

Project of an experimental plant for the production of plates and granules of foam glass and composite material on this basis

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Abstract: A conceptual design of a technological line for the production on the one hand of a continuous flat strip and block and on the other hand granules and pieces of foam glass, including a ware house for raw materials, a workshop for preparation of materials, workshops for foamed granules and a continuous flat strip of foam glass, workshop for composite elements semi O, P and slabs, repair section and warehouse for finished products is presented. The necessary equipment and materials, building the technological line and functioning of the plant as a whole, are presented.

Keywords: TECHNOLOGY FOR FOAM GLASS PRODUCTION, FOAM GLASS PRODUCTION EQUIPMENT, FOAM GLASS BASE COMPOSITE MATERIAL

1. Introduction

The idea for an experimental plant, including a technological line for the production of foam glass (FG) and composite materials on this basis is very annual and is based on research experience, with the participation and implementation of several projects funded by BSMEPA at the Ministry of Economy and Research Fund at the Ministry education [1-4].

The processes of glass formation, the structure of the glassy state and the properties of different vitreous materials have been studied by a number of authors [5-12].

Foam glass as an insulating material has high chemical resistance, mechanical strength, sound and temperature resistance. It does not destroy under the influence of atmospheric conditions, does not burn and retains its mechanical and thermal insulation properties at temperatures up to 600°C. Foam glass is superior to similar known thermal insulation materials in terms of thermal conductivity, mechanical strength and moisture absorption in combination. The thermal insulation made of foam glass has a lower cost and higher operational resistance, does not require frequent repairs, which are typical for other materials. It has good sound insulation properties as it absorbs sound oscillations of different frequencies. Foam glass materials are easily machined and easily bonded to various building materials and elements, due to the uniform nature of its material - silicate compounds. The combination of the features and different properties of the foam glass allows its wide application in the form of blocks and plates such as solid foam glass and granules and pieces with a binder as a composite material for making structural elements from them and from solid foam glass, as well as independent use of granules and pieces as bulk material. All these types of materials are used to make thermal insulation in construction, shipbuilding, machinery, units, etc.

The resulting composite material consists of foam glass granules and a binder in the form of an aqueous dispersed colloidal system, including Portland cement in an amount of 92 ÷ 98% by weight and zeolite in an amount of 2 ÷ 8% by weight with a particle size similar to that of Portland cement and water in an amount half the mass of Portland cement and zeolite.

As a result of the developed projects many inventions have been created [13-17], many years of experience have been gained in their development and testing of operability, durability, determination of productivity, maintainability and other important parameters for the operation of a facility.

Currently, an application has been launched for the registration of two new technical solutions [18, 19] for patent protection, which overcome some of the weaknesses of previous solutions and create opportunities for greater productivity.

The envisaged factory price which includes a minimum profitability of 12% of production is from 60 to 100 EUR/ cubic meter, and the market price, which is offered for financial calculations is 130 EUR / cubic meter without VAT or 156 EUR /

cubic meter with VAT, as the international market price for Bulgaria, which is known to the company Pittsburgh Corning Europe in Brussels (for the ex-factory in Belgium) is 320-412 EUR/ cubic meter (March 2019).

2. Main units of the experimental plant. Conceptual plan scheme.

Level of specialization.

The experimental plant for the production of foam glass ware specializes in this production, concentrating the optimal technique of new machines created by inventions for the construction of a technological line with different branches to obtain various high quality products and products. The proposed plan scheme is designed for an ideal site.

Special requirements.

The production process of the foam glass (FG) is a normal production process for the silicate industry. The construction of the devices is safe, does not emit harmful gases and carcinogenic substances. The transport and storage of glass particles takes place in closed facilities, mainly closed bunkers. An aspiration system for dedusting is also provided.

Table 1: List of required areas in the factory.

Dimensions	A	B	H	Level	
Type of room	M	M	M		
1. Warehouse of raw-materials	20	10	6	Shed	
2. Preparatory section	20	15	6	I floor	
3. Mill section (closed)	15	15	8	I floor	
4. Workshop with shaft furnaces	I workshop	22,5	15	12	I floor
4a. Workshop composite elements	II workshop	22,5	15	12	I floor
5. Cut section (closed)	9	15	4	I floor	
6. Warehouse of finished products	20	15	6	I floor	
7. Repair workshop	10	6	4	I floor	
8. Repair area	9	6	6	I floor	
9. Substation	9	9	4	I floor	
10. Laboratory	9	8	4	II floor	
11. Area for additives and foaming agents	15	15	4	II floor	
12. Management	7	15	4	II floor	
13. Living quarters	9	7	4	II floor	
14. Secretary's room and stairs	4	15	4	II floor	
15. Pumping station (under the substation)	9	9	3	Basement	

Schematic technological plan – drawings.

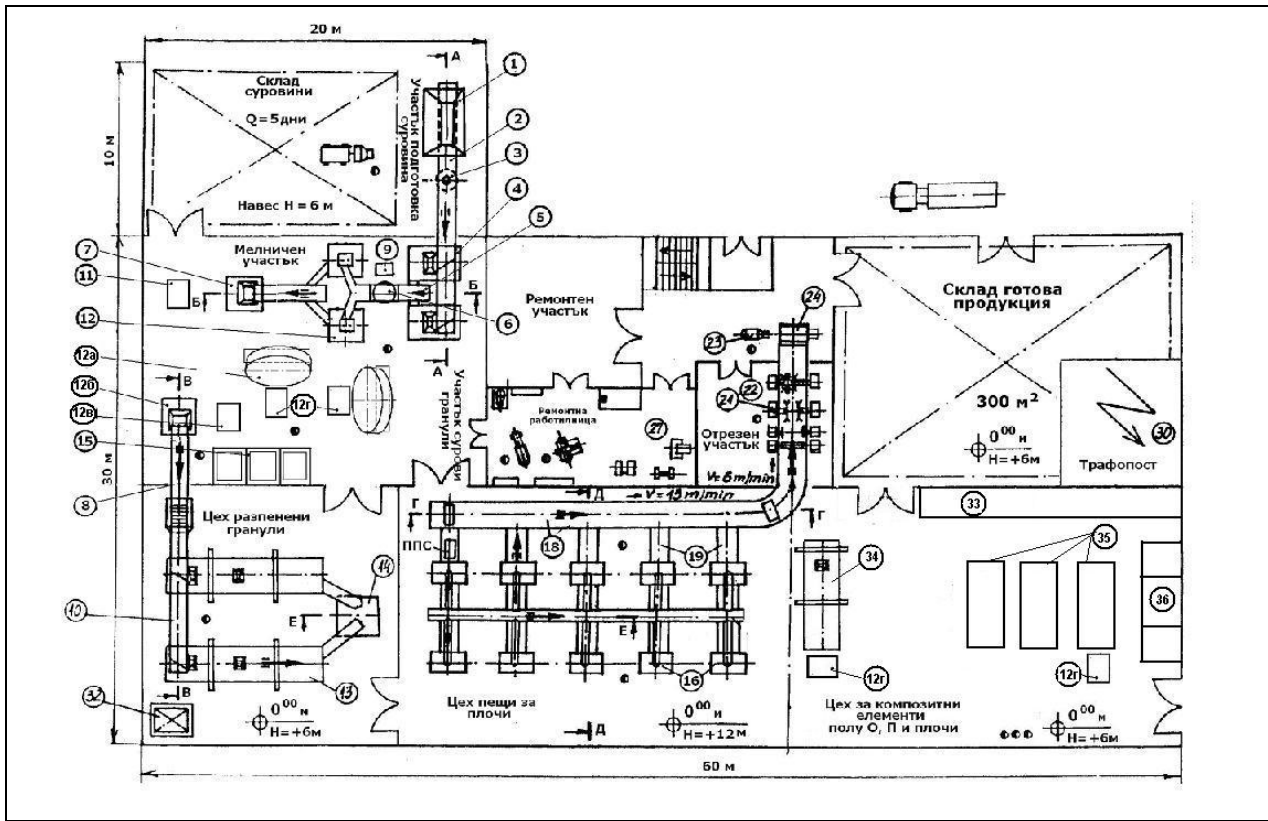


Fig. 1. Scheme of the workshop - floor 1.

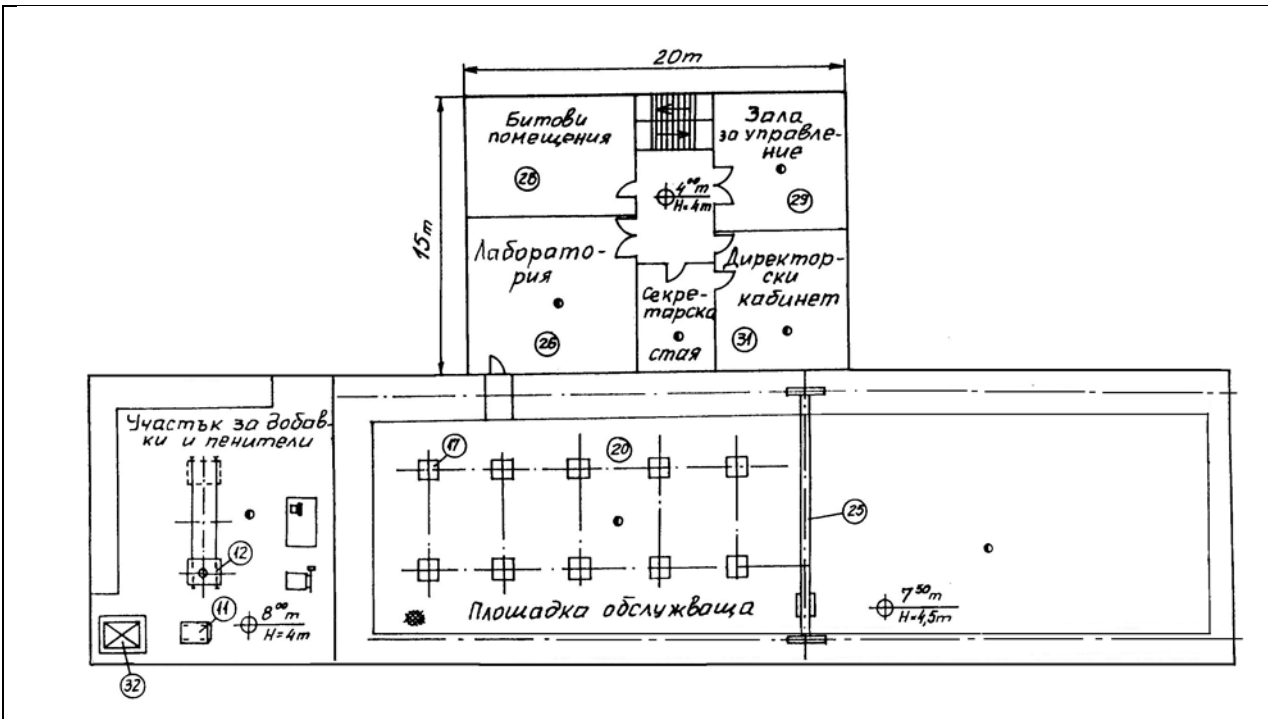


Fig. 2. Scheme of the workshop - floor 2.

Basic technological scheme-description

Warehouse of raw materials

The raw material - crumbs (waste) arrives by truck and is stored outdoors in the warehouse.

Crushing compartment.

From the receiving hopper through a series of conveyors and crushing machines the raw material is fed to a mill. From the

second floor with a gravity conveyor are fed the additives - soot or glycerin (Bulgarian know how). The mill also acts as a mixing reactor - homogenizer of the charge of the future foam glass. The size of the ground glass particles is a powder with dimensions of 0.0063 mm. The next process is granulation with a device called a granulator. The dimensions of the raw granules are 5 to 10 mm, which are fed into the hopper above the furnace and foaming, stick together and form a homogeneous foamed structure, forming a foam glass plate or foamed independently in a rotating furnace.

Furnace compartment.

By gravity, the charge enters a vertical shaft furnace with a continuous process of operation. Passing through several technological zones in the furnace, the semi-factory comes out of the lower and shaped part. Using a circular saw, the length of the semi-factory is cut to a length of 1.2 m. The other two sizes of the FG plates are formed in the kiln - 0.6 m wide and 0.06 m thick. Through a gravity arc roller conveyor or a lowering device the PS plates enter a horizontal conveyor. The furnace is the result of several Bulgarian inventions and patents.

Cut section and warehouse of finished products (FP)

Through the horizontal roller conveyor the plates or block are moved to the warehouse for finished products.

Table 2: Preliminary title list of machines and equipment (all necessary facilities and equipment for the operation of the plant are laid).

No	Equipment
1	Feeding hopper
2	Conveyor
3	Shower for washing glass waste
4	Crusher type Vibromax VM - 20 vibrating
5	Conveyor
6	El. magnetic separator
7	Sieve vibrating flat closed
8	Scraper conveyor for raw granules
9	Non-glass waste hopper
10	Conveyor belt for carrying
11	Addition cart with scales
12	Mill on the special construction of Dipl. Eng. Toms Hrant
12a	Granulator
12b	Raw granule feed hopper
12B	Trays for drying raw granules
12r	Trolley with trays for ready raw granules
13	Rotary furnace for granules
14	Bunker with sieve for feeding foamed granules
15	Drying of raw granules
16	Vertical (shaft) system (without automation)
17	Container feeding system with charge
18	Rolling master
19	Rolling mill under the furnaces
20	Aspiration system around each furnace
21	Cut section with machines
22	Aspiration system around each machine in the cutting area
23	Transport internally at the factory
24	Packaging machine
25	Workshop crane
26	Quality assessment laboratory
27	Repair workshop
28	Living quarters
29	Control and computer control system
30	Substation
31	Telephone connections - system - Director's office
32	Freight elevator
33	Shelves for drying and hardening
34	Composite mixture homogenizer
35	Stretch table are products
36	Matrices for products

On the roller conveyor there is a cut section with longitudinal and transverse cutting of the massive slabs or block in order to produce slabs of other sizes (on request). At the end of the roller conveyor, the plates with dimensions of 1.2 x 0.6 x 0.06 m are lined up in europallets with dimensions of 1.2 x 0.18 x 0.15 m with a height of 1.8 m. machine for stacking and palletizing - a total of 39 pcs. in one pallet (30 lying and 9 vertical). Packed with or without polyethylene foil, the finished product (1 t) placed on pallets is transported by forklift to a storage room or a truck.

Repair workshop.

Universal equipment is provided for the maintenance of the FG production line. There is also a grinding machine for sharpening circular saws. Cutting can also be done with a thread.

Filling compartment and storage for auxiliary materials.

Auxiliary materials, additives and foaming agents are stored by means of a pallet truck and a platform trolley in the auxiliary material warehouse. From it they are measured in weight ratio for use in the production line of raw granules in the section for preparation of the raw material. The powdered auxiliary materials from sacks are poured into the homogenizer placed after the mill or the mill itself plays the role of a homogenizer after grinding the specified dose of glass. Then they are lifted on the second floor above the mill, where a filling compartment is provided. With a freight elevator, the finished raw and dried granules are lifted above the respective kilns, and gravitationally enter the kilns on the lower floor.

Workshop composite elements.

It is planned to make 3 types of composite products - semi-O-shaped, U-shaped and flat elements from a homogeneous mixture of granules with different diameters and binder. The finished products also enter the warehouse for finished products.

Laboratory

All the necessary devices and apparatus for control of the technological process and the finished products are set.

Heating and ventilation

All workshop production rooms are heated in winter to + 5 ° C. All workers are placed in cabins 3 x 3 m, heated for winter and summer to +20°C. The cabins are isolated, with telephone connection and video surveillance.

Substation, subscriber station, auxiliary premises, etc.

All the necessary facilities, equipment for the operation of the above premises are set.

3. Conclusions

The conceptual design of an experimental plant for the production of foam glass ware is the basis for discussion, adjustments and development of a working design for the production of foamed glass granules and pieces, continuous tape or block of foam glass and various elements of composite material based on foam glass granules.

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