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ANALYSIS OF WAYS TO REDUCE ENERGY RESOURCES CONSUMPTION FOR BUILDING HEATING OF TELECOMMUNICATION COMPANIES

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АНАЛІЗ ШЛЯХІВ ЗМЕНШЕННЯ СПОЖИВАННЯ ЕНЕРГОРЕСУРСІВ ДЛЯ ОБІГРІВУ БУДІВЕЛЬ ТЕЛЕКОМУНІКАЦІЙНИХ КОМПАНІЙ

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АНАЛИЗ ПУТЕЙ УМЕНЬШЕНИЯ ПОТРЕБЛЕНИЯ ЕНЕРГОРЕСУРСОВ ДЛЯ ОБОГРЕВА ЗДАНИЙ ТЕЛЕКОММУНИКАЦИОННЫХ КОМПАНИЙ

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Abstract. The increase of the traditional energy resources cost, due to the need to reduce carbon dioxide emissions, leads to an increase of the cost for services provided by telecommunications companies. One of the ways to reduce the use of traditional carbon energy resources is to replace them with alternative energy sources such as renewable chemical energy sources, solar and wind energy equipment, heat pumps and others. The most promising of these is the use of solar collectors. However, currently, most popular types and models of the solar collectors on the Ukrainian market are geared towards hot water supply systems, and their integration into existing air heating systems is related to the need to significantly modernize them. Thus, in practice, the modernization of existing air heating systems leads to many technical and organizational problems. At the same time, promising directions for utilization of solar radiation energy for the building heating are the use of air solar collectors and their integration with heat pumps. However, in Ukraine, this trend has not yet become widespread despite its undoubted advantages. The article discusses the methods of using solar collectors for the telecommunication companies' building heating, which require minimal integration of them into already existing engineering systems of building. Two promising methods are considered: the use of solar air collectors and the integration of water solar collectors in existing air conditioning systems based on heat pumps. Attention is paid to the advantages of using air solar collectors to heat the premises. The proposed methods of using solar collectors can become the basis for the development of new facilities and systems for building heating, which will reduce the consumption of organic fuels and the environmental impact of the environment.

Key words: solar collector, air conditioning, heating system, heat pump, alternative / solar energy.

Анотація. Збільшення вартості традиційних енергоресурсів, що обумовлена необхідністю зменшення рівня викидів вуглекислого газу, призводить до збільшення вартості послуг, що надаються телекомунікаційними компаніями. Одним зі способів зменшення використання традиційних вуглецевих енергоресурсів є заміна їх альтернативними джерелами енергії, найбільш перспективним із яких є використання сонячних колекторів. Однак на сьогоднішній день більшість присутніх на українському ринку сонячних колекторів орієнтовані на системи гарячого водопостачання, а їх інтеграція в уже існуючі системи опалення пов'язана із необхідністю істотної модернізації останніх, що на практиці призводить до цілої низки технічних та організаційних проблем. У той самий час перспективними напрямками утилізації енергії сонячного випромінювання для обігріву приміщень є використання

повітряних сонячних колекторів та інтеграція їх із тепловими насосами. Однак в Україні цей напрямок поки що не набув широкого розповсюдження, незважаючи на його безсумнівні переваги. У статті розглянуті методи використання сонячних колекторів для обігріву приміщень телекомунікаційних компаній, що потребують мінімальної інтеграції їх в уже існуючі інженерні системи будинків. Зокрема, розглянуто два перспективних методи: використання повітряних сонячних колекторів та інтеграція рідинних сонячних колекторів в уже існуючі системи кондиціонування на основі теплових насосів. Особливу увагу приділено перевагам використання повітряних сонячних колекторів для обігріву приміщень. Запропоновані способи використання сонячних колекторів можуть стати основою для розробки нових пристроїв та систем для обігріву приміщень, що дозволять зменшити витрати органічних видів палива та рівень екологічного навантаження на довколишнє середовище.

Ключові слова: сонячний колектор, кондиціонер, система обігріву, тепловий насос, альтернативна/сонячна енергетика.

Аннотация. Увеличение стоимости традиционных энергоресурсов, обусловленное необходимостью уменьшения уровня выбросов углекислого газа, приводит к увеличению стоимости услуг, предоставляемых телекоммуникационными компаниями. Одним из способов уменьшения использования традиционных углеродных энергоресурсов является использование солнечных коллекторов. Однако на сегодняшний день большинство присутствующих на украинском рынке солнечных коллекторов ориентированы на системы горячего водоснабжения, а их интеграция в уже существующие системы отопления связана с необходимостью существенной модернизации последних. Перспективными направлениями использования энергии Солнца является использование воздушных солнечных коллекторов и интеграция их с тепловыми насосами. Однако в Украине это направление пока не получило широкого распространения. В статье рассмотрены методы использования солнечных коллекторов для обогрева зданий телекоммуникационных компаний, требующих минимальной интеграции их в уже существующие инженерные системы зданий. В частности, рассмотрены два перспективных метода: использование воздушных солнечных коллекторов и интеграция жидкостных солнечных коллекторов в уже существующие системы кондиционирования на основе тепловых насосов. Предложенные способы использования солнечных коллекторов могут стать основой для разработки новых устройств и систем для обогрева помещений, позволят уменьшить затраты органических видов топлива и уровень экологической нагрузки на окружающую среду.

Ключевые слова: солнечный коллектор, кондиционер, система обогрева, тепловой насос, альтернативная/солнечная энергетика.

Introduction. The need to reduce the use of traditional energy resources, which leads to an increase in the level of concentration of CO_2, is an urgent problem facing the whole world today [1]. Under existing conditions, the most effective way to reduce the use of organic fuels is to increase its cost. In recent years, the cost of natural gas in the Ukraine has increased several times, and several more stages of increase are expected soon.

The increase in the cost of natural gas and other types of traditional energy resources leads to the increase of the cost of services provided by telecommunication companies. The situation is aggravated by the fact that most of the telecommunication companies' buildings were built in the times of the USSR, have a high level of heat energy losses, and should be modernized soon.

In addition to thermo-modernization of building, reducing the level of consumption of organic fuels is possible by replacing them with alternative energy resources, one of which is solar power [2]. In [3, 4], it is shown that the total amount of solar energy during the heating period in the Ukraine can reach 1 GJ/m^2 [4], and these data are well-correlated with international calculation methods [5]. For example, if you dispose at least a quarter of this energy, a building of a rural post office with a dimension of 10 m x 10 m and a height of 3 m, located, in the Odessa region will be able to receive additional energy during the heating period:

$$(Q_N S_N + Q_E S_E + Q_S S_S + Q_W S_W + Q_H S_H)/4 =$$
$$= (248 \cdot 30 + 454 \cdot 30 + 881 \cdot 30 + 480 \cdot 30 + 876 \cdot 100)/4 \approx 37 \text{ GJ},$$

where Q_N, Q_E, Q_S, Q_W, Q_H – total amount of energy received during the heating period one square meter vertical (oriented, respectively, to the north, east, south and west) and the horizontal surface

of the building located in the Odessa region (MJ/m^2) [4]; S_N, S_E, S_S, S_W, S_H – the total area of these surfaces (m^2). This amount of energy allows you to save about 1000 m^3 of natural gas from heating, which corresponds to almost 2 tons of CO_2 per year.

One way of utilizing solar energy is to use solar collectors. However, today most of the solar collectors on the Ukrainian market are focused on hot water supply systems. Their use in heating systems relates to the necessity of significant modernization of existing engineering systems of buildings, which significantly impedes their practical use.

The promising ways of solar energy utilization for the heating of buildings are the use of air solar collectors [6] and their integration with heat pumps [7 – 9]. However, in Ukraine, these ways have not yet become widespread, although existing research [10] shows its promise. In addition, despite the large number of methods for using solar collectors to heat the premises, in Ukraine it is expedient to first use those which require minimal refinement of existing engineering systems of buildings, but the number of such research in Ukraine is also limited.

The purpose of the article is the determination of the ways of solar collectors' use for the telecommunication companies' buildings heating with the simple integration into existing buildings engineering systems.

The simplified typical heating system with solar collectors is shown in Fig. 1. As can be seen from the figure, in most cases, solar collectors should have a separate insulated circulating heat carrier which uses a non-freezing liquid (in most cases it is the propylene glycol $C_3H_8O_2$). This greatly complicates the system and requires the use of additional equipment, which sometimes cannot be installed.

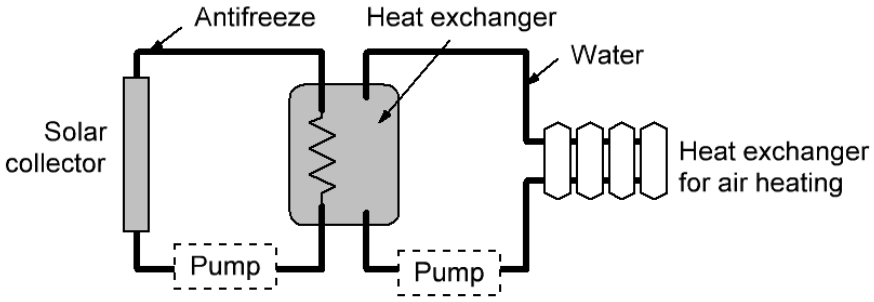

Figure 1 – The simplified building heating system with solar collectors.

The easiest way to utilize solar radiation for indoor heating is to use air solar collectors. Although air has a lower coefficient of thermal conductivity compared to water or antifreeze, the use of it as a coolant has several significant advantages:

1. The building heating system is intended for heating the air, so the use as a coolant air does not require separate isolated circuits for circulation of the coolant, which greatly simplifies integration of the solar collector into the existing system. In the simplest case, for example, when the solar collector is located directly on the wall of the building, it is necessary to make at least two holes for it (Fig. 2).

2. This system can work entirely autonomously and does not require integration with existing systems. On a clear day, at a significant level of solar insolation, the solar collectors will raise the temperature in a certain room, while the amount of coolant supplied to the radiators of water heating can be reduced automatically, for example, with the individual temperature regulators.

3. When using air solar collectors, the heating system can be easily combined with a ventilation system by connecting the entrance airway to a source of clean air – placing it either directly into the environment, for example, in the attic – where the air temperature is higher than at the lower environment.

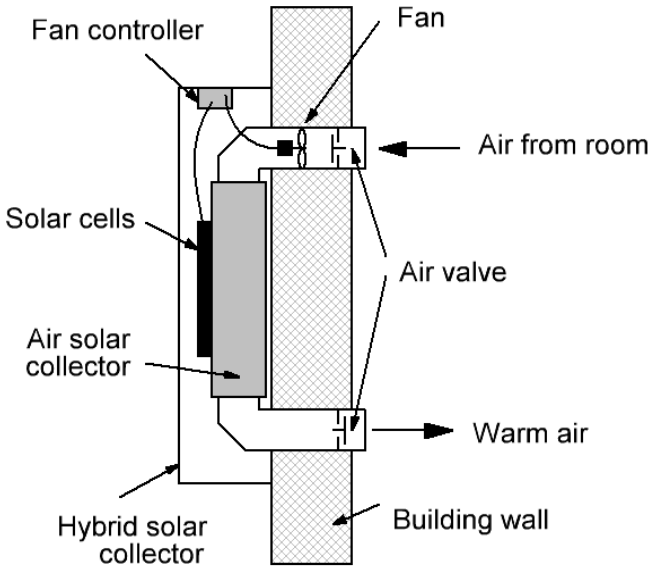

Figure 2 – Building heating with an air solar collector.

4. You can use a solar cell to power the fan that circulates the air in the solar collector. Since the required power of the fan is proportional to the solar radiation level and, accordingly, the power generated by the solar cell, such a system does not require additional sources of eclectic energy to power the fans, which will positively influence the cost of the system. In addition, because the fan power is relatively small (not more than 10 W), it is possible to use inexpensive amorphous silicon solar cells by sticking them directly to the absorber of the solar collector. In this case, the solar collector will be completely autonomous and needs minimal control – in the simplest case, only the power switch of the fan is required to shut down the system in the summer.

5. The air solar collector is much simpler and cheaper compared to water analogues. It does not require compulsory full sealing of the circulation channels of the coolant and can work efficiently in case of violation of tightness.

6. Since the air solar collector can be located directly on the wall or roof of the building, its thermal insulation can be additionally used to increase their thermal resistance. If such a technology shows its effectiveness, then in the future it is possible to set up production, for example, of specialized sandwich panels with integrated insulation, absorber, air circulation channels and solar panels.

Another way to use solar collectors is to connect them to existing air conditioning systems. Today, Ukraine has already installed many air conditioners, most of which are used only in the summer to cool the buildings. In this case, the air conditioner, which is an air heat pump, can work both in the cooling and heating modes. But for the effective selection of heat from the ambient air, the temperature of the external heat exchanger must be below the temperature of the environment air. This leads to the fact that in winter the external heat exchanger can freeze up, so for most domestic air conditioners, the minimum ambient temperature in the heating mode is 0...–5 °C.

The use of heat pumps for the building heating is recognized as the world's most energy-saving technology since at a quantity of 1 kWh of electrical energy, the heat pump can move up to 5 kWh of heat (for most domestic air conditioners this figure is approximately 3 kWh). Thus, for existing air conditioners to do the heating of premises, they need to have an outside source of thermal energy.

Such a source can be a solar collector. If you connect the compressor of the air conditioner to the absorber, in the circuit of which the Freon circulates (Fig. 3), then it is possible to move the

received heat into the building, thereby providing energy savings. Among the advantages of such a project can be identified as follows:

1. Today, most air conditioners are already installed in buildings and actively used as individual and centralized air conditioning systems. In this case, their connection to the solar collector requires the adaptation of only that part of the system that is outside without the adaptation of internal communications.

2. Just as in the case of using air solar collectors, such a system can be used in parallel with the existing heating system without the need for its integration.

3. Theoretically, the air conditioner can be powered from the solar cells that are glued on a collector's absorber (it is a hybrid solar collector), and the solar cells can generate energy both in winter and in summer when the air conditioner is in cooling mode.

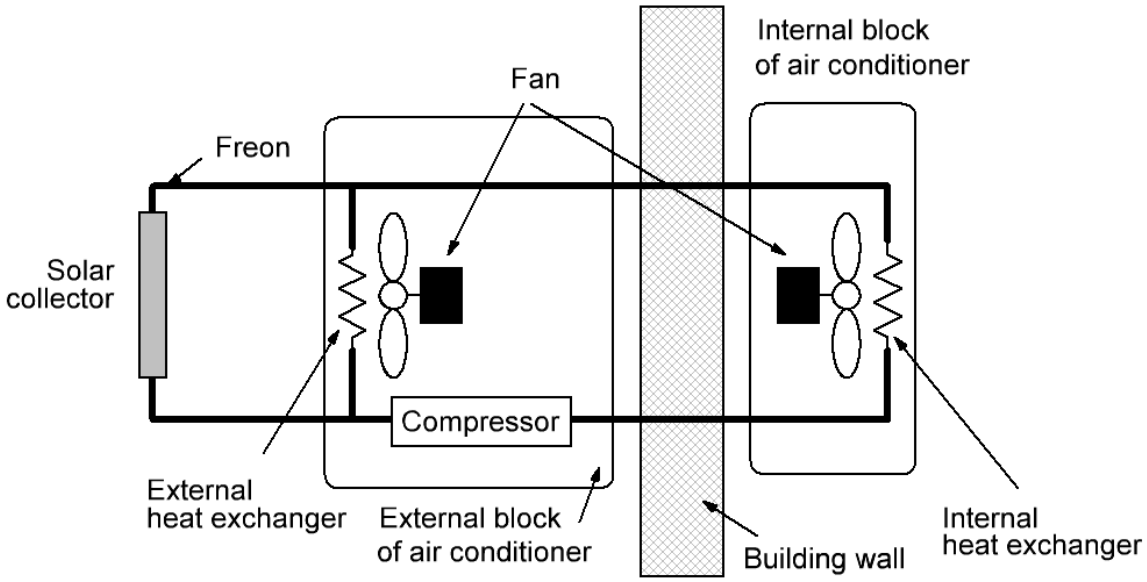

Figure 3 – Connection of the solar collector to the air conditioner.

4. Since the Freon will circulate in the collector circuit in this case, vacuum solar collectors that are most effective will be more suitable for use in the system.

Unfortunately, such a system requires the modernization of most existing air conditioners, first – the adaptation of an external unit, which will invalidate the manufacturer's warranty. But perhaps in the future, if this technology is to show its effectiveness, the manufacturers of the equipment will begin the production of new type air conditioners in which the possibility of connecting an external solar collector will be a standard option or the external unit can directly perform the function of the solar collector.

Conclusions. The use of solar collectors for telecommunication companies' building heating has a great potential and requires further research, for which, based on the O.S. Popov Odesa National Academy of Telecommunications within the framework of research work that it plans to create several experimental installations.The research of the efficiency of air solar collectors made based on existing enclosing constructions of buildings will be conducted. For example, according to the author, one of the most promising areas can be the use of roof tiles as an absorber, as well as the development and research of various variants of sandwich panels. It is also planned to reconfigure one of the installed air conditioners and connect it to its solar collector system made, for example, a heat exchanger from a domestic freezer.

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