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HEAT RECOVERY APPARATUS FOR THE LOCAL AIR TREATMENT

BY

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Abstract. The present paper presents a heat-recovery apparatus with heat pipes, originally designed by the authors for the controlled mechanical ventilation systems to ensure the comfort in the insulated buildings. The paper highlights a close correlation between the heat pipes heat exchangers and the concepts of thermal comfort, energy economy, environment, etc.

Key words: Thermal comfort; air treatment; heat pipes heat exchangers.

1. Introduction

Reducing energy consumption in buildings represents a relevant social-economic specific reason for which intensive programs of energy rehabilitation and modernization of envelope and systems installations are promoted.

Unconventional energy forms capitalization and waste heat recovery led to the development and implementation of various types of heat recovery.

There is a wide range of heat exchangers, increasingly improved and more effective, among them, the heat pipes heat exchangers have now a well-known place.

The compactness and the possibility of regulating the transferred heat flux recommend heat pipes heat exchangers for heat recovery in air conditioning and mechanical ventilation systems [1], [2].

Property of reversibility and high reliability confers such devices the possibility of using both for cooling and heating for various thermal agents.

In spite of slightly higher prices of those heat exchangers it is estimated that the benefits they will ensure present a promising development of the domain. Increasing the sealing of envelope elements determines the reducing of fresh air inlet in the interior spaces.

Starting from this reality and the need of controlling the outside air intake, a heat exchanger with heat pipes was designed, for local air treatment, which works with hot water as a primary agent, that can be achieved both by exploiting unconventional forms energy – solar, geothermal – as well as from other available sources [3]. The heat pipe heat exchanger were properly sized to ensure the rate of fresh air needed for an apartment, for air flows between 100 and 250 m^3/h and outside calculus temperatures up to –21°C according to Romanian Standard 1907.

The primary agent temperature was adopted in the 50°...65 °C range.

Taking into consideration the requirements of thermal comfort and the quality of inlet air for interior spaces, in the proposed heat exchanger were integrated two MidasAnAir UV generators, performing air disinfection with germicidal effect in the waveform spectrum of 254 nm, produced by Midas Electronics, Romania.

The heat exchanger was equipped with gravitational heat pipes manufactured by nPowerTek Company, Taiwan, with the following characteristics:

a) Exterior diameter: 12 mm.
b) Length: 1,000 mm.
c) Maximum transferred heat flux at 60 °C: 187.5 W.
d) Operating temperature: +5…+230°C.
e) Working agent: water.

2. Description of Heat Exchanger

In order to study the influence of the constructive organization and direction of flow of working agents upon the thermal efficiency, the two devices have been designed with different principles.

The heat pipes are distributed on concentric circles and are washed by the working fluid longitudinally.

The heat exchanger, (Fig.1), is equipped with a vertically beam composed of nine heat pipes (*1*) arranged concentrically, a central tube and eight disposed perimetral located on a circle with a radius of 50 mm. The ensemble is mounted inside a cylindrical mantle (*2*) with a diameter of 200 mm.

The evaporator (*3*) has a length of 300 mm and is powered from the available heat source (*10*).

The condenser (*4*) has a length of 700 mm; it is separated by tight flange (*5*) and is powered from the input channel of fresh air (*6*).

The main important characteristic of this heat exchanger is that the movement of working fluid is axial, washing the heat pipes in uniflow in the evaporator area and in counter-flow in the condenser area.

In the condenser area (*4*), inside the mantle are located generators of UV radiation (*8*) for treatment of introduced air.

The evacuation of the working fluids is made through concentric lateral channels (*7*).

Primary agent is reintroduced in the heating circuit (*11*) and treated air is introduced in the interior space through the diffuser (*9*).

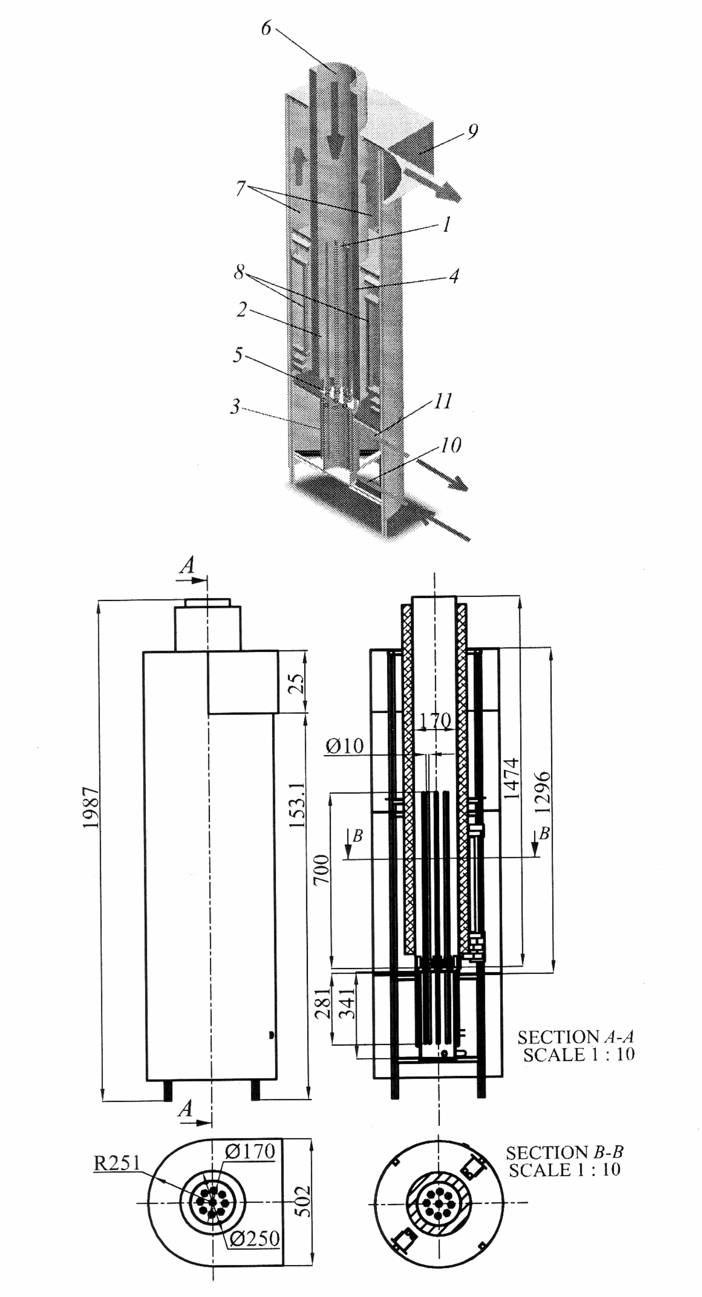

Fig.1 – Heat pipes heat exchanger: *1* – heat pipes; *2* – cylindrical mantle; *3* – evaporator; *4* – condenser; *5* – flange; *6* – input channel of fresh air; *7* – lateral channels; *8* – generators of UV radiation; *9* – diffuser; *10* – from the heat source; *11* – return to the heat source

3. Utilized Method and Obtained Results

The experimental results obtained from the mentioned parameters measurements were recorded in real time for each functional regime, have been systematized and processed with Microsoft Excel program to determine the following characteristic dimensions:

a) Thermal heat flux, *Q*.

b) Convective heat transfer coefficients, α_1 and α_2, in the evaporator and the condenser, respectively.

c) The temperature of the heated air, *T22*.

d) Thermal effectiveness, *E*.

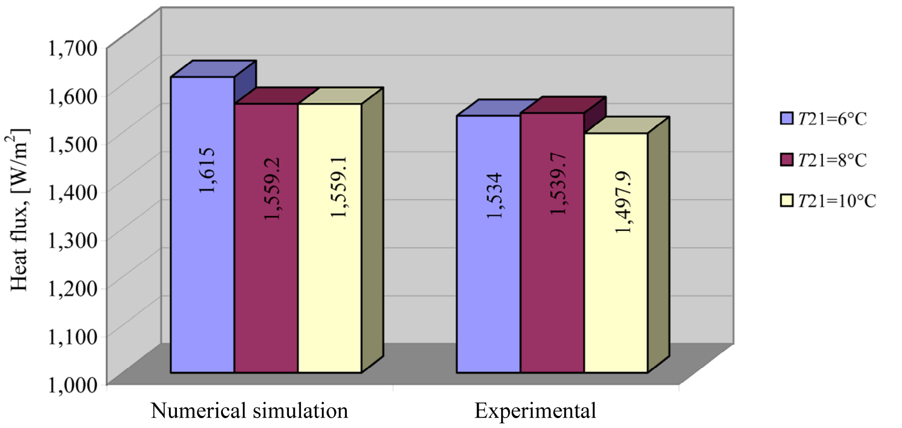

Fig. 2 – Heat flux, *Q*.

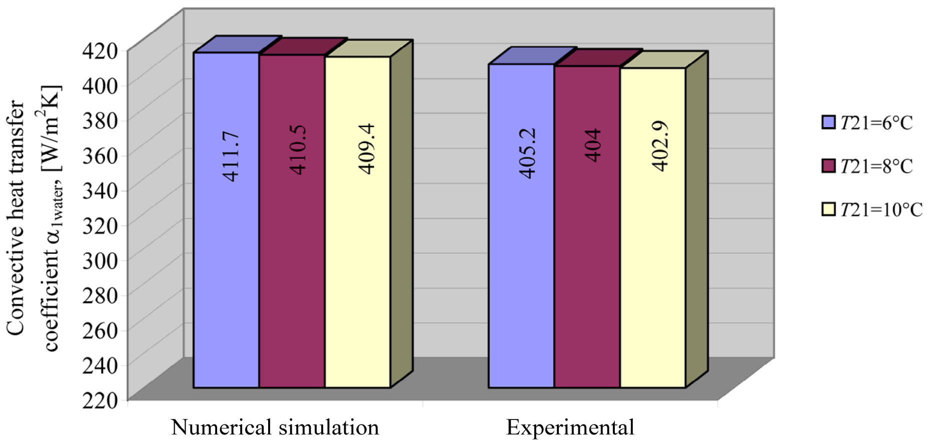

Fig. 3 – Convective heat transfer, $\alpha_{1\ water}$.

For the validation of the heat exchanger model the experimental results were analysed and compared with the main characteristic values obtained from the numerical simulation (Q represents the heat flux, α_1 – convective heat transfer coefficient, $T22$ – temperature of the heated air, E – thermal efficiensy) for the same operating conditions (temperature of the water from the thermal source, $T11$ = 65° C, the flow of water – $Q1$ = 4 l/min, the temperature of the cold air, $T21$ = 6, 8, 10°C, the flow of the air, $Q2$ = 200 m^3/h) (Figs. 2,…,5).

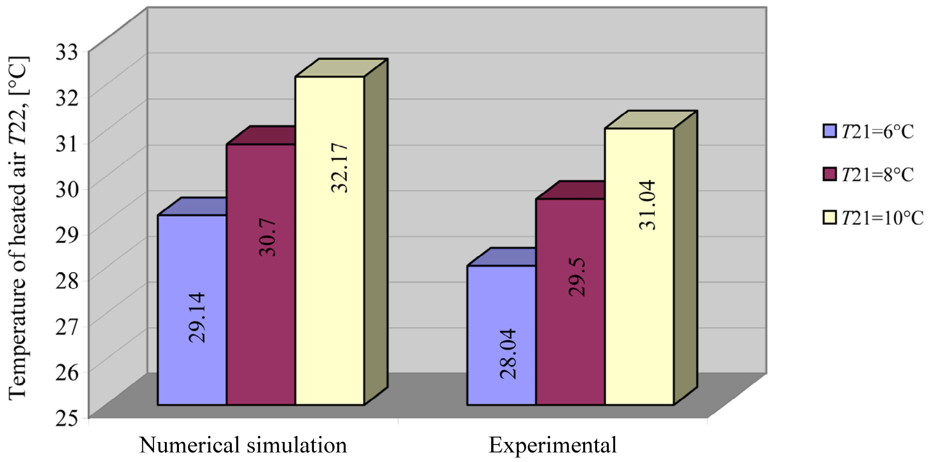

Fig. 4 – Temperature of heated air, $T22$.

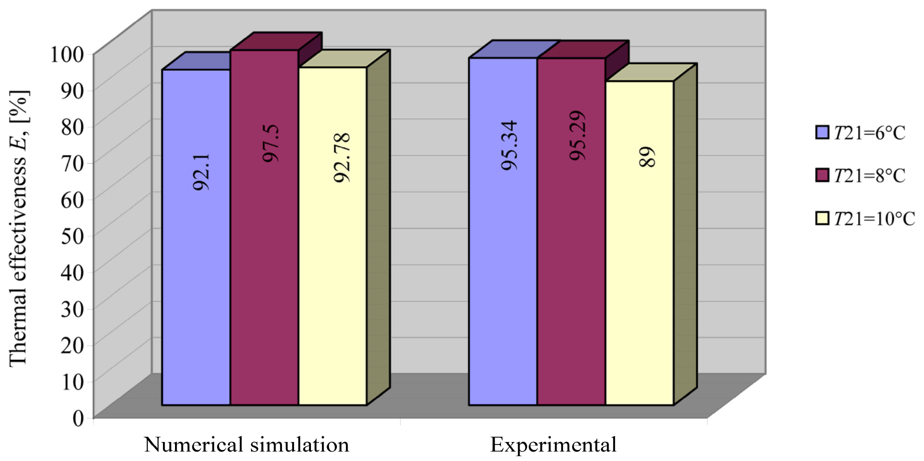

Fig. 5 – Thermal effectiveness, E.

4. Conclusions

1. By comparing the obtained results for the main characteristic values Q, α, $T22$ and E evidently results the correlation between the numerical simulation and the experimental ones with a difference of maximum 5%, validating the model of the proposed heat exchanger;

2. The proposed heat pipes heat exchanger represents a feasible and effective solution to compensate the adverse effects associated with the housing insulated spaces;

3. From the exploitation point of view, the heat exchangers with heat pipes don't have moving elements, so they determine low maintenance and use costs.

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APARAT RECUPERATOR DE CĂLDURĂ PENTRU TRATAREA LOCALĂ A AERULUI

(Rezumat)

Se prezintă un aparat recuperator de căldură cu tuburi termice, de concepție originală, utilizabil in sistemele de ventilare mecanică controlată, pentru asigurarea condițiilor de confort in clădiri cu anvelopa etanşă.