: both in refrigeration units and in the insulation of skating rinks and sports grounds with artificial ice. Also important is the use of this concept to preserve snow during favorable temperatures, tested at the facilities of the Olympic Games in Sochi and other winter tourism facilities.

Conclusion

From the standpoint of energy efficiency requirements, insulation systems using polyethylene foam make it possible to minimize heat losses due to the low thermal conductivity of the material itself and the formation of seamless coatings along the surface of the insulated surfaces; to increase the terms of non-repair operation of objects due to the high operational stability of insulating elements and their mechanical fastening on structures. From the standpoint of ease of use, a reliable insulating shell, combined with the use of modern engineering systems, allows you to create an internal microclimate that is comfortable for living, or the implementation of specific technological processes, for example,

during the construction of production workshops, warehouses, including for storing agricultural products, hangars for vehicles, etc. The development of formulations and technological methods to reduce flammability and improve other fire-technical properties of foamed polymers makes it possible to use polyethylene foam in almost all areas of building and technical insulation.

References

1. Ter-Zakaryan KA, Zhukov AD (2021) Short overview of practical application and further prospects of materials based on crosslinked polyethylene. In: Thomas J, Thomas S, Ahmad Z (Eds.), Crosslinkable polyethylene. Materials Horizons: From Nature to Nanomaterials. Springer, Singapore.
2. Ter-Zakaryan KA, Zhukov AD, Bobrova EY, Bessonov IV, Mednikova EA (2021) Foam polymers in multifunctional insulating coatings. Polymers 13(21): 3698.
3. RF Patent No. 2645190. Locking technology of thermal insulation material for seamless welding of connecting locks.
4. RF patent for utility model No. 199048. Heat-insulating multilayer material.

