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IMPACT PARAMETER LOW - POTENTIAL HEAT ON THE CONVERSION OF PRIMARY ENERGY INTO HEAT IN THE GAS HEAT PUMP.

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ABSTRACT:

The heat pump is an energy system that can efficiently transform otherwise unusable low potential energy into higher potential energy. In the market there are a number of heat pumps. In order to save primary energy is emerging gas heat pump is most suitable alternative for obtaining the thermal energy. The gas heat pumps exist only in system air – water. Air as a primary energy source is not stable throughout the year and at the time the largest heat demand reaches the lowest values. It is therefore essential by measuring the impact of the parameters of primary energy source for performance of gas heat pump.

INTRODUCTION

Gas heat pump (GHP) is a renewable source of heat and cold, which was the primary source of heat recovery uses outside air. Gas heat pump systems operating in air / water or air / coolant making it able to adapt to any installation. The heat pump system shown in figure 1 is a popular design in Japan, where it was developed as an alternative for electric heat pumps. A GHP consists of an evaporator, a compressor, a condenser and an expansion valve. Used to drive the compressor gas engine running on gas. Refrigerant circuit heat pump uses refrigerant R410A (refrigerant CFC-free) with zero coefficient of ozone depletion potential, which makes an environmentally friendly heating and cooling. GHP obtains heat not only from renewable energy sources, but also the engine cooling and exhaust system are participating of the total production of heat. Based on current analysis, it appears that transformation of primary energy into heat more effective in GHP.

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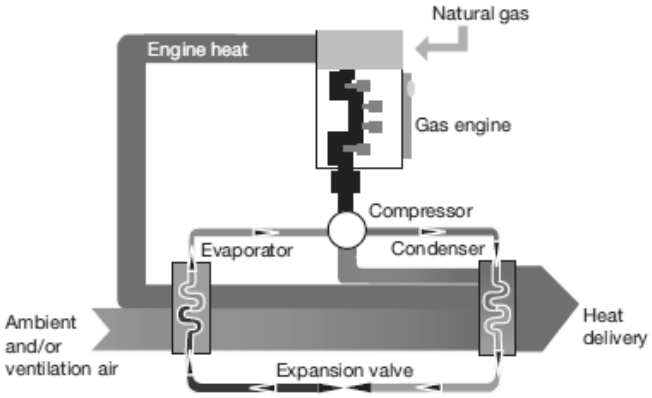

Fig. 1

Operation principle of gas heat pump

EXPERIMENTAL GAS HEAT PUMP

Gas heat pump is installed at the University Campus in Žilina and is connected according to the scheme in Figure 2. The outdoor unit consists of exchangers air / refrigerant (1), the compressor (2), internal combustion engine (3) and heat exchanger for preheating of refrigerant (4). The inside part is called technology unit AWS (airwater system - 5), which is used to transfer heat from the refrigerant circuit to the water.

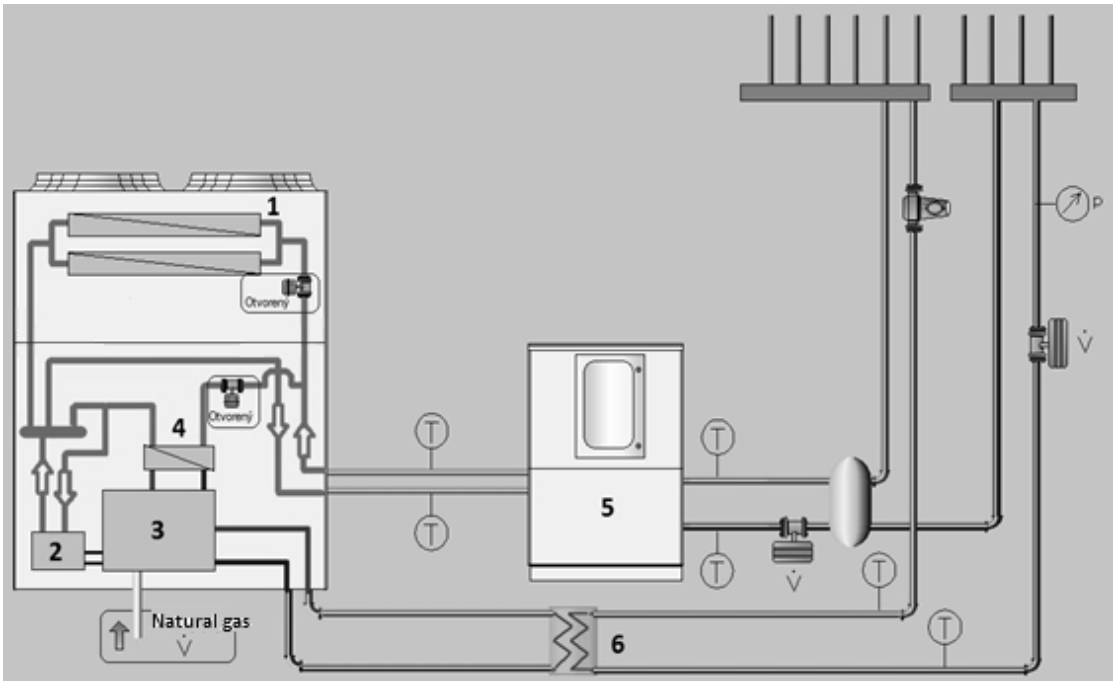

Fig. 2

Schematic diagram of experimental device

The part of GHP is also HOTKIT (6), which forms the heat exchanger water – water and it is connected to the engine cooling circuit. Water from AWS as well as HOTKIT is distributed to the distributor and used to heat the corridors and laboratories at the University of Žilina. Each sensor temperature, pressure and flow are installed in locations according to the scheme in Figure 2. Other parameters of the gas heat pump is given in Table 1.

Tab. 1 Technical specification of gas heat pump

Toyota AISIN 10HP				Model AXYGP 280 E1
Rated output	Rated cooling capacity		kW	28
	Rated heating capacity		kW	31,5
	Maximum heating capacity		kW	33,5
Electrical features	Power supply		V	230
	Power consumption	Cooling	kW	0,44
		Heating	kW	0,258
Consumption	Gas consumption	Cooling	kW	19,2
		Heating	kW	20,3
Engine	Rated output		kW	6,2
	Revolution range	Cooling	rpm	800 - 1550
		Heating	rpm	800 - 2700
Compressor	Type			Scroll
	Revolution range	Cooling	rpm	1640 - 3178
		Heating	rpm	1640 - 5535
External dimension	Heigh		mm	2077
	Width		mm	1400
	Depth		mm	880
Weight			kg	570

Because of GHP is working on the principle of air - water, it is taking heat from low potential primary source from the outside environment, on the roof of the building was installed the weather station from producer AHLBORN in Figure 3.

The weather station consists of measuring devices that measure the following parameters:

- outside air temperature [˚C],
- wind direction [˚],
- wind speed [$m.s^{-1}$],
- relative humidity [%],
- global radiation [$W.m^{-2}$].

Fig. 3

The weather station

MEASUREMENT RESULTS

The measurement was realized for a period from 1.12.2012 to 19.12.2012, when the temperature reached low values. GHP worked at all times in the heating mode. Heat pumps are rated based on Coefficient of performance (COP). Gas heat pumps reach COP from 1,2 to 2,4. The biggest impact on performance GHP has the temperature of low-potential heat source and water temperature for the heating system. During the measurement was achieved maximum outdoor air temperature 4,7 ˚C on 15.12.2012 between 4 and 5 am. The lowest measured outside temperature was -14.3 ˚C on 08.12.2012 between 7 and 8 o'clock in the morning. Achieving value COP gas heat pump ranged from 0,6 for 0,95. Figure 4 shows the dependence COP GHP on the outside temperature. COP GHP were calculated according to the following equation:

$$COP_{PTČ} = \frac{Q_{OUT}}{G_{HP,drive}} \quad (1)$$

where Q_{OUT} [kW] is energy produced at temperature T_{OUT}, $G_{HP,drive}$ is energy supplied to the heat pump (contained in natural gas).

For the comparison is shown in Figure 4 also COP gas condensing boiler whose value is constant COP = 1.

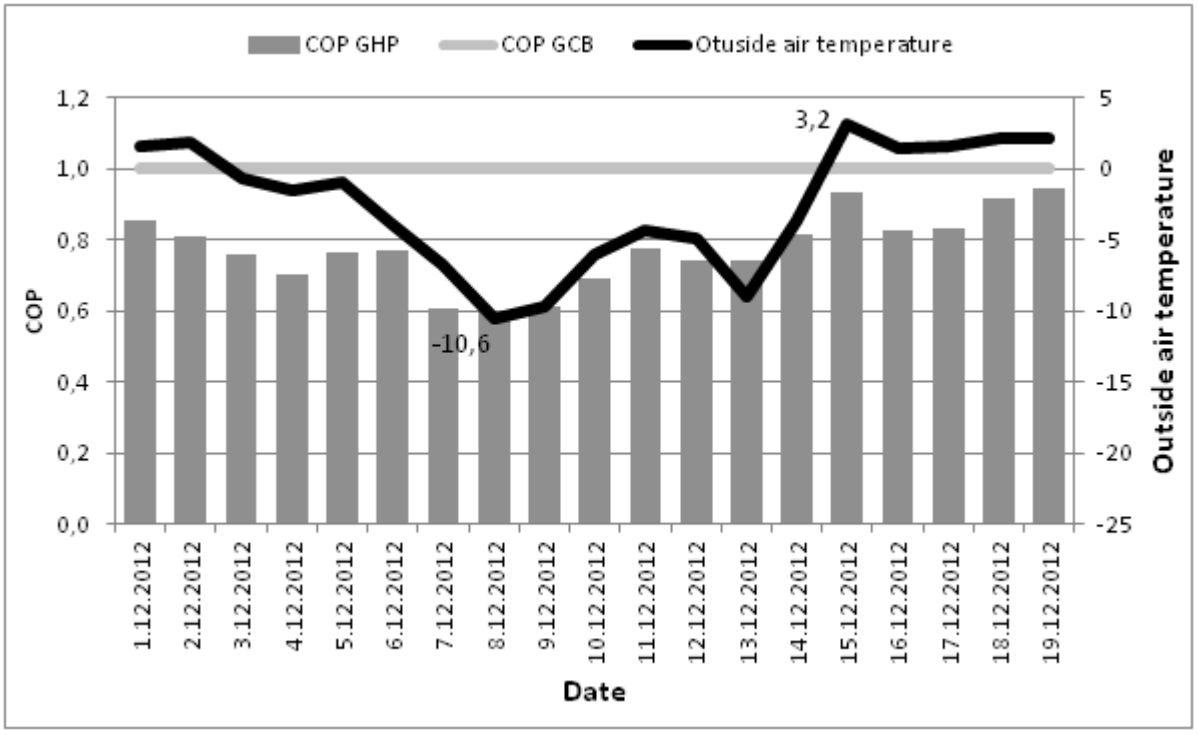

Fig. 4

COP gas heat pump air - water depending on the outside air temperature

CONCLUSION

Measurement to obtain the relevant data on the gas heat pump in real conditions. The measurements were determined COP values that are significantly different from the tabulated values. These differences may be influenced by a higher outlet temperature to the heating system (45 degrees Celsius) than recommended, low-temperature source of primary energy and the lack of taking heat from GHP. GHP did not work at full power but only 80 %. The analyzes appear to be interesting the higher temperatures, where gas heat pump should deliver better performance parameters. Producer also recommends the use of heat pumps in the bivalent connection. Therefore, it is necessary to make further measurements under various conditions and gain a wider range of data on the progressive heat sources using renewable energy sources.

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