12th International Research/Expert Conference
”Trends in the Development of Machinery and Associated Technology”
TMT 2008, Istanbul, Turkey, 26-30 August, 2008

THERMAL REGISTERS WITH CORE FOR HEATED INSTALLATIONS WITH GEOTHERMAL AND HEAT WATER

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ABSTRACT

This paper has presented theoretical based fundamentals and construction of special thermal registers used in heated installations with geothermal and normal heat water for heat of small warm houses or individual houses. The novel consists in application of first thermodynamics principal for construction of special thermal registers characterized by a core located within inner cylindrical cavity from filler of porous materials with good properties of thermal regulator with great thermal hysteresis and with desire heat coefficients. In addition, it has presented the integration of special thermal networks as thermal resistances within of heat installation with geothermal and heated water.
Keywords: geothermal water**,** heat installation**,** thermal register

1. INTRODUCTION

In locations with geothermal water from Bihor County, Romania, has used specific heat installations for small and medium warm houses, or individual houses. These installations have characterized by used heat exchangers, pipes, special hydraulic pumps, junctions, expansion vessels, and warm-water heating or thermal registers. The geothermal water get in heat exchanger, where pre-heat water from apart inner hydraulic channel, which arrives at thermal registers or warm-water heating due to heat the environment. The warm water has distributed at thermal registers from inner heating circuit to environment.

The normal thermal registers of drawing steel or aluminum, used as thermal resistances in closed-loop hydraulic circuit, present following disadvantages: great consumption of caloric energy, great volume of water which must be pre-heated, large transportation time of pre-heated water in closed loop hydraulic circuit of heat installation.

These disadvantages had avoid by using of heat installations with geothermal or warm water of special thermal registers with cores, filler from thermo-rigid materials, having the property of high thermal hysteresis and thermal regulator device. The phenomena and physics laws, which has stated at new construction base of thermal registers with porous cores are transport phenomena of thermal energy, first law of thermodynamics, Fourier law of radiations and thermal conduction law (similar with Ohm law) [1-4].

2. THEORETICAL FUNDAMENTALS

The atoms, respectively molecules in fluids are going in permanent thermal moving. At heat installations with warm water and closed-loop circuit, from passing through thermal pipes are going thermodynamics processes, which presume a altering of state sizes, being connect at environment by heat exchanger. The heat amount exchanged depends by difference of temperature size (enter-exit), specific heat of fluid and of intermediary element, depression and warm water volume. In this case, the energy exchange between thermodynamic system (thermal register) and environment arising an energy exchange by result contour, which are going in both ways [6,8]. The energy exchanger of thermodynamic system with environment is going under form of mechanical work and heat. In fig.1

has presented the energy exchanger of thermodynamics system for thermal register to heat installation with geothermal or warm water [9,10].

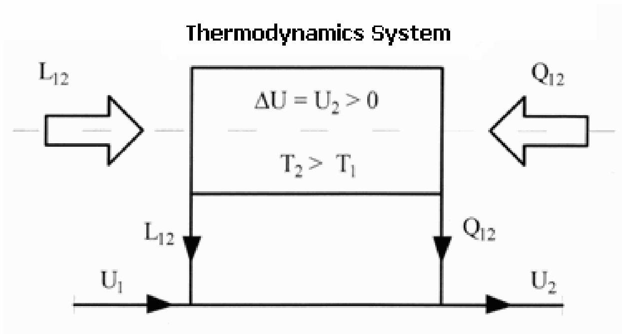

Figure 1. The energy fluxes in a thermodynamic system.

The receiving of heat and mechanical work by system due to increasing the internal energy-U of system with value-ΔU, in conformity with first thermodynamics principle [7,9,10]:

$$\Delta U - Q_{12} - L_{12} \quad (1)$$

, where: Q_{12}-is heat amount [J], and L_{12}-mechanical work [J]. The system energy-U [J] from fig.1 has changed when it has realized an exchange of heat with environment. For improving the system temperature with ΔT [K] it's necessary using certain materials for registers, with great specific heat-c [J/kg·K] and great mass-m [kg], in conformity with the relation [9,10]:

$$Q = c \cdot m \cdot \Delta T \quad (2)$$

By differentiation of relation (2) is obtaining the specific mass heat-c:

$$c = \frac{1}{m} \cdot \frac{dQ}{dT} \quad (3)$$

At contact of two bodies with temperatures and heats different ($T_2 > T_1$) has realized a heat exchange until at uniform of average temperature-T_m in system. In fig.2 has presented a section through thermal register from a heat installation with warm water, where: 1 - metallic tub, 2 - treated warm water, 3 - coupling joint, T_1-environmental temperature, T_2-water temperature, T_m-average temperature of thermal register.

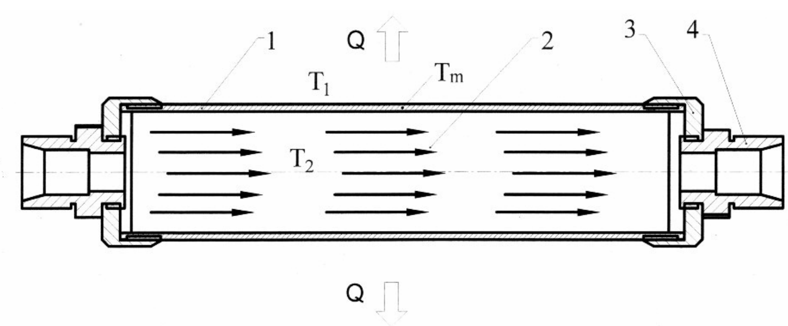

Figure 2. Simple thermal register.

Between heat added in system and heat leaving in system has the relation:

$$c_1 \cdot m_1 (T_2 - T_1) = c_2 \cdot m_2 (T_m - T_1) \quad (4)$$

, where: c_1-is specific heat of tub, and c_2-specific heat of fluid. For a thermodynamics system with n-bodies, the relation (4) became:

$$\sum_{i=1}^{n} c_1 m_i \cdot T_i = T_m \sum_{i=1}^{n} c_i \cdot m_i \quad (5)$$

From relations (3) and (5) results that elementary exchange heat, is proportional with specific heat-c, the quantity of heat leaving to environment -Q depends by process nature from volume variations, pressure and temperature of warm or geothermal water. By reduce of water volume-V, which passing through thermal registers, composed from more bodies-n of a heat installation, by increase water pressure-p_a and temperature-T_2, due to improving the quantity of heat leaving to environment –Q, in conformity with first thermodynamics principal [7,9,10]:

$$\frac{dQ}{dT} = \frac{dV}{dT} + \frac{dL}{dT} \quad (6)$$

The expression dQ/dT is proportion with specific heat-c, depending by exchange of mechanical work from variation of warm water volume. Another law, which actions in thermodynamics system of reinforced thermal register is Fourier Law [9,10]:

$$q = \frac{1}{A} \cdot \frac{dQ}{dt} = -\lambda \frac{dT}{dz} \quad (7)$$

, where: q- represents density of stream heat, dT/dz-is temperature gradient to environment, dQ/dt-heat quantity which passing through a section-A [m] during a time-dt, and λ- thermal conductibility of thermal register [W/m·K].

Besides of these phenomena, inside of thermal register acting the conduction law [9,10]:

$$\Phi = \frac{dQ}{dt} = \frac{\Delta T}{R_t} \quad (8)$$

, where: Φ-is stream heat, R_t- thermal resistance [K/W], in this case is resistance of thermal register. The formula of R_t for thermal register is get by relation:

$$R_t = \frac{1}{\lambda \cdot A} \quad (9)$$

From relations (6)-(9) results that transfer of heat to environment depends of surface-A of thermal resistance-R_t, coefficient of thermal conductibility-λ of R_t and difference of temperature water-tub. Their applications had realized by extension the surface-A of $R_{,t}$ by located inside of inner cylindrical cavity a porous core from materials with desired great specific heat. This mod of thermal transfer in special thermal tubs has diminished significant the warm water volume necessary the heat exchange, due to enhance the thermal efficiency of heat installation with geothermal or warm water for small warm houses, individual houses, block's apartments.

3. THERMAL REGISTERS WITH POROUS FILLER FOR HEAT INSTALLATIONS

The thermal register is a device that realizes the heat transfer between fluids to environment, between them exist a temperature gradient. These registers function for normal temperatures (50-150^{0}C), and water passing by installation with a low pressure.

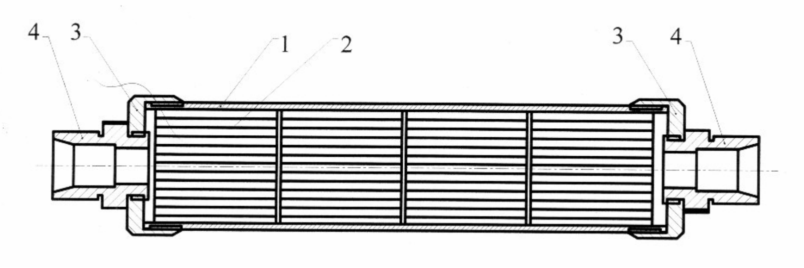

Figure 3. Reinforced Thermal Register.

Where: 1 - Metallic pipe, 2 - Porous ceramics parts, 3 - Covers, 4 - Couplings.

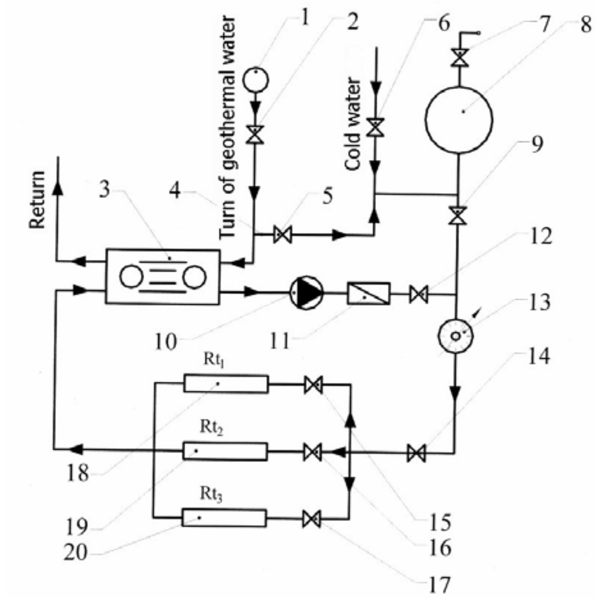

Figure 4. Flow chart of closed thermal installation with reinforced thermal registers.

Where: 1-Sourse of thermal water, 2-Tap, 3-Heat exchanger with plates, 4-Water pipe, 5,6-Taps, 7-Safty valve, 8-Closed buffer tank, 9-Tap, 10-Hydraulic pump with electric acting, 11-Flap valve, 12-Tap, 13-Pressure gauge, 14-17-Taps, 18-20-Reinforced thermal registers (R_t).

In buffer tank-8 has maintained the pressure from work pipe, so the pump-10 assured only a difference pressure between required pressure in installation and available pressure in thermal register. The circulation of pre-heat water through installation with closed circuit by heat echanger-3 and reinforced thermal registers-18-20, at a low pressure is assured by electrical hydraulic pump-10.

The new element of installation is use thermal register reinforced with porous core. The tests had done at National Geothermal Research Center from University of Oradea, used as porous medium the metallurgical cake coal with porosity 50%, moister content of 3%, minim carbon content 86%, etc.

4. CONCLUSIONS

The reinforced thermal registers with porous core using in heat installations with geothermal and warm water assuring a maxim heat transfer to environment. Its construction is new, simple and easy to realize with reduce cost.

The new reinforced thermal registers assuring a small pre-heated water volume recycle in heat installation with closed loop circuit.

The hydraulic pomp located in hydraulic circuit has a small current consumption.

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