NEW EQUIPMENT FOR THE PRODUCTION OF A CONTINUOUS BAND OR A BLOCK OF FOAM GLASS

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Abstract: Based on the experience gained during the creation, experimentation and study of two devices and technologies for the production of foam glass from household glass waste according to Bulgarian Patents Nos. 65718/24.11.2004 and 65745/26.05.2006, an idea was developed for a new device for which a patent application has also been filed. The basic operational concept of the previous devices is preserved, but some of their deficiencies discovered during their experimentation have been corrected.

Keywords: Foam glass, Equipment for production of foam glass

1. Introduction

At the Institute of Metal Science, Equipment and Technologies with Hydro- and Aerodynamics Centre „Acad. A. Balevski“, - Bulgarian Academy of Sciences (IMSETHC-BAS), a new technology and an installation for the manufacturing of continuous tape and blocks of foam glass has been developed using a vertical method (Bulgarian method) [1, 2, 3 and 4], which differs from the traditional methods for obtaining these products [5].

The new installation was tested under a project funded by the Bulgarian Ministry of Education and Science under a program of the Bulgarian National Science Fund (BNSF) “Study of the technological processes in the production of thermal insulation material – foam glass obtained in a model of a foam unit of a new vertical production device” – Contract No DTK-02/72 of 17.12.2009 under Bulgarian patents Nos. 65718/24.11.2004 and 65745/26.05.2006 “Model of a vertical installation for manufacturing of continuous tape of foam glass” [6 and 7].

The project, now completed, was the basis for the creation and testing of an experimental model of a production facility and shows the possibility of introducing the foam-glass material into the Bulgarian market. We would like to attract the attention of the Bulgarian companies in order to organize the production and the use of foam-glass materials.

Table 1. Technical characteristics of the foam glass material produced in Bulgaria using the new vertical installation.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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<tbody>
<tr>
<td>Density, kg/m³</td>
<td>from 120 to 300 and more (at the customer’s request)</td>
</tr>
<tr>
<td>Water absorption, %</td>
<td>max 3 (practically 0)</td>
</tr>
<tr>
<td>Thermal conductivity, W/m.K</td>
<td>from 0.032 to 0.093</td>
</tr>
<tr>
<td>Compressive strength, MPa</td>
<td>from 1.9 to 4.2 (up to 8 with modifiers)</td>
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</table>

Foam glass is the strongest of all known heat-insulating materials. Its compressive strength is several times higher than that of fiber materials and poly foam. The compressive strength of the heat-insulating material is of great importance for the construction industry because the higher the compressive strength is, the more resistant to contraction caused by external influences is the material. While all types of wools are highly hygroscopic, the foam does not wet and therefore retains its thermal conductivity under all conditions. This is why the work on improving the existing technology is ongoing.

2. Analysis of the test results of the installation for the production of continuous bands of foam glass.

The building and the testing of a vertical installation for the production of a tape or a block of foam glass and the creation of a technology for the operation of the system includes several main tasks: preparation of a test site, manufacturing, assembly and testing of the individual aggregates and units of the model, wiring all heating elements into a heating system, designing the control panel, putting the equipment into operational mode and running it for a certain amount of time to prove its functionality.

The tested installation is shown on Fig. 2 and Fig. 3. It is an 8-meter-high facility featuring 5 heating sections with a total of 43 heating elements and a furnace space which can produce a continuous foam glass tape or foam glass blocks. Despite the difficulties due to the reduction of the project funds by BGN 100,000, the model of the system was tested. The experiments included the testing of each individual unit and a final test of the assembled installation. Two complete industrial-technological experiments were carried out with different tape thicknesses – 60 mm and 160 mm – with the corresponding test reports. From the test samples obtained, test bodies were prepared in accordance with the requirements of the relevant standards and testing methods.

Despite the limited resources, a complete analysis of the test results was carried out, as well as an evaluation of the effectivity of the installation in the realization of the technological tasks. The evaluation was based on a special methodology with a ten-point scale for each technological and construction task.

3. Construction solutions for improving the performance of the new equipment.

The performed analysis has revealed some minor shortcomings in the construction of the installation. They include the following:

The quality of the middle layer of the monolithic ingot is not satisfactory due to the adherence of the foamed material to the housing of the heating unit since the foaming takes place at the lower end of the wedge-shaped heating unit which has ribs on its outer surface. The purpose of this positioning of the heating unit was to maximize the use of foam-forming energy by supplying it in the middle of the tape or block being processed. This hinders the technological process and the finished product does not achieve the desired quality.

![Fig. 1. Plates made of foam glass](image-url)
Also, in the existing installation there are thin metal strips which form the side walls of the foamed glass tape or block. These strips get deformed and torn due to the pulling of the propelling rollers located at the top of the device. This all affects the quality of the final product. In addition, the thin metal strips get deformed in the temperature at which the material is foamed.

To avoid these shortcomings, a new construction of the installation was developed. It is shown in Fig. 4. The new construction solution was developed after analyzing the experimental results and is protected with Patent Application No. 111891/19.12.2014 - Device for the manufacturing of foam glass [8]. The main disadvantage – adhesion to the surface of the inner heater – is eliminated by moving the heaters to the upper part of the ingot which is formed by accumulating granules so that the contact of the ingot with the walls and the ribs of the heater are minimal. In the new installation the lower surface of the vertical inner prismatic heating block is the heating roof of a rectangular furnace with a homogeneous temperature. Additionally, during the construction stage the inner wall of the rectangular furnace will be required to have minimal contact with the softened batch and a mandatory temperature-resistant dressing against adhesion. In addition, a requirement will be set for minimal clearance between the inclined wall of the rectangular furnace and the thin movable metal strips. The propelling of the thin metal strips will be carried out by the lower rollers of the installation, designated in Fig. 4 as both driving and pulling. This allows the thin metal strips to stay tightened. As a result, the efficiency of the system improves considerably.

4. Conclusions
An analysis of the constructive solution of the new installation for the production of foam glass with the reconstructed heater and furnace was carried out. The following conclusions are derived:
1. With the help of the new and improved technical solution, an important optimization task is solved – the efficiency of the system is improved.
2. The proposed new construction for the foaming unit of the installation for forming a continuous band of foam glass in a vertical manner guarantees low energy consumption due to the moving of the inner heater to the upper part of the foamed tape or block.
3. The main goal is achieved – the heating and foaming of the input raw material and the obtaining of a quality product.
4. The technological decision for the type of feed batch – in the form of granules – remains unchanged.
1. Rectangular feeding bin
2. Feed unit
3. Rectangular furnace
4. Frameworks
5. Vertical inner prismatic heating unit
6. Electric heaters
7. Thermal insulation
8. Continuous movable thin metal strips
9. Rollers
10. Propelling and pulling rollers
11. Cutting mechanism
12. Pulling rollers
13 & 21. Heating panels
14. Cooling unit
15. Lubricating devices
16. Ingot
17. Granulated batch
18. Longitudinal ribs
19. Horizontal electric heaters
20. Heating metallic walls
22. Vertical inner prismatic heating unit
23. Foaming layer
24. Solid foamy layer
25. Tempered glass
26. Cooling layer
27. Freshly spilled layer

5. References
1. Project НФ-00-92/05.05.2005 for a feasibility study entitled “Research on the possibility of designing technology and equipment for the industrial introduction of energy-saving insulations (foam glass) made of waste packaging glass”. Contract No. НФ-02-19/24.10.2005 for subsiding the participation in a bid for funding under the Financial scheme for supporting innovative enterprises from the National Innovation Fund of the Bulgarian Small and Medium Enterprises Promotion Agency (BSMEPA)” jointly with KAM Ltd., Troyan, Bulgaria.