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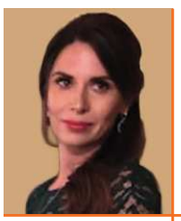
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AUTOCLAVE AERATED CONCRETE IN UKRAINE. MAJOR MANUFACTURERS AND PRODUCT RANGE

АВТОКЛАВНИЙГАЗОБЕТОН В УКРАЇНІ. ОСНОВНІ ВИРОБНИКИ І АСОРТИМЕНТ ВИРОБІВ

АВТОКЛАВНИЙ ГАЗОБЕТОН В УКРАИНЕ. ОСНОВНЫЕ ПРОИЗВОДИТЕЛИ И АССОРТИМЕНТ ИЗДЕЛИЙ

Abstract. The article provides an overview of Ukrainian enterprises that produce autoclaved aerated concrete. The range of products manufactured for the period 2016-2019 is considered. The performance of enterprises and systemic technical solutions for the installation of energy-efficient exterior walls from AEROC LLC are analyzed.
Key words: autoclaved aerated concrete, frost resistance, panels, productivity, compressive strength, average density, wall blocks.
Анотація. У статті наведено огляд українських підприємств, що виробляють газобетон автоклавного тверднення. Розглянуто асортимент продукції, виробленої за період 2016-2019 р.р. Проаналізовано продуктивність підприємств і системні технічні рішення з улаштування енергоефективних зовнішніх стін від ТОВ "Аерок".
Ключові слова: автоклавний газобетон, морозостійкість, панелі, продуктивність, міцність при стиску, середня щільність, стінові блоки.
Аннотация. В статье приведен обзор украинских предприятий, которые производят ячеистый бетон автоклавного твердения. Рассмотрен ассортимент продукции, производимой за период 2016-2019 г.г. Проанализирована производительность предприятий и системные технические решения по устройству энергоэффективных наружных стен от ООО "Аерок".
Ключевые слова: автоклавный газобетон, морозостойкость, панели, производительность, прочность при сжатии, средняя плотность, стеновые блоки.

Modern trends in the development of the building complex are more and more focused on energy saving – as one of the main criteria that determines the type and material for the construction of walling.

The efforts of scientists and manufacturers of building materials are aimed at improving competitiveness, developing and introducing fundamentally new design solutions that provide resource and energy savings, and, as a result, high technical and economic indicators and consumer qualities of buildings. At the same time, cost optimization is ensured through the use of durable, lasting, high-quality building materials and system solutions. In addition to the economic component, another important aspect is the environmental friendliness of building materials and products, which can be achieved by using appropriate materials for the production and observing the strict technological regime of the closed cycle.

Given the shortage of financial and energy resources, the use of aerated concrete products allows you to quickly and efficiently solve housing problems. Products made from autoclaved aerated concrete (AAC) are notable for their good strength, high heat-insulating ability and significantly affect the energy savings necessary for heating facilities while maintaining a healthy indoor climate. This modern high-tech building material is best suited to the conditions of balanced development, both in the production process and in application.

Due to its porous structure, it has a significant heat-insulating effect: the thermal resistance of enclosing structures made of cellular concrete is three times higher than in brick and 8 times higher than in heavy concrete. Low density and high heat-insulating qualities of products allow to reduce the mass of walls by three times in comparison with brick walls and 1.7 times – from expanded clay concrete. Thus, the use of aerated concrete products in building envelopes can reduce the material consumption of a building, improve energy-saving and aesthetic indicators of structures, and reduce the cost of housing construction.

In modern conditions, energy saving is the most relevant for the Ukrainian economy, where more than 40% of energy is consumed in the housing and communal sector. One of the most affordable ways to solve this problem is the transition to new designs of exterior walls using materials with improved thermal insulation performance.

In the climatic conditions of Ukraine, AAC is practically the only wall material that can be used for the construction of single-layer walling. Today, the operational properties and high economic efficiency of the production and use of autoclaved aerated concrete have led to an intensive growth in its production, including and in Ukraine.

The establishment of more stringent requirements for thermal insulation of walls and the rise in price of energy carriers to Ukraine led to the main trend in the production of AAC – a decrease in the density of wall products while maintaining the strength characteristics of the products.

Today in Ukraine there are 16 enterprises of different capacities for the production of autoclaved aerated concrete (Table 1).

Table 1.

Characteristics of technological lines of AAC manufacturers in Ukraine

Manufacturer	Production line	Location	Maximum line productivity	
			m^3/day	thousand m^3 / year
1	2	3	4	5
Orientir-BUDELEMENT LLC (TM Stonelight)	Hoetten (modernized line)	Brovary, Kiev region	3 800	1300
AEROC LLC (TM AEROC)	WEHRHAHN (Obukhiv), HESS (Berezan)	Obukhiv and Berezan, Kiev region	3 200	1000
UD K LLC (TM UDK)	Masa-Henke	Dnipro	1 500	430
LLC Energy Product	Aircrete	Nova Kakhovka, Kherson region	1 300	450
Jupiter LLC (TM JU TON)	WKB Systems	Voznesensk, Mykolaiv region	850	280
PJSC "Tavrian Housing Company" (TBK)	Wuxi Mettle, China	Kherson	400	120
LLC Ternopolstroy (TM GazoBET)	No data, China	Ternopil	500	160
PJSC "Zhytomyr Plant of Silicate Products"	Universal-60, WEHRHAHN	Zhytomyr	250	80
Corporation "Kharkiv Construction Materials"	Hoetten	Kharkiv	600	200
PP "Budtekhnologiya-N" (Kupyansky silicate plant)	Universal-60 (2 lines)	Kupyansk, Kharkiv region	600	200
SILICATOBETON LLC	No data, China	Sumy	400	150
PP "Autocraft"	PE "INTERBudMa" (Ukraine)	Bershad, Vinnytsia region	250	80
Dneprovsky plant of building materials	EXTRA BLOCK	Dnipro	150	50
LLC Teplobud-Sivershchina	USSR	Chernihiv	20	5
		In ALL:	**18 170**	**4 435**

The largest of them, with an annual production and sales capacity of over 1 million m^3 of products, are two companies. These are Orientir-Budelement LLC (TM Stonelight), which produces over 1.3 million m^3 of AAC masonry units per year at a plant with one production line, and LLC Aerok (TM AEROC), which is produced at two plants and three production lines 1.1 million m^3 of AAC products per year. These companies are located in the Kiev region and occupy more than 30% of the Ukrainian market of autoclaved aerated concrete each.

Medium-sized companies are those with an annual production capacity of over 400 thousand m^3. There are also two such enterprises. These are UDK LLC (TM UDK, Dnipro) with an annual production capacity of 450 thousand m^3 of AAC and Energy Product LLC (Nova Kakhovka, Kherson region) with an annual capacity of 450 thousand m^3 of AAC.

Of the remaining enterprises, only Jupiter LLC (Voznesensk, Mykolayiv region) and KSM Corporation (Kharkiv) operate stably and have a good workload.

The one manufacturer of autoclaved aerated concrete in the western region of Ukraine is the new plant of the Ternopolstroy company (TM GazoBET). Estimated capacity of the enterprise is about 500 m^3 per day. Since the beginning of 2020, the enterprise has not yet begun work. Factories "Dnieper ZSM" (Dnipro), PJSC "Zhytomyr KSI" (Zhytomyr), PJSC "TBK" (Kherson) are not working at full capacity.

PP "Budtekhnologiya-N" (Kupyansky silicate plant Kupyansk, Kharkiv region) due to the loss of the traditional market and lack of modernization of production is in a difficult economic condition.

The enterprises of Silikobeton LLC (Sumy), Teplobud-Sivershchina LLC (Chernihiv) and Avtokraft PE (Bershad, Vinnytsia region) do not work, the production capacities of these companies are mothballed.

Large Ukrainian manufacturers of AAC are constantly engaged in the modernization of production lines and the expansion of existing production capacities:

- LLC "Orientir-BUDELEMENT" increased the maximum daily capacity from 3650 m^3 to 3800 m^3 per day;
- in the plans of development of Aerok LLC, a further increase in production capacity due to the installation of another 1 autoclave at a plant in Berezan.

The Aerok company has passed the procedure of environmental certification of products in accordance with the requirements of international environmental standards of the ISO 14024: 1999 series and received environmental certificate No. UA.08.002.341. AEROC products are the first and only ones that have received the right to label their products with an eco-label (Green Crane), which confirms the advantage and safety of AEROC aerated concrete.

AEROC products also received the European quality certificate 1397-CPR-0494, which means compliance with the European standard EN 771-4 "Specification for masonry units – Part 4: Autoclaved aerated concrete masonry units".

A wide range of Ukrainian enterprises produce high-precision wall and partition aerated concrete masonry units (geometry ± (1–2) mm) with a width of 75 mm to 500 mm, reinforced AAC lintels, floor and cover panels.

The dry density of the manufactured cellular concrete is from 300 kg/m^3 to 500 kg/m^3, the compressive strength is mainly in the range from 2.0 MPa to 3.5 MPa. Frost resistance – from F25 to F100 depending on the manufacturer.

Data on the ratio of the density of manufactured products from autoclaved aerated concrete are presented in

Fig. 1. It should be noted that in comparison with 2016, the proportion of aerated concrete blocks with a mark in the average dry density D300 increased significantly. Since 2016, wall blocks with a density of D600 are practically not produced in Ukraine. The proportion oftongue-and-groove wall blocks is about 20%, the rest of the prod ucts are made with smooth end surfaces. The most common block width is 250-300 mm (about 70%), blocks with a width of 350-500 mm – from about 20% to 30%.

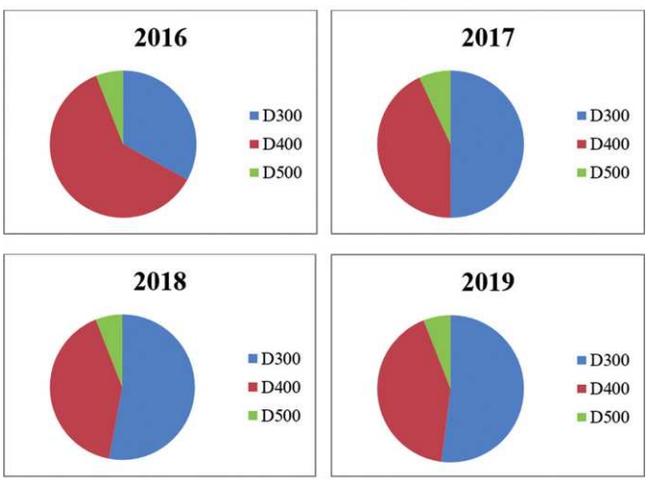


Figure 1. The ratio of the density of manufactured products from AAC in Ukraine

Shaped products – U-blocks are also produced. In addition, heat-insulating plates from autoclaved aerated concrete with a density of 150 kg / m^3 (AEROK LLC) are produced, whose thermal conductivity is 0.05 W/m·K.

LLC "Orientir-BUDELEMENT" produces partition blocks 600x200x (100; 120; 150 mm), wall blocks 600x200x (200; 250; 280; 300; 360; 375; 400; 500) mm, U-blocks 500x200x (200; 250; 280; 300; 360; 375; 400; 500) mm; grades in density D300, D350, D400, D500. Frost resistance of AAC is at least 35 cycles for all densities, compressive strength – at least 2.0 MPa.

UDK LLC produces wall blocks of grades in density D400, D500 and U-blocks. Dimensions of wall products are 200x600x (100; 150; 250; 300; 375; 400; 500) mm, U-blocks 500 (600) x200x (250, 300; 375; 400; 500) mm. The compressive strength of AAC products is at least 2.0 MPa, the frost resistance grade is at least F100.

LLC Energy Product produces wall and partition blocks D300, D400 and D500 with compressive strength of at least 1.5 MPa, size 600x200x (75; 100; 150; 200; 250; 300; 350; 375; 400) mm, 600x500x (100; 200) mm.

AEROC LLC produces wall and partition masonry units with density of D300 and D400, U-blocks, reinforced AAC lintels, floor and cover panels. The frost resistance grade of wall products is not less than F100, compressive strength 2-2.5 MPa and higher.

Among Ukrainian manufacturers of autoclaved aerated concrete, AEROC LLC is the most innovative company. The company actively cooperates with scientific and research organizations in Ukraine and abroad, constantly developing and introducing new systemic technical solutions for the installation of energy-efficient exterior walls, which are fundamentally different from alternative offers from other manufacturers of aerated concrete.

In Ukraine, according to the requirements for the heat-shielding properties of wallings, the coefficient of thermal resistance for external walls R must be at least 3.3 m^2·K/W. As you know, AAC is a material from which it is possible to create a homogeneous single-layer wall that will provide this thermal resistance.

AEROC LLC produces wall blocks with an average density of 300 kg / m^3 from structural and heat-insulating aerated concrete and heat-insulating blocks and boards with a density of 150 kg/m^3.

If we compare the thermal conductivity of these materials with the thermal conductivity of traditional AAC products, then, with the same thickness, the walls of AEROC D300 have 40% less heat loss than walls from the D400 block, and 60% than walls from the D500 block. When using AEROC ENERGY with a density of 150 kg/m^3, the reduction in heat loss is 129% and 162%.

The heat transfer resistance R of the external walls from AEROC units is (3.33 ÷ 5.3) m^2·K/W, which exceeds the standard value for external walls and is higher than the R values of the "wide" walls of other manufacturers. At the same time, the load-bearing capacity of the walls from AAC, manufactured by AEROC LLC, allows for the implementation of projects of 2-3-story frameless houses.

The most optimal option from the point of view of the ratio "cost of building a house – saving on heating a house" is the use of AEROC wall blocks with a density of 300 kg/m^3 with a width of only 300 mm (option 1, see Fig. 2). The bearing capacity of one running meter of such a wall is up to 16 tons with an eccentric load and up to 24 tons with a load in the center of the wall. Scope: the bearing external walls of buildings up to 2 floors high. Heat transfer resistance R = 3.53 m^2·K/W. The cost of 1 m^2 of the wall is 23.60 €.

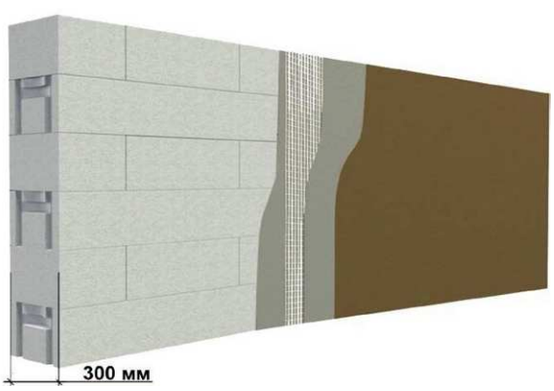


Figure 2. Option 1. External wall of aerated concrete D300 300 mm wide

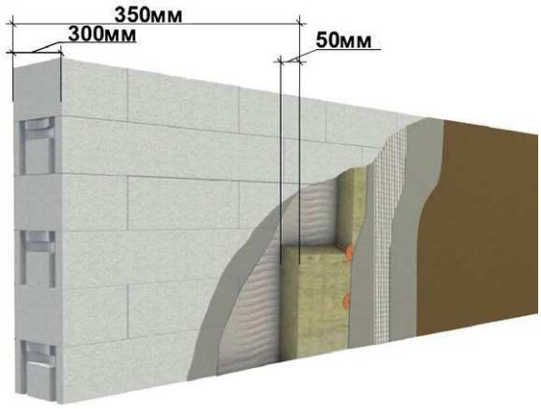
By their heat-insulating properties, AEROC walls with a density of 300 kg/m^3 and a width of 300 mm are equivalent to aerated concrete walls with a width of 375 mm and a density of 400 kg/m^3 or 450 mm wide walls of aerated concrete 500 kg/m^3.

When building a house from aerated concrete blocks with a density of 300 kg/m^3 300 mm wide, the cost savings is 25% of the cost of 1 m^2 of wall from AAC blocks with a density of 400 kg/m^3 and a width of 400 mm, and 67% of the cost of 1 m^2 of walls from blocks with a density of 500 kg/m^3 and a width of 450 mm. At the same time, operating costs for heating a house are almost equal.

Such a constructive solution of walls is cheaper than alternative options, for example, walls of denser aerated concrete (AEROC D500) 300 mm wide with mineral wool insulation 50 mm thick (version 1.1 of Fig. 3) or 400 mm wide (AEROC D400) without insulation (version 1.2 Fig. 4).

Wall bearing capacity (1 linear meter):
- up to 25 tons with an eccentric load
- up to 37.5 tons with a load in the center of the wall
Scope: bearing external walls of buildings up to 3 floors
R = 3.3 m^2·K/W, the cost of 1 m^2 of the wall is 27.72 €

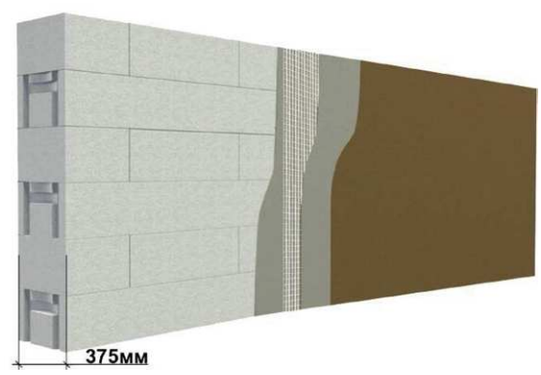
Figure 3. Option 1.1. External wall of aerated concrete D400 375 mm wide



Wall bearing capacity (1 linear meter):
- up to 20 tons with an eccentric load
- up to 30 tons with a load in the center of the wall
Scope: bearing external walls of buildings up to 3 floors
R = 3.33 m^2· K/W, the cost of 1 m^2 of the wall is 29.37 €

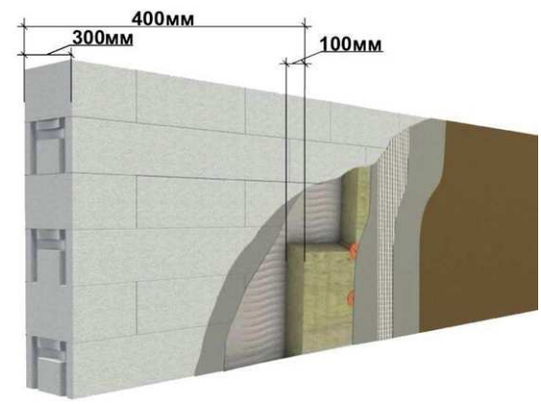
Figure 4. Option 1.2. External aerated concrete wall D500 300 mm wide with mineral wool insulation 50 mm thick

The external walls of AEROC blocks with a density of 300 kg/m^3 and a width of 375 mm (option 2, Fig. 5) provide high heat transfer resistance (R = 4.41 m^2·K/W) and are not inferior in this indicator to walls made of denser aerated concrete with a width of 300 mm with mineral wool insulation with a thickness of 100 mm (version 2.1, Fig. 6). At the same time, the cost of 1 m^2 of the external wall with AEROC AAC blocks with a density of 300 kg/m^3 is cheaper than the alternative.



Wall bearing capacity (1 linear meter)
- up to 20 tons with an eccentric load
- up to 30 tons with a load in the center of the wall
Scope: bearing external walls of buildings up to 3 floors
R = 4.41 m^2·K/W, the cost of 1 m^2 of the wall is 27.71 €

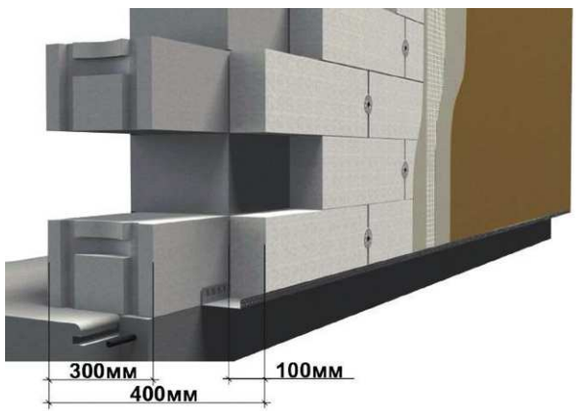
Figure 5. Option 2. External wall of AEROC D300 blocks with a width of 375 mm



Wall bearing capacity (1 linear meter):
- up to 20 tons under load with eccentricity
- up to 30 tons with a load in the center of the wall
Scope: bearing external walls of buildings up to 3 floors
R = 4.37 m^2·K/W, the cost of 1 m^2 of the wall is 29.93 €

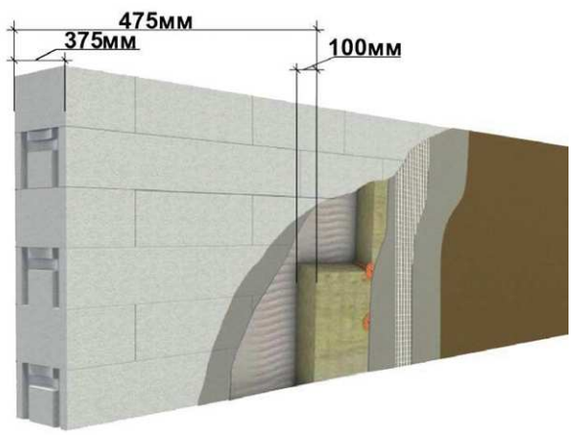
Figure 6. Option 2.1 External wall of aerated concrete D500 300 mm wide with insulation with mineral wool boards 100 mm thick

The design of the load-bearing walls made of AEROC blocks with a density of 300 kg/m^3 and a width of 300 mm with thermal insulation of the AEROC ENERGY facade insulation with a density of 150 kg/m^3 and a width of 100 mm (option 3, Fig. 7) provides wall heat transfer resistance R = 5.42 m^2·K/W, which is equivalent to the thermal performance of aerated concrete walls with a density of 400 kg/m^3 and a width of 375 mm, insulated with mineral wool insulation 100 mm thick (option 3.1, Fig. 8). At the same time, the cost of 1 m^2 of the outer wall with AEROC aerated concrete with a density of 300 kg/m^3 is cheaper than the alternative.



Wall bearing capacity (1 linear meter):
- up to 16 tons with an eccentric load
- up to 24 tons with a load in the center of the wall.
Scope: bearing external walls of buildings up to 2 floors
R = 5.42 m^2·K/W, the cost of 1 m^2 of the wall
is 28.94 €

Figure 7. Option 3. AEROC D300 AAC wall 300 mm wide with insulation AEROC ENERGY 150 kg/m^3 100 mm thick



Wall bearing capacity (1 linear meter):
- up to 20 tons with an eccentric load
- up to 30 tons with a load in the center of the wall
Scope: bearing external walls of buildings up to 2 floors
R = 5.29 m^2·K/W, the cost of 1 m^2 of the wall is 34.91 €

Figure 8. Option 3.1. External wall of aerated concrete D400 375 mm wide with mineral wool insulation 100 mm thick

Facade thermal insulation from AEROC ENERGY AAC with a density of 150 kg/m^3 is characterized by durability comparable to the life of the building as a whole, absolute fire safety and high environmental friendliness in comparison with polystyrene or mineral wool insulation.

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