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Border conditions for cooling throughout solar thermal radiation

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Abstract The paper deals with an absorption cooling system-simulating the influence that size has on cold storage for the efficient operation of absorption units of a selected experimental room. The research is based on an experimental device (absorption units with a performance of 10kW). Outputs in this paper are processed so that they connect the entire scheme of the solar absorption cooling system (i.e. the relationship between the solar systems hot and cold storage and the absorption unit). To determine the size of the storage required, calculated cooling for summer months is considered by the ramp rate of the absorption unit and required flow rate of the collectors. The following simulations will take place with connection of the all the components, in order to the whole scheme work efficiently. The individual simulations took place in the simulation program TRANSOL.

Keywords solar cooling, absorption cooling, solar tank volume, solar tank temperature, software Transol.

1. INTRODUCTION

The summer months are increasingly seeing a lot of hot days. Therefore it is increasing demand for air conditioning in dwelling houses, hospitals, hotels, work spaces and other commercial buildings. In many countries air conditioning is the biggest consumer of energy in the buildings. Reducing energy consumption we can achieve in different ways.

The paper deals with progressive technology of the solar cooling by using of solar system which is connected with the absorption equipment and additional technical equipment. The aim is to create an appropriate system with the minimum energy consumption and thus CO_2 production. With growing requirements for indoor comfort, increased attention is being paid to sorption cooling systems which can be powered by heat flux with temperatures beginning at 70°C. This paper specifically considers solar absorption cooling.

At the STU in Bratislava, Daniel Curka developed an absorption unit with a maximum capacity of 10kW as is shown in Figure 1.

Figure 1: Absorption unit at STU in Bratislava

2. ABSORPTION COOLING PRINCIPLE

The refrigerant vapours (absorbate) are absorbed by appropriate liquid (absorbent) during evaporating pressure in the absorber. Together create a solution, which is transformed to the higher (condensing) pressure and transported to the ejector by pump. In ejector during thermal energy supply is the solution led to boil point and refrigerant, which has lower temperature like absorbent is released in these solution and in state of overheating steam is took away to the condenser. The solution depleted about evaporated coolant is transported back to absorber to repeat the process after pressure adjustment to evaporation pressure. In absorption cooling device are realized two circuits - the coolant circulation and solvent circulation [1]. The function scheme of sorption cooling system is mentioned in Figure 2.

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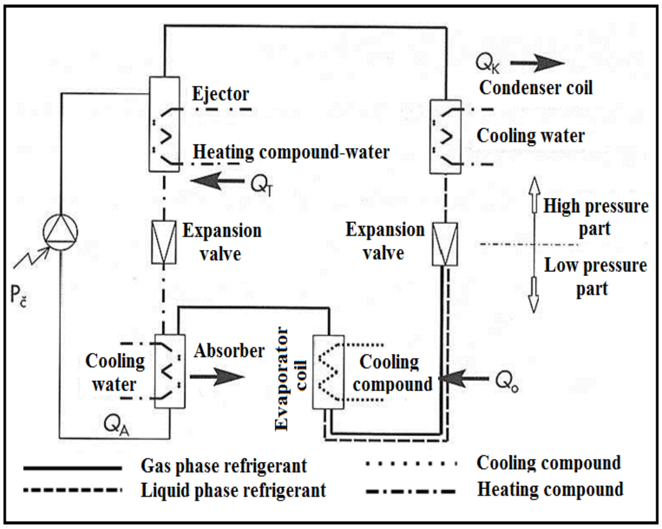

Figure 2: Generally function scheme of absorption unit

3. MATERIALS AND METHODS

One of the purposes of experiments and calculations is the achievement, or at least the approaching to the ,,building with nearly zero energy consumption,,. For the individual simulations will be used scheme in Figure 3.

The core of scheme is mentioned absorption unit from the STU Bratislava with the performance of 10kW. Before the unit is the heat storage and after the unit the cold storage. For the performance of absorption unit will be used flat plate collectors with orientation on the south side and 45° inclination. Furthermore, there will be used the photovoltaic panels with storage batteries that cover the electricity consumption of the absorption unit and fans providing fresh air into the room. Individual involvement of the equipment should be managed by a controller that will be placed in the room, through which data will be collected and recorded on your computer.

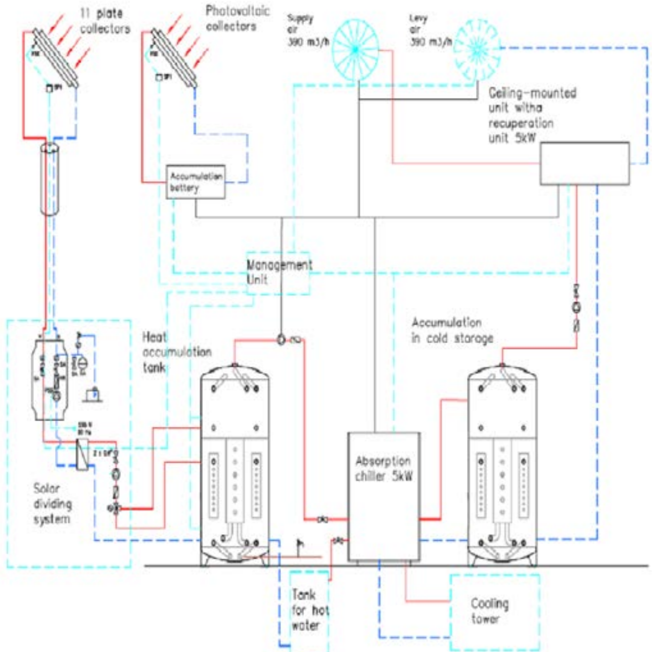

Figure 3: The function scheme of solar cooling connection [2]

The function scheme of solar cooling connection system is divided into the individual phases of solution that are mentioned in Table 1.

Table 1: Phases of solution

Phase number	Solution phase process
1	Phase of heat tank dimensioning and collectors dimensioning
2	Phase of cold tank dimensioning
3	Phase of DHW tank dimensioning
4	Phase of total function scheme dimensioning

As mentioned in previous section in table 1, in the next step we will deal with the phase one -the heat storage tank. Simulations will be done in the simulation software TRANSOL. This step requires the following input values, mentioned in Table 2, 3:

Table 2: Phases number 1 – required input values for absorption unit (measured values)

Individual temperatures	Measured values
Input temperature	77°C
Returning cooled liquid	67°C
The chilled water	18°C
Heated water returning from the end elements	24°C

To determine performance and number of collectors, we have chosen the room - school classroom, where is the necessity of cooling power 10kW. Absorption unit for this performance has COP=0,52. Number of collectors for cooling power 10kW is needed 11 pieces of collectors and area of 1 piece is 2,2m^2.

Table 3: Phases number 2 – input / output parameters into the tank – selected constants

Input parameters into the tank	Selected constant values
Numbers of collectors	11 pieces
Liquid flow rate	240 kg/h
The inlet temperature of water to heat tank	90°C
Heated water returning from the end elements	24°C
Output parameters from the tank	**Selected constant values**
Outlet temperature from the tank	77°C
Outlet liquid flow rate	1700 kg/h
Returning temperature into the tank	67°C
Returning liquid flow rate	1700 kg/h

The observing factor is a volume of storage for the heat. We need to simulate the state in which we ensured the optimal volume of hot water in a way to achieve the longest collection of water at 77°C. The conditions with the heat storages of volume: 300, 500, 700, 900 Liters were simulated.

4. RESULTS

Simulations were realized in a simulation program TRANSOL. The following pictures show the process of temperatures for selected days in the month of July for the city Kosice, Slovakia. The results from simulation software are presented in Figures 4, 5, 6 and 7. The legend of lines is presented in Table 4 [3, 4, 5].

Table 4: Legend of lines (for figures 4, 5, 6, 7)

Marking of line	The name of process
	Outlet temperature of collectors
	The temperature in the tank
	The temperature moves from the tank to units (at 8 to 15 hrs.)
	Outside air temperature

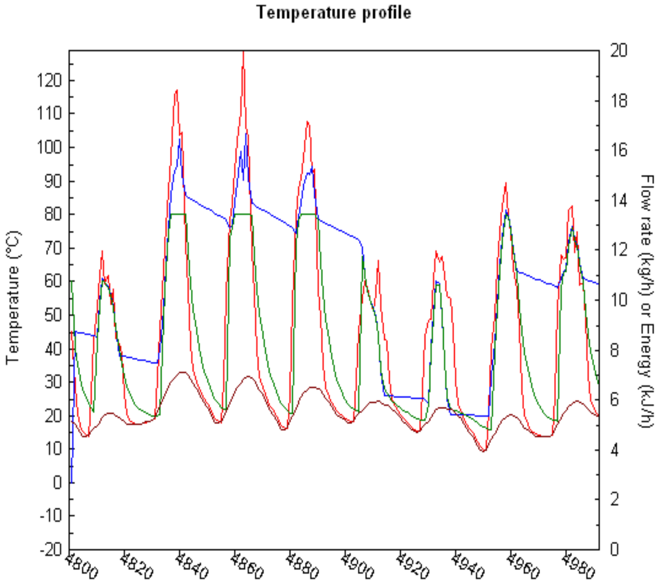

Figure 4: Temperature curve process at tank volume 300L

Figure 5: Temperature curve process at tank volume 500L

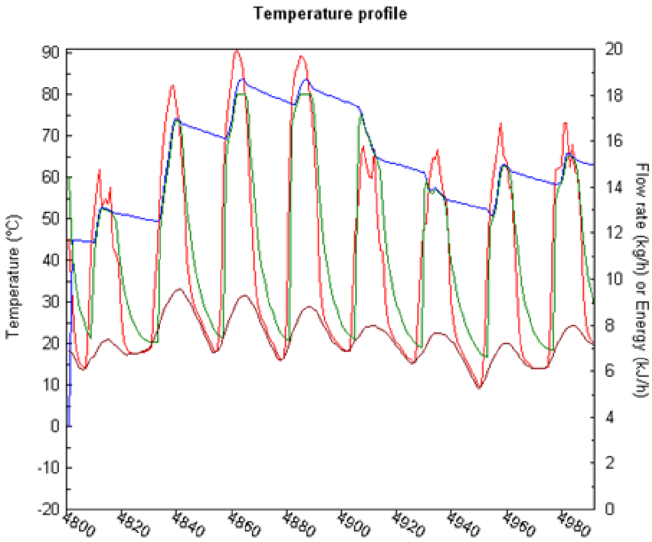

Figure 6: Temperature curve process at tank volume 700L

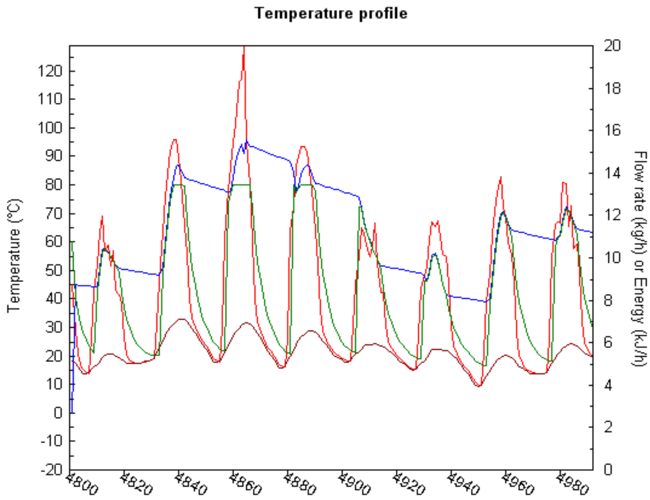

Figure 7: Temperature curve process at tank volume 900L

5. DISCUSSION

On selected days from 20th to 27th of July we can see, that the temperature of outside air in days 21, 22, 23 is being the highest. It is predictable that in those days is the greatest need for cold in the room. In the other days the temperature did not raise even above 25°C, so the need for cooling, we consider with the three days. In evaluating the individual volumes of tank we are working on the main parameters (from the outlet temperature of the tank, the required flow rates and the need for cooling). At these parameters we can see from the graphs that optimal volume of tank is 500-700 L. It is evident, that outlet temperature of tank (shown in green) at the time of cooling needs during three days at a time from 8 to 15 hours, can power the absorption unit. In the not cooling room time, we can the longest to recharge the tank to the cold at collection water of 77°C. Thinking about the fact that the cold tank is not behind the unit, we would suffice 500L heat tank. In case that the cold tank is behind unit, individual curves heat utilization would be changed. Mentioned facts we will find out by simulating a Phase 2. The number of collectors depends on the performance of absorption unit and hence the need to cool the room. By the tuned scheme is possible to simulate also other sizes and obtain the relationship depending heat tank by the number of collectors.

6. CONCLUSION

The solar cooling offers an important opportunity to fight against climate changes, to reducing emissions and proliferation of greenhouse gases. The change of solar energy into heat and electric energy with the using of absorption unit with a small power begins to get into the people´s mind in present days. In our contribution was simulated state of tank for heat at different volumes. In this case, for the power 10kW and the number of 11 collectors is released 500-700L tank. In the article has been resolved only the first part of the circuit diagram of solar absorption device. Further simulations will be done by the involving all components, that whole assembly work efficiently. It deals with the possible use of unconventional sources of energy with their using for cooling rooms with their achievement of thermal comfort for humans. It's the right pure clean energy, which production in small amounts burdens the environment in contrast with the compressor cooling.

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