Green Technologies in Manufacturing and Construction

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Abstract: In recent years, much attention has been paid all over the world to the development and implementation of environmentally friendly energy-saving technologies aimed at reducing the harmful effects on the environment. The so-called "green building" is gaining more and more popularity. The most relevant environmental technologies for rural areas, where there are more conditions and opportunities for their implementation.

1 INTRODUCTION

According to statistics, all existing buildings in the world consume about 40% of the world's primary energy, 67% of electricity, 40% of raw materials and about 14% of the total supply of drinking water. At the same time, they produce about 35% of the world's carbon dioxide emissions and about 50% of solid waste. It was these statistics that made engineers and architects think about improving building technologies, resulting in the emergence of "green buildings".

The definition of "green building" characterizes not just a certain type of buildings or the use of a certain set of architectural techniques in its construction - this concept implies a complex system of specially developed principles on the basis of which both the construction and operation of the building are carried out directly.

Basic principles of "green building":

- Savings and energy efficiency - rational use of resources (land, energy, building materials);
- Comfort - providing an adequate level of convenience for people who will live or work in these buildings;
- Environmental friendliness - ensuring a minimum level of harmful effects of the building on the environment and human health.

Each "green building" throughout its life should remain environmentally friendly and energy efficient. This applies to all stages - from design and construction to demolition.

Despite the fact that the concept of "natural building" is also commonly referred to as "green building", in general, "green building" is not based on the use of only 100% natural materials.

2 MATERIALS AND METHODS

In order to assess the compliance of buildings under construction with the basic principles of "green building", special standards have been developed. The first "green" standards appeared in 1990, when BRE Global introduced the BREEAM (BRE Environmental Assessment Method) standardization system in the UK. Currently, this system for assessing the environmental friendliness of buildings is used in many countries around the world. According to this standard, each building is evaluated according to 9 criteria:

1. Management.
2. Energy.
3. Health and well-being.
4. Transport.
5. Garbage.
6. Materials.
7. Land use and ecology.
8. Pollution (Nikoláeva, 2018).

Later, in 1998, another rating system appeared in the United States for certification of "green buildings" - LEED (Leadership in Energy and Environmental Design). To be certified in this system, a building must be distinguished by the maximum use of

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renewable energy sources in its construction and operation. Evaluation of buildings according to this standard is carried out according to 5 criteria:

1. Territory for building.
2. Energy and atmosphere.
3. Materials and resources.
4. Air quality.
5. Innovation.

For each point, the building is assigned certain points, on the basis of which a certain certificate is then issued: for 40 points - a green certificate, for 50 points - silver, for 60 points - gold, for 80 points – platinum (Sheina, 2015).

The international standard "Passive House", developed in Germany, is developing and has a great future.

The higher a building is rated according to these standards, the more comfortable, safe and environmentally friendly it is.

Russia is currently developing its own environmental standards for construction. The idea of leading a healthy lifestyle, respecting the environment, choosing certain eco- or bio-products is gradually conquering the world.

In Russia, more and more such goods appear. And if everything is clear to the buyer here, how this or that product differs, then he can buy it because of his convictions, principles or simply desires or not. But when we choose housing, we do not always have the necessary knowledge and understanding of why we need a certain environment for living and why it is worth making a choice in favor of a house built according to the “green” principle. And so the situation looks paradoxical in many respects.

It seems that there is a trend, but how it can be appreciated - many do not yet understand. First of all, this concept includes energy efficiency, environmental friendliness, aesthetics, economy. It is important to note that "green" technologies are beneficial in operation - be it energy efficiency, reduced utility bills, visual and acoustic comfort in the building, etc.

And if earlier the concept of "green object" could include the adjacent territory, now it is largely technology, engineering, economical operation, materials. And during the life cycle of an object, the use of "green" technologies will be obvious.

Every year there are new residential complexes that choose certification from scratch. This is at least 5-10 developers a year, and their number is steadily increasing. And, best of all, the objects are located in different regions of Russia.

"Green" construction will be in demand in the next 5-10 years, we just need to tell people more about eco-technologies, show them the benefits of eco-housing. “In my opinion, the lack of strong customer interest is due to ignorance of the benefits of “green design”. For example, there is still a misconception that environmental materials are much more expensive than usual ones. And yet they are in demand. In interiors, the use of natural materials, organic forms, indoor plants as decor, and handmades are relevant. Increasingly, they are asking to make a “smart home” system, introduce energy-saving technologies, water purification, because the durability of the materials used is important for them. As for the purchase of housing, then, based on my experience, customers are primarily concerned about the ecology of the area, and not the availability of "green technologies". But this is only because not everyone fully understands all the advantages of "green" construction.

In fact, "green" houses have been in demand for a long time in the world. This is relevant and understandable not only from the point of view of preserving the environment, but there are real savings for residents. When designing such houses, the emphasis is still on the development of the adjacent territory, which attracts people. I think that in Russia, largely due to climatic conditions, it is difficult to make a choice in favor of a house built using new technologies, but I am sure that this will become very popular in the near future (Green Zoom, 2019)

Houses are being built in Russia - this is the Hill8 premium-class apartment complex on Prospekt Mira, certified according to the British BREEAM standard, and 4 minipolises in the Moscow Region, receiving the certificate of the Russian GREEN ZOOM system. And most importantly, it is really possible not to increase the cost of construction when using "green" technologies. First of all, this is facilitated by BIM design of objects, when each technological solution can be weighed, tested and optimized even before the construction stage, which allows choosing the optimal set of "green" parameters. And it is worth telling buyers about all these parameters so that they understand that these technologies are already being laid at the construction stage. It should be noted that the idea of environmental certification of housing is included in the Moscow renovation program. Thus, gradually environmental certification of residential complexes will become the norm for housing and the mass segment.”

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Need a systematic approach

One of the main tasks facing builders and future owners of construction projects, whether residential or industrial buildings and structures, is to increase the efficiency of the structures used by developing and implementing energy-efficient design and technological solutions into construction practice.

Energy efficiency is a useful (rational) use of energy resources in order to optimize the amount of energy used to maintain a constant level of energy supply to a building or structure.

Currently, energy-efficient designs of buildings and structures are successfully used in Canada, the USA and most European countries. In Russia, energy saving technologies have been more intensively introduced into construction practice since 1996 after the adoption of the Federal Law "On Energy Saving" dated 03.04.96 No. 28-FZ. In accordance with the provisions of this law, it was envisaged to tighten the requirements for the reduced resistance to heat transfer of building envelopes, as well as to classify buildings and structures in terms of energy efficiency. The rise in prices for thermal energy and energy carriers also determines the need to increase the thermal protection of buildings and structures at the stage of their operation (Zubareva, 2015).

At the moment, there is no single classification of buildings by energy consumption. In Europe, the following classification has become widespread:

- energy-saving houses of low consumption (annual heat consumption 70-30 kWh/m2); energy-saving houses of ultra-low consumption (annual heat consumption 30-15 kWh/m2);
- energy-passive houses (annual heat consumption up to 15 kWh/m2); energy-saving houses (annual heat consumption reduced to 0);
- energy efficient houses (they produce more energy than they consume).

Against the backdrop of growing interest in energy efficiency, the priority areas for improving the energy efficiency of buildings can be noted:

- effective thermal insulation of enclosing structures; reduction in the length of heat pipes;
- the use of renewable energy sources: solar energy, wind energy, thermal energy of the soil; increasing the efficiency of heating systems;
- effective planning of the building site and the choice of an energy-saving form of the building; use of forced ventilation systems with recuperation;
- efficient computerized energy management system.

A dwelling will be as economical as possible if it was designed taking into account all energy-saving technologies. It will be more difficult, more expensive to remake an already built house, and it will be difficult to achieve the expected results. An important point is to take into account the climatic features of the region.

To save resources, you need to pay attention to the layout and appearance of the house. The dwelling will be as energy efficient as possible if the following nuances are taken into account:

1) correct location. The house can be located in the meridional or latitudinal direction and receive different solar radiation. It is better to build a northern house meridional in order to increase the influx of sunlight by 30%. Southern houses, on the contrary, are better to build in the latitudinal direction in order to reduce the cost of air conditioning;
2) compactness, which in this case is understood as the ratio of the internal and external area of the house. It should be minimal, and this is achieved by refusing protruding rooms and architectural decorations such as bay windows. It turns out that the most economical house is a parallelepiped;
3) thermal buffers that separate living spaces from contact with the environment. Garages, verandas, loggias, basements and non-residential attics will be an excellent barrier to cold air entering rooms from the outside;
4) proper natural lighting. Thanks to simple architectural techniques, it is possible to illuminate the house with the help of sunlight for 80% of the entire working time. The rooms where the family spends the most time (living room, dining room, children's room) are best located on the south side, for the pantry, bathrooms, garage and other auxiliary rooms there is enough diffused light, so they can have windows on the north side. East-facing windows in the bedroom in the morning will provide a boost of energy, and in the evening the rays will not interfere with rest. In summer, in such a bedroom it will be possible to do without artificial light at all. As for the size of the windows, the answer to the question depends on the priorities of each: save on lighting or on heating. An excellent technique is the installation of a solar pipe. It has a diameter of 25-35 cm and a completely mirrored inner surface: receiving the sun's rays on the roof of the house, it maintains their

intensity at the entrance to the room, where they are scattered through a diffuser.

The light is so bright that once installed, users often reach for the light switch when leaving the room;

Even a house built with all architectural tricks in mind requires proper insulation in order to be completely airtight and not release heat into the environment.

3 RESULTS AND DISCUSSION

The foundation of an energy efficient home

Through the foundation and the floor of the first floor, 10% of heat is lost. The floor is usually insulated with the same materials as the walls, but other options can be used: bulk heat-insulating mixtures, foam concrete and aerated concrete, granular concrete with a record thermal conductivity of 0.1W / (m°C). It is possible to insulate not the floor, but the basement ceiling, if such is provided for by the project.

Traditionally, during the construction of cottages in Russia, they did not pay attention to the thermal insulation of the foundation and the blind area. The parts of the building that were in contact with the ground were actually conductors through which heat flowed into the ground and “warmed the ground”.

When building passive houses, this is unacceptable. Designing a cottage involves thermal insulation of all enclosing structures. The thickness of this insulation is calculated using special software tools (Zubareva, 2015).

Simple floor insulation is not enough here, since it does not solve the problem of "cold bridges" through which the cottage loses heat. It is the continuity of the thermal circuit that is important to us. With a simple floor insulation, the junctions of the walls and the foundation are weak points, interrupting this contour.

The simplest and most common solution used in the construction of energy-efficient cottages, passive houses is an insulated foundation slab. In Germany, the use of polystyrene foam insulation under a slab up to 30 cm thick is officially allowed.

If a basement (ground floor) is built in a passive house, the slab underlying the base (as well as the walls) is insulated.

The slab energy-efficient foundation of a passive house can also serve as an element of the heating system of a cottage (however, like other types of buildings). In this case, even before pouring concrete, at the stage of fixing the reinforcement, a heating system is arranged - pipes are laid through which the coolant will circulate. This principle is used, in particular, in the construction of foundations, which are called insulated Swedish slab (UShP). A large volume of concrete in an energy-efficient foundation accumulates and radiates a corresponding amount of heat. This type of technology refers to the so-called thermal activation of structures, a principle that is often used in modern energy-efficient construction, in particular in passive houses.

For example, a “cut-off” is arranged on top of the tape - a special high-density insulation is placed (a special brand of Foamglas foam glass is used) - on which walls are already being erected. Thus, a potential cold bridge is eliminated.

To insulate the foundation structures of a passive house from below, including the blind area, foam glass chips (foam glass crushed stone) are often used.

When designing and building cottages, architects must take into account potential “weak spots” in the building envelope that can lead to heat loss, they are calculated using “thermal bridges” modeling tools, which, according to the results of cottage design, are reduced to zero.

And most importantly. In a passive house, the foundation is insulated not only to save energy, but also to improve the consumer properties of the cottage and the comfort of its inhabitants, which is ensured by uniform heating of the room and the absence of cold surfaces.

Cellular concretes. Porous building material based on concrete. It has many varieties: aerated concrete, foam concrete, expanded clay concrete, polystyrene concrete. The thermal conductivity of cellular concrete in a dry state is approximately three times less than that of a brick. And if we consider that brick and block walls lose the most heat through the masonry mortar, then the energy efficiency of porous concrete is even higher: its large blocks have precise dimensions, so they can be laid on an adhesive mortar with a joint thickness of

Today, the production of methanol, the demand for which is growing from year to year, belongs to green technologies. ThyssenKrupp Industrial Solutions AG, the licensor of the recently launched nitric acid production technology at JSC Grodno Azot, proposes a scheme for the production of methanol not from natural gas, but from water and CO2, which is obtained in flue gases from fuel combustion (Tugushev, 2020).

It is proposed to obtain hydrogen from water by electrolysis using renewable energy sources, and methanol from it. Then use it as a fuel, the products of which are CO2 and water. Then start the process in

a new circle. And the energy for this can be obtained from the sun, wind, etc.

Russian manufacturers have 8-10 projects of such installations in their plans or at the initial stage of construction.

By the way, OJSC Mozyr Oil Refinery uses methanol supplied from OJSC Grodno Azot for the production of methyl tert-butyl ether. As one of the options for the future development of the enterprise, I believe that such a green technology would be quite acceptable. Gases containing CO2 and water are available at the enterprise.

Today, it is expensive and cannot compete with large-scale installations or where natural gas is used as a cheap feedstock, such as in Russia. But for countries where the price of energy resources is high, this technology has great prospects as an alternative production. Indeed, in many foreign countries there are various directives regulating CO2 emissions. Therefore, everyone is trying to reduce them. Let it be an object of small capacity, but the enterprise will reduce emissions into the environment and receive a valuable product, the surplus of which can be sold.

Many processes use water as a solvent. However, to obtain a product from an aqueous solution, water must be evaporated and returned to the cycle so as not to be lost with exhaust gases. All this requires energy. As a solvent, liquid CO2 is much more efficient than water. A good example is the production of instant coffee. It is produced using CO2. The caffeine is extracted with carbon dioxide, then the pressure is reduced. The carbonic acid evaporates without polluting the coffee. As a result, with minimal energy costs, the necessary food product is obtained. If this were done using water, then how much energy would be required to evaporate and clean it

The advantage of CO2 can also be attributed to the fact that it is easier to achieve the supercritical state of carbon dioxide than water - it is cheap, relatively non-toxic. It is characterized by low viscosity, low heat of vaporization, which eliminates overheating, as well as the ease of separation from the reaction medium in the form of a gas when the pressure is released (Efremov, 2016).

CO2 is a product that we can take from the waste of existing industries, and thereby reduce the amount of emissions, reduce the environmental burden.

In 1998 P.T. Anastas and J.S. Warner in his book "Green Chemistry: Theory and Practice" formulated twelve principles of green chemistry:

It is better to prevent waste than to recycle and clean up leftovers.

Synthesis methods must be chosen in such a way that all materials used in the process are transferred to the final product as much as possible.

Synthetic methods should be chosen whenever possible so that the substances used and synthesized are as least harmful to humans and the environment as possible.

When creating new chemical products, it is necessary to try to maintain the efficiency of work achieved earlier, while toxicity should decrease.

Auxiliary substances in production, especially solvents or separating agents, should preferably not be used, and if this is not possible, then their use should be harmless.

The cost of energy, its impact on the environment and the cost of the product must be considered. Where possible, the synthesis should be carried out at temperatures close to ambient temperature and at atmospheric pressure.

Both raw materials and consumables must be renewable if they are technically and economically viable.

Intermediates should be avoided whenever possible. Catalytic processes should always be preferred (preferably the most selective).

Chemical products should not be left in the environment after use, but should decompose into safe products.

Analytical methods need to be developed to monitor the formation of hazardous products in real time.

Substances and forms of substances used in chemical processes should be selected to minimize the risk of chemical hazards, including spills, explosions and fires.

In Russia in 2010, the production of environmentally friendly insulation in the form of linen mats was launched.

In addition to environmental safety, such thermal insulation materials have a number of important practical advantages. Mats (plates) made of plant fibers have some of the best heat capacity, good acoustic characteristics.

An example would be the Thermo-Hanf insulation (Thermo-Hanf). It is manufactured at the Hock GmbH & Co. in Nördlingen (Germany). Thermo-Hanf products consist of 83-87% hemp fibers and do not contain additives harmful to human health. Hemp is especially resistant to adverse influences. When grown, it is not treated with fungicides, and when used as a heat-insulating material, it not only does not rot and mold, but also helps protect building structures from them. Therefore, hemp is called a natural antiseptic.

Roof insulation. About 20% of heat escapes through the roof. For roof insulation, the same materials are used as for walls. Mineral wool and expanded polystyrene are widespread today.

Technologies do not stand still, many studies are aimed at finding new energy-saving technologies. So, Swedish engineers from SolTech Energy, which has been working in this area for several years, managed to find a new roofing material - glass tiles, which can not only perform the functions of an ordinary roof, but also heat your house using solar energy. In terms of its shape, dimensions and weight, glass tiles are no different from their clay counterparts, but they are made of impact-resistant glass, which increases their service life by several times compared to clay. In addition to beauty and strength, such a roof will produce most of the thermal energy needed to heat the house, even in the most northern areas.

At present, special types of glass for roofing are practically not produced in Russia; products of foreign manufacturers are used in this area. One of the exceptions is OAO Saratov Institute of Glass, which conducts research work in the field of compositions and new types of float glass and produces tinted float glass, reflective, low-emission, tempered glass, as well as energy-saving double-glazed windows (Porfiriev, 2010).

"Green" roof and facade. One of the elements of the heat-shielding shell of a green building can be a "green" roof. This is a multilayer enclosing structure, consisting of a reinforced concrete roof slab, the main layer of a waterproofing carpet, thermal insulation from extruded polystyrene foam boards, a separating layer of geotextiles, a drainage and filtering layer, a soil layer, and a vegetation layer (Fig.). Depending on the type of vegetation layer, roof gardening can be divided into intensive and extensive. In intensive landscaping based on the use of tall plants with a developed root system (roof garden), a massive soil layer up to 1 m thick may be required; such a roof requires, as a rule, constant care by gardeners. Extensively green roofs, on the other hand, do not require systematic maintenance, and a minimum layer of soil or compost is required to accommodate plants. Compared to "intensive", "extensive" roofs have a simpler design solution (Efremov, 2016). The main advantages of green roofs are:

- mitigation of the effect of "heat islands" by equalizing the temperature of the surfaces; in the summer, an increase in the area of \u200b\u200b"green" roofs can significantly reduce the average temperature of an entire city; reducing the cost of heating the building during the cold season due to the high resistance to heat transfer of the structure; green roof buildings approach passive house standards;
- reducing the cost of cooling and air-conditioning of buildings in the warm season by increasing the mass of the structure, as well as due to the natural evaporation of moisture; a significant reduction in air pollution and its enrichment with oxygen, which, in turn, increases comfortable living conditions and reduces the number of allergic and asthmatic diseases;
- increasing acoustic comfort due to additional absorption of urban noise, while the soil layer absorbs mainly low-frequency sound, and the vegetation layer absorbs high-frequency sound;
- reduction of the amount of moisture entering the storm sewerage system in the form of precipitation; coverings with landscaping purify rainwater, including heavy metals.

4 CONCLUSIONS

In recent years, due to the increase in the concentration of greenhouse gases in the atmosphere, the process of global warming has been observed. Greenhouse gases are mainly carbon dioxide, a product of the combustion of fuels, which are released into the atmosphere in large quantities; methane, the emissions of which occur mainly in agriculture, and nitrous oxide, the so-called "laughing gas". As a result of global warming, various cataclysms occur in the world: heat and drought; downpours and floods, hurricanes and rising sea levels in various places. The vegetation on the roofs, as a result of photosynthesis, reduces the amount of carbon dioxide by absorbing it using the energy of the sun, as a result, oxygen is released into the atmosphere. "Green roofs" can contribute to saving humanity from global warming.

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