УДК 620.91

EXPERIMENTAL STUDY ON AN ADSORPTION COLD STORAGE BAD USED FOR SUPPORTING THE AIR CONDITIONING SYSTEM IN SINGLE-FAMILY HOUSE

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The article presents experimental results on open adsorption storage unit. According to the experiment there is calculated how large should be a cold storage unit for single-family house.

Keywords: *adsorption refrigeration, cold storage, energy efficiency*

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Energy storage in any form is one of the largest challenges in recent years. For markets where the price of energy fluctuates at short intervals, energy storage proves to be profitable even in cases where it does not make thermodynamic sense. The standard of living in Europe is growing constantly [1]. This process causes the energy consumption for air conditioning is also growing all the time. While in commercial or office buildings air conditioning

system is a standard, in residential buildings, market saturation is estimated at level of 10% (in Europe) and 8% in Poland. In the United States, market saturation is 87%, and Japan market is saturated in almost 100%. It is estimated that within a few years, air-conditioning systems will be the main energy consumers in buildings next to the heating systems. For office buildings it is already a fact.

Cold storage is significantly different from the heat storage because the systems have a small temperature difference between the supply and return of the working fluid. Cooling storage systems can be divided into several types [1, 2]: cold storage as a cold water tank; cold storage using change of phase: (ice type; binary ice type; dry ice type); other PCMs (phase change materials); cold storage using sorption phenomena.

In all types of storage, an additional working fluid has to be used to storage energy. The cool storage medium should meet several conditions: it should be commonly available, cheap, environmentally friendly, non-flammable, non-explosive, non-toxic, compatible with materials used in popular HVACR systems, does not cause a corrosion, chemically neutral, well-documented thermo-physical properties, high density, low viscosity, high specific heat (for non phase change storage systems), high thermal conductivity, works at low pressure, stable (the properties of the fluid should not change during long term usage). Unfortunately, none of the real working fluids meet all the requirements at the same time. In cold storage systems, the most frequent are used: water, water-glycols solutions and water-salt solutions.

This thesis presents the results of experimental research for a cold storage system based on a silica gel bed for a small single-family residential building with an internal volume of 600 m^3. Adsorption cold storage systems can be divided into an open or closed type. For this research the open type was selected. In order to analyze the possibility of using adsorbent beds for air conditioning purposes, a measurement stand was constructed. The stand consists of a fan, an air heater, a humidifier, a test adsorbent bed. The bench makes it possible to study the sorbent deposit in the conditions that occur in summer in Poland. The tests were conducted in such a way as to determine the impact of atmospheric conditions on the deposit but also to determine the capacity and inertia of the deposit [4].

The measurements show that the V_0=0.60 liter adsorption bed was able to decrease the outside air temperature for t_0=160 seconds. The results of the measurements were generalized to the air temperature in August 2018 in Warsaw In the selected month during the day the temperature reached thirty-several degrees and at night it dropped below 20 °C. The aim of the generalization was to determine how large the adsorbent bed must be, to allow the temperature to fall below 25°C for the inflow air. Assuming that the air will flow through the bed all the time in one direction and that the building volume is 600 m^3 (and the required air exchange rate is 0.5), to maintain the airflow temperature over 25°C in Polish climatic conditions the bed must have V_1=0.98 m^3 volume.

Storage of cold in the absorption bed enables obtaining one of the highest energy density coefficients. While heat storage can be carried out in a water tank, in the case of cold this

tank must be several times larger to store the same amount of energy. For this reason, in the case of cold storage, technologies such as PCM or storage in the form of adsorption beds are being developed. The experiment shows that when it is built a sufficiently large adsorption storage unit, it can eliminate compressor systems from air conditioning systems. However, during the experiment there was a problem with the amount of energy needed to pump air through the bed. This problem can be eliminated by building a bed with a small thickness and a large air inflow area. However, this solution requires an appropriate building design.

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