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HEATING AND VENTILATION OF BUILDINGS WITH ZERO ENERGY CONSUMPTION

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Abstract: The features of the heating and ventilation systems design for civil buildings with zero energy consumption have been studied. The scheme of heating, ventilation and hot water supply with heat and cold supply in a system using a heat pump and a ground collector is considered.
Key words: zero energy, energy efficiency, recovery, ventilation systems, heat pump, heating and cooling.

Introduction

The constant increase in prices for heat and energy resources and, accordingly, their rational use is a pressing issue in the economic development of the country. As a result of the first world energy crisis of 1974-75, states began to think on saving the global energy.
The largest volume of energy consumption occurs in buildings, so the most relevant method of reducing energy consumption is the construction of buildings with low energy consumption, i.e. energy efficient construction.
Many countries worldwide have developed and are successfully implementing programs for the energy modernization of the construction field, according to which by 2050 the share of fossil heating in the energy supply of buildings will be completely eliminated, which will reduce CO2 emissions. into the environment to zero. Currently, Georgia is at the initial stage of implementing this global program. Georgia has passed a law [1] according to which, from 2030, all new buildings must be net zero. This law is mandatory for public buildings from 2027. In addition, every year 3% of buildings must become net-zero energy.

Main part

Buildings are considered the largest consumers of energy in the country. A significant share of energy consumed in buildings (about 87%) comes from heating, ventilation and hot water supply systems. The thermal load of buildings emanating from these systems is mainly determined by the architectural and structural solutions of the building. Over the past 50 years, limiting structures of buildings have been created that minimize their thermal loads (Table 1).

Thermal loads of buildings by year

Table 1

years of construction	1970-1980	1980-1990	1990-2000	2000-till today
Thermal energy consumption for heating kWh/m^2 per year	200-300	125-200	90-125	25-90

As would be seen from this table, over the past 50 years, thermal loads in massive buildings have decreased by almost 8 times.

Energy-efficient (zero-zero) buildings created in Germany, known as "passive houses", have a design thermal load of 10 W/m2, in contrast to buildings of the last century, whose design load is 100 W/m^2.

Reducing the heat load of buildings by 10 times makes it possible to avoid installing a heating system. So, for example, 20 sq. The amount of heat required to warm a room is actually equal to the amount of heat emitted by one light bulb or one person.

But in order to ensure such a low design thermal load, the building must be absolutely airtight, its enclosing structure must be completely insulated ($U_{bond.\ const.}$≤15 vt/m^2gr), In surrounding structures, heat-conducting inserts, called "cold bridges," must be completely eliminated, and window structures must be energy efficient ($U_{wind.}$ ≤0,8 vt/m^2 °C).

One of the important conditions for achieving zero heat load - "building tightness" - requires the installation of a special supply and exhaust recuperative ventilation system in the building. This

ventilation system ensures constant renewal of air in the building, heating it through heat recovery and preparing hot water for domestic needs. This ventilation system is used for air conditioning in summer.

The zero-energy circuit is shown in Fig. 1. The main element of the system is the air-to-air recuperator, which is a highly efficient heat exchange device. The efficiency of such a heat exchanger reaches even 95%. The work of warm room air, passing through the recuperator, transfers heat to the incoming (supply) air from outside. In summer, hot air coming from outside is cooled by cold air taken from the storage area and supplied to the storage area.

The temperature of the air supplied to the compartment is determined by the formula:

$$t_{del} = t_{ext.} + (t_{sh} - t_{ext.})\eta$$

where t_{del} - Temperature of air supplied to the compartment°C,

$t_{ext.}$ - external air temperature°C,

η - Efficiency coefficient of the recuperator.

A prerequisite for zero energy homes is that η≥0,75.

In houses with zero energy consumption, the thermal energy generated in the recuperator, which is transferred to the room through the supply air, is quite enough to establish the appropriate temperature regime in it without installing an active heating system.

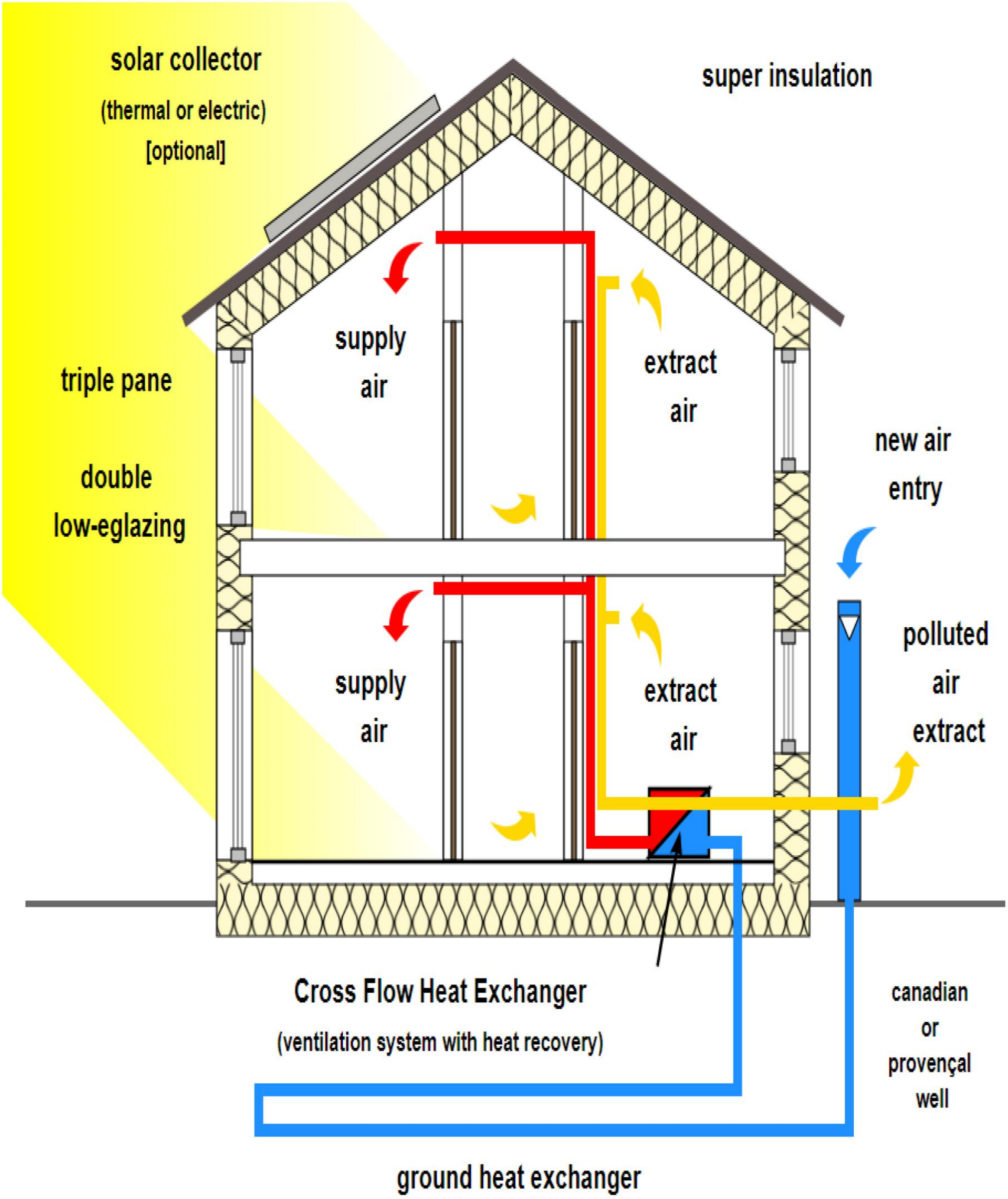

Fig. 1

If the heat collected in the recuperator is not enough to heat the supply air, then we can additionally use an air-to-water heat pump, which will return waste heat to us for additional heating of the supply air.

On Fig. 2 is presented a schematic diagram of zero heat and cold supply to a house when low-energy techniques and construction technologies are used in such buildings. In addition to the recuperator, a small heat pump is built into the ventilation system, which takes heat from the spoiled air and collects it in the form of hot water in a volumetric water heater. The heat from the latter is transferred to the supply air through an additional heat exchanger. A volumetric water heater is also used to provide hot water for domestic needs.

We can also connect a solar collector to the volumetric water heater for additional hot water supply.

The presented diagram shows one important detail of the ventilation system of a zero building - ground heat exchangers, which are plastic pipes. It is installed in the ground at a depth of 1.5÷2 m. Passing through this pipe, the ventilation air is preheated before entering the recuperator. The length of the pipe is calculated on the assumption that at low outside temperatures (-20°C) at the entrance to the recuperator, its temperature does not fall below 0°C, which prevents the recuperator from freezing. Let us take the length of the ground heat exchanger to be within 30-50 m.

The use of a ground heat exchanger further improves the energy efficiency of the building. These heat sinks are used if the building has a suitable land plot (individual residential buildings, kindergartens, detached low-rise buildings, etc.).

If it is not possible to use a ground collector near the building, outside air is supplied directly to the recuperator.

It is especially important to use a ground heat exchanger in summer conditions. At the same time, we can reduce the temperature of the supplied outside air from +35°C to +20°C, which eliminates the need to use air conditioning in the building and the associated costs.

The specified scheme can be used for any civil buildings (residential buildings, offices, administrative buildings, etc.).

Due to the characteristics of this building, the above scheme for providing heat and cold can be either built into one block or separated.

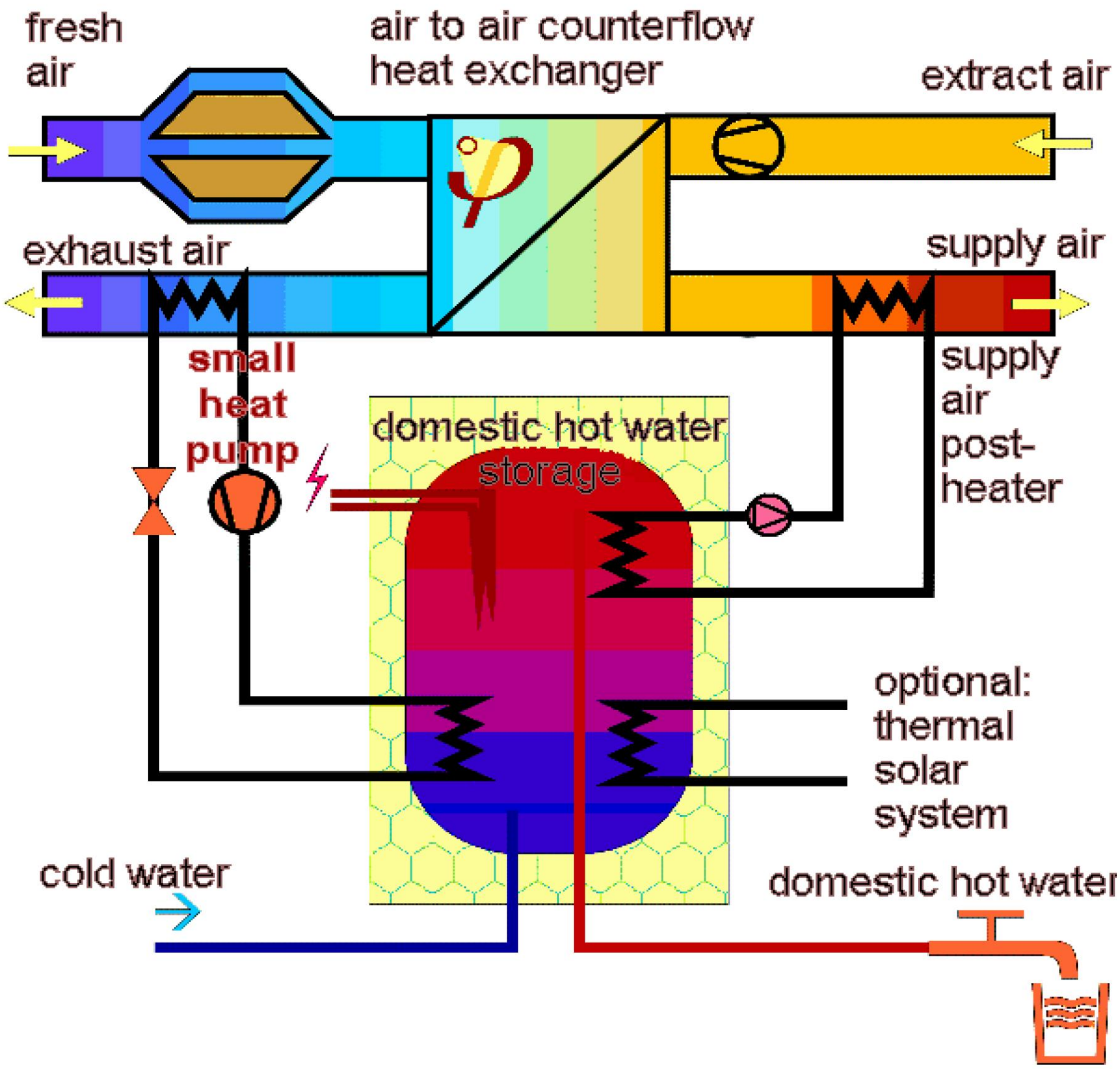

Fig. 2

conclusion

Zero energy buildings are the construction of the future, and in them the consumption of primary energy is reduced to a minimum, almost to zero. The building does not require a heating system, and in most buildings (residential buildings, offices, administrative buildings, etc.) cooling, air and heat modes in the summer are provided by an air-to-air recuperator. The building eliminates the burning of fossil fuels and the resulting environmental pollution.

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