HYBRID SOURCE OF ENERGY FOR PRIVATE FAMILY HOUSE

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Abstract

There is a family house located near the town Žiar nad Hronom whose demands on energy necessary for heating and preparation of hot supply water are covered especially by the solar collectors and heat pump. In order to enhance the efficiency of the heat utilisation, the house is equipped with wall and floor heating systems, and in addition, the house is well heat-insulated.

The built-up area of the family house together with winter garden (conservatory) is 135 m^2. The habitable area, including the attic storey is about 240 m^2.

The external walls are made of porous airbricks 45 cm thick, bound by perlitic mortar, and of 25 mm thick layer of wood-wool slabs. The roof is insulated by 250 mm mineral insulation layer, and the ground floors by the hard polystyrene, of 150 mm thickness. For the windows, including winter garden the isolation double glasses filled by argon and provided with antireflection coating were used.

There are 28 m^2 of flat vacuum collectors Heliostar 400 V placed on the saddle roof oriented south-west by south. The excess heat is used for heating the outdoor swimming pool in summer, in winter it is stored underground.

The solar radiation deficiency during the winter half-year is compensated by the heat pump ground – water. Both the underground collector (pipes in earth) and low power heat from solar collectors serve as a source of the low power heat for the heat pump. The ground collector pipes are buried in wet loamy soil protected against the underwater.

Both sources of heat, i.e. solar collectors and heat pump are linked up with central heat accumulator. It is insulted glass-fabric laminate container 6 m high, of 5000 l volume situated approximately in the central part of the house across both floors. There is a stratified tube with outputs for connectors from the solar collectors and

from the heat pump. Due to this system, the entering water of a certain temperature is not mixed with the water in the container but it is layered on separate levels according to its temperature. Water of lower temperature flows to the lower parts of the container, and vice versa – that of higher temperature to the upper levels. The hot supply water is delivered from the 200 l boiler, placed over the central heat accumulator container being interlinked with it on the free fall basis. If necessary, the additional heating is ensured by the electric heating coil in the upper part.

The water of a suitable temperature is supplied to the heating system by means of two electric valves placed on various levels of the central heat accumulator, and operated by a regulator.

The house temperature (heating output) depends on the atmospheric temperature and can be adjusted by the thermostatic valves installed on the wall heating system in any room separately.

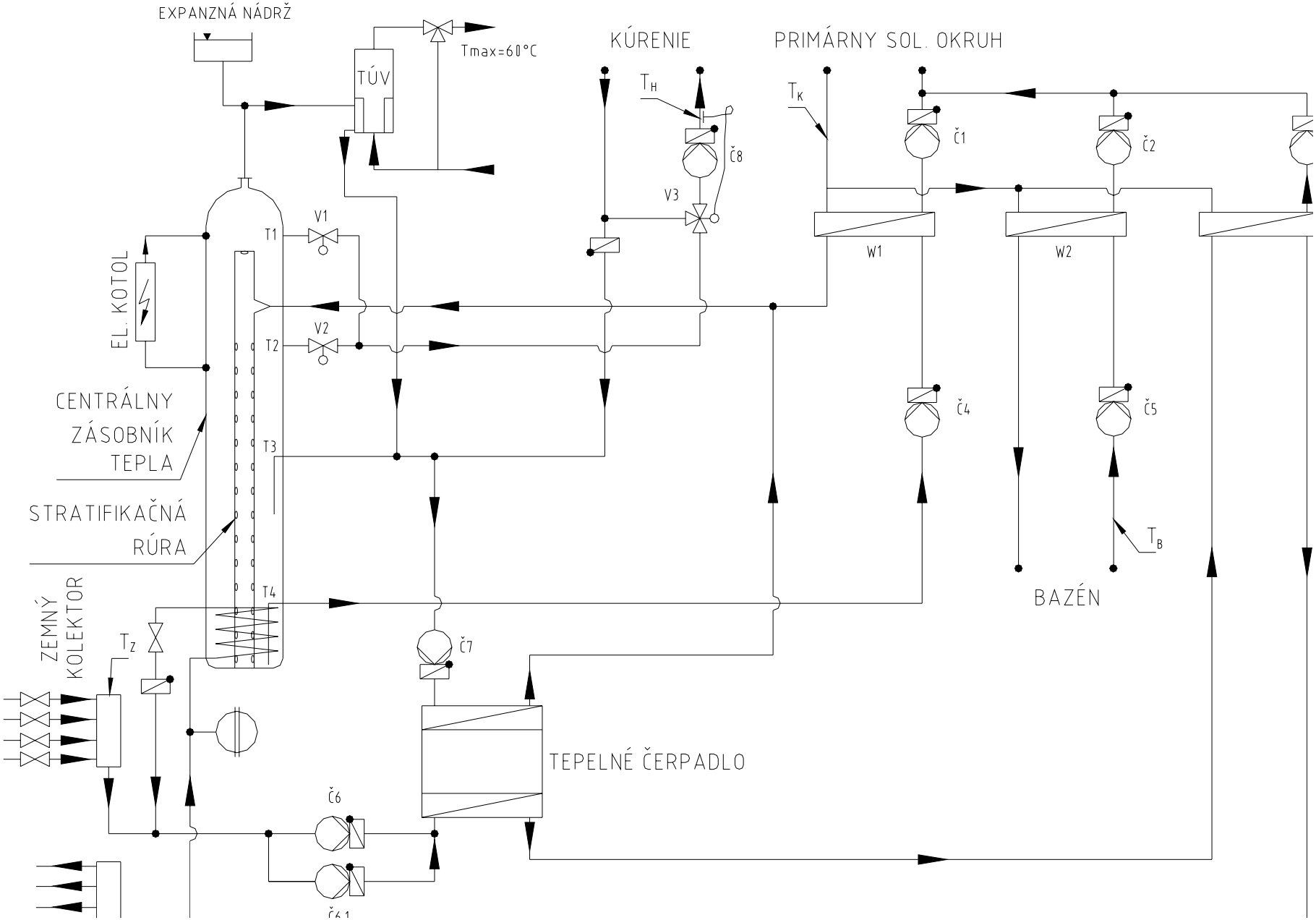
The wall heating system is built-in in all the external walls, it is of law thermal lag, what enables to regulate the thermal input power quickly. It is well complemented by the floor heating installed over the total ground floor area, and in the bathroom on the first floor. As the floors are made of massive ceramics, the thermal lag of this part of heating system is high, creating, this way, an additional heat accumulator.

Another advantage of so designed heating system grounds in the possibility to ensure the necessary heating output even if the entering water temperature is very low. It enhances the effectiveness of solar collectors' work and that of the heat pump, ensuring a very good temperature comfort for householders.

There are two additional sources of heat. The hearthstone in the sitting-room is used for comfortable winter evenings. The electric boiler situated in the upper part of the central heat accumulator represents the 100 % reliable source of heat in case of other sources failure.

Fig. 1. – The simplified hydraulic diagram of the complete energetic system of the house.

Fig.1 Hydraul. scheme
of energ. system of house



Brief survey on the hydraulic diagram

The central 5000 l heat accumulator container with the built-in stratified tube is charged from:

- solar collectors
- heat pump
- electric boiler

In addition to it, the solar collectors can heat also the swimming pool, or the excess heat may be stored underground by means of an underground collector of the heat pump.

The heat pump operates on the basis of the night current. The source of the low power heat is the ground heat collector, and partially also the lower part of 5000 l heat accumulator through the built-in spiral heat exchanger. The output of the heat pump leads to the stratified tube in 5 000 l heat accumulator container.

For the case of heat pump failure, there is a possibility to ensure the spare heating by the electric boiler on the night current. The electric boiler with the built-in thermoregulator is switched manually.

1. The heat from the primary solar circuit (solar collectors) may be distributed to:
   - stratified tube of 5000 l heat container, No. 1 and No. 4 are running simultaneously,
   - if the heat container is charged, or the sun radiation intensity is low ($T_K - T_4 < 5°$ C), the pumps No. 1 and 4 are switched off, and the pumps No. 2 and 5 are switched on – the outdoor swimming pool becomes to be heated,
   - if the swimming poll temperature achieves the adjusted value $T_S <$ 24–30 ° C >, the pumps No. 2 and 5 are switched off, and those No. 3 and No. 6.1 are switched on – the excess heat starts to flow to the ground collector of the heat pump,
   - under the winter mode the swimming pool is blocked. If the temperature achieves the value of $T_K \geq 10$ °C, the pumps No. 3 and 6.1 are switched and the solar heat is led to the ground collector (the day mode).

2. The heat pump can be switched on by the timer only between 22.00 and 6.00 hours (the night current). The heat pump compressor starts to operate together with the pumps No. 6 and No. 7, and it runs until the adjusted temperature T_3 is achieved (within the range of < 40 – 50 °C >). The heat pump is regulated by the thermostatic switch placed in the accumulator on the level T_3.
   Note: The output of the pump No. 6 (used for the purposes of the heat pump) is substantially higher than that of the pump No. 6.1 for the off take of the solar heat.

3. If the heat pump fails, the electric boiler operating on the basis of the night current and equipped with a built-in thermostat may be switched on manually.

4. The boiler for the hot supply water need not be regulated, as it is connected with the 5000 l container on the free fall basis (it is placed over the container).

5. The pump No. 8 takes off the hot water from the appropriate container level through the valve T_2 for the low energy wall and floor heating.
   If the water temperature T_2 falls below the demanded T_H, the valve V_2 will be closed and the valve V_1 opened – the water will start to be delivered from the higher (warmer) level of container (T_1).

The return from the swimming pool to the heat accumulator, in case of the solar radiation intensification during the day is performed as follows: If the temperature $T_4 \leq 40$ °C, the liquid circulation in the primary solar circuit is interrupted for about 30 s every hour (No. 2 and No. 5 are switched off), and the difference $T_K - T_4$ is tested. If this difference is higher than 5 °C, the charging of central heat accumulator starts (No. 1 and No. 4 are switched). Similarly during the winter period, the ground collector charging is replaced again by the charging of central heat accumulator.

Key to the used symbols and abbreviations:

<u>Temperature sensors:</u>

- T_1, T_2, T_3, T_4 - temperatures on various levels of 5000 l heat accumulator
- T_K – temperature on the solar collectors,

- T_B – swimming pool temperature
- T_H – heating water temperature
- T_Z – ground collector temperature

Action parts:

- No 1 – the primary solar circuit pump connected to the exchanger W_1 (accumulator)
- No 2 – the primary solar circuit pump connected to the exchanger W_2 (swimming pool)
- No 3 – the primary solar circuit pump connected to the exchanger W_3 (ground collector)
- No 4 – the pump taking off the heat from the exchanger W_1 and delivering it to the central heat accumulator
- No 5 – the pump taking off the heat from the exchanger W_2 and delivering it to the swimming pool,
- No 6 – the pump conveying the low energy heat from the ground collector to the heat pump,
- No 6.1– the pump taking off the low power heat (in winter),or the excess solar heat (in summer) from the exchanger W_3 and delivering them to the ground collector,
- No 7 – the connection of heat pump condenser with the 5 000 l heat accumulator container,
- No 8 – the heating of the object by hot water taken from the heat accumulator container through the valves V1 or V2,
- V1 – valve of the heat accumulator for the delivery of heating water – higher (warmer) level,
- V2 – valve of the heat accumulator for the delivery of heating water – lower (colder) level
- V3 – T - mixing valve – heating.