ANNALS of the ORADEA UNIVERSITY.

Fascicle of Management and Technological Engineering, Volume VII (XVII), 2008

A SIMPLE LOCAL DEVICE FOR THE PREPARATION OF WARM WATER WITH A HEAT EXCHANGER HAVING A PLATES AND SOLAR THERMIC PICK-UP

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KEYWORDS: warm water, heat exchanger, plates, solar pick-up

ABSTRACT

The devices for warm water preparation are built with direct heating for which it is necessary to use caloric energy obtained by combustibles' burning, by electrical energy, solar energy, natural gases etc.

The most economical device used for warm water preparation is the device which uses solar energy. The solar energy is a scattered energy source that assures the conversion at the usage place, the distance transportation disadvantage being removed, it is not polluting and it is environmental friendly.

Heating the warm water using solar plane thermic pick-ups is an application of the solar energy.

The pick-ups usually have an insulated absorbent black metallic plate. On that plate one or more glass plates or transparent plastic are fixed, creating the greenhouse effect. The heat absorbed from the sun is transmitted to a fluid in thermic contact with the absorbent plate. The work fluid assures the transfer of the captured heat to the user. Temperature of the heat carrier fluid of the solar pick-up on exit could reach 50°-100° C.

That temperature of 50°-100° C allows the plate heat exchangers to be used in the hydraulic circuit of the local device for the preparation of warm water.

1. INTRODUCTION

The devices for preparation of hot water locally are with direct heating and they are using caloric energy from fuel burning in furnace, electric energy, solar energy, natural gases, etc.

The most economical installation for hot water preparation is that used with solar energy. Solar energy is a spread source of energy, which assures conversion at the utilization point without the disadvantage of long distance transportation, doesn't pollutes and doesn't affect the wellbeing of biological environment.

An application of solar energy utilization is the warming of hot water through plain solar thermal receivers.

Plain receivers are composed mainly from metallic black board, absorbing isolation. Over the board is or are situated one or more glass or transparent plastic boards, which creates the green house effect. The absorbed heat from the sun is sent to a fluid situated in thermal contact with the absorbing board. The work fluid assures the received heat transfer to the user. The heat holding fluid temperature at the exit from solar receiver can reach temperatures about 50-100 Celsius degrees.

The fluid temperature of 50 -100° Celsius degrees permits utilization of switchers with boards in the hydraulic circuit of local installation for hot water preparation.

2. BASIC THEORETIC FUNDAMENTALS

The concentration of solar vibes is based on a optical system of reflex ion and refraction of the light, which grows the density radiation vibes which fall on the absorbing surface of the thermal solar receiver. The heat of solar vibes of light is transferred to the receiver through radiation and absorption going to the fluid through conduction and convection.

Thermal radiation corresponding of a electromagnetic spectrum of radiation has the wave length of 0.76-360µm. The radiant flux of heating *Q* falls over a body, a part of this flux *rQ* is reflected, *aQ* absorbed and a part *dQ* which diffuse.

Standard norm:

$$r + \alpha + d = 1 \tag{1}$$

Q - Radiant heating flux
rQ – Reflected heating flux
aQ – Heating flux absorbed by the receiver
dQ – Diffused heating flux

For a body which reflects the full incident flux incident:

$$r=1$$
$$a=d=0$$

is called reflecting.

An absolute black body or diathermy if permits incidents radiation which diffuses in the hole:

$$d=1$$
$$r=a=0$$

The quantity of absorbed energy is an element of surface *dS* is:

$$dQ = aE * dS$$

The a absorption coefficient is dependent of the values *T1* and *T2* of the temperatures which sends and, receive energy.

By the Kirchoff Laws, for every surface which is found in thermal equilibrium with the ambient environment, the absorption coefficient is equal with the energetic factor of emission e (a=e).

Exchange heating through thermal radiation with solar thermal receiver is:

$$Q_{12} = \sigma_0 * S\left(T_1^4 - T_2^4\right) \tag{3}$$

T1 and T2 – Temperature of the inner and outer surfaces of the receiver.

Taking in consideration the energetically factors of emission e_1 and e_2 formula (2) would be

$$Q_{12} = c_{12_0} * S\left(T_1^4 - T_2^4\right) \tag{4}$$

The mutual coefficient of emission being:

$$i_{12} = \sigma_0 / \left(\frac{1}{e_1} + \frac{1}{e_2} - 1\right) \tag{5}$$

$$Q_{12} = \varphi_{12} * s_1 * e_1 * e_2 * \varphi_0 \left(T_1^4 - T_2^4\right) \tag{6}$$

where φ_{12} – medium angle coefficient dependent by the dimension and magnitude of the surfaces of solar receiver. From the solar thermal heat flux is transmitted to the thermal primary fluid through convection and much further, through the exchange heater with boards, in reverse current through convection, conduction, of the secondary fluid.

The heating flow necessary for preparation of hot water is released by the primary thermal agent through the surfaces of exchanging boards s, the secondary agent of the reverse installation in reverse current.

$$Q = G_{0\max} * c(\Theta_c - \Theta_a) = G_1 * c_1(\Theta_1^{'} - \Theta_1^{''}) = \varphi * k * s * \Delta\Theta_m \quad (7)$$

where*:* *Q* is the heating flow in W (kcal/h) necessary for preparation of consumption hot water ;

G_{0max} – the maximum hourly flow of hot water in kgf/h;

c – the specific heat of hot water in J/kgK;

Θ_a, Θ_c – temperatures of cold water (Θ_a=10°C), and of hot water(Θ_c=40-60°C);

G_1 - the flow primary of thermal agent in kg/h;

c_1- the specific heat of primary thermal agent in J/kgK or kcal/kgf°C;

$\Theta_1^{'}, \Theta_1^{''}$– the temperatures of primary agent at the entrance and exit from the reverse current, in °C;

k- the global heating transmission coefficient from primary thermal agent to secondary thermal agent thought the area heating exchanging boards, in W/m^2K or kcal/m^2h °C;

σ - the heating area use coefficient with a value of 0.8 -0.9;

$\Delta\Theta_m$- the logarithmical mean of temperature difference between primary thermal agent temperature and the consuming of hot water in °C.

$\Delta\Theta_m$ may be calculate with the next formula:

$$\Delta\Theta_m = \frac{\Delta\Theta_{\max} - \Delta\Theta_{\min}}{2.31\mathrm{g}\frac{\Delta\Theta_{\max}}{\Delta\Theta_{\min}}} = \frac{(\Theta_1^{''} - \Theta_a) - (\Theta_1^{'} - \Theta_c)}{2.31g\,\frac{\Theta_1^{''} - \Theta_a}{\Theta_1^{'} - \Theta_c}} \quad (8)$$

From (7) formula result the necessary area σ of heat change:

$$s = \frac{Q}{\varphi * k * \Delta\Theta_m} \quad (9)$$

The movement of primary hot water is made through pumps, and the movement of secondary hot water, with the help of the pressing from the tap.

3. INSTALLATION FOR HEATING WATER FOR CONSUMPTION WITH SOLAR THERMAL RECEIVER, HEAT EXCHANGING BOARDS AND HEATING STORAGE

Principle of installation for heating water with solar thermal receiver is:

1. solar thermal receiver
2. movement pump
3. holding flap
4. tube
5. tap
6. expansion jar
7. tap

8. heat exchanging
9. pump with current water
10. tap

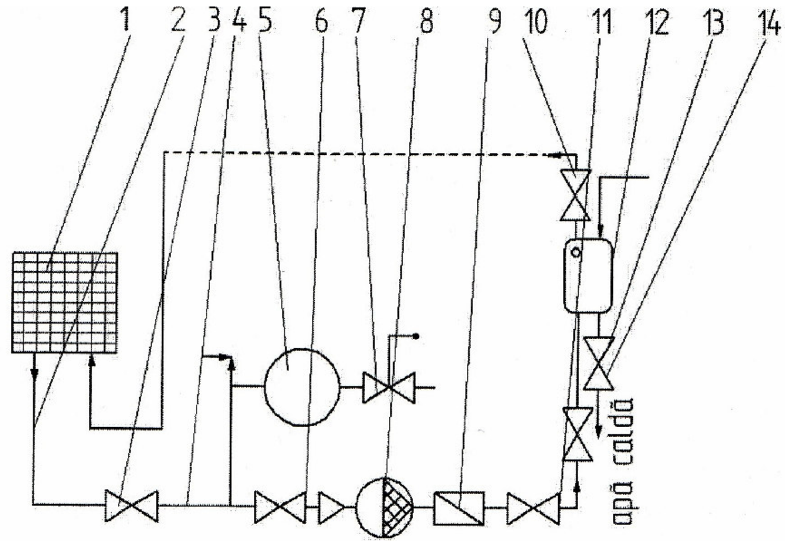

Fig. 1 Installation for hot water preparation with solar thermal receiver and heat exchanging boards

The second variant of project in secondary circuit will be insert a heating storage with a capacity of 100 l, made diagrammatic in fig. 2

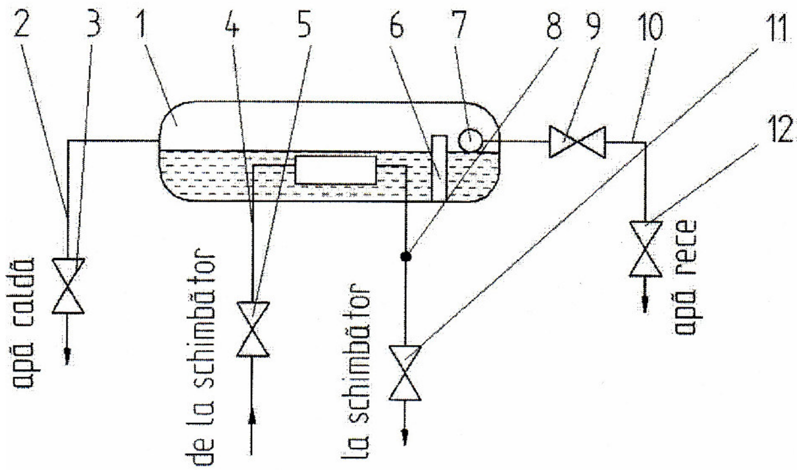

Fig. 2 The heating storage inserted in heating installation

Were made the text notation:

1 - heating storage
2.,4.,8 - pumps
3, 5, 12 - tap
6 - partition wall
7 - floating

The temperature of the fluid in primary movement can reach 50 - 100° C, with a highest pressure of 15 – 20 bar, and in secondary movement, the temperature of the fluid may reach until 60° C, and the storage temperature until 50 - 55° C.

The new elements characteristics of installation composed of heat exchanging boards introduced, hydraulic assembling and supplementary heat storage introduced in secondary hot worm water circuit.

4. CONCLUSIONS

1. The installation for hot water preparation with solar thermal receiver, heat exchanging boards and heat storage is a simple, efficient and economy construction.
2. Solar thermal receiver and heat exchanging are ecology and economy.
3. The following installation can be produced easily may be used for easy feeding of buildings with hot water cheap.

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