A MEASUREMENT SYSTEM FOR AN ENERGETIC CIRCUIT WITH A NON-CONVENTIONAL COMBUSTION ENGINE

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Abstract

The basis of a non-conventional energetic circuit is a trivalent system in which the ignition combustion engine is a source of primary energy. The system produces electric and thermal energy at three thermal levels. The system is referred to as non-conventional because of the non-conventional cooling circuit of the combustion engine which has been designed as a thermo compressor for absorptive cooling circulation.
The paper deals with an automated measuring system implemented in the above-mentioned non-conventional energetic circuit.

Keywords: *non-conventional energetic system, measurement system, non-conventional combustion engine*

1. Introduction

The cogeneration units with a combustion engine are very perspective systems from the point of view of overall efficiency. The presented energetic circuit gives possibilities for mechanical energy, high potential heat or coldness to meet requirements.

2. Problem description

The combustion engine in the solved adsorption refrigerant system performs a function of a heat source. The amount of heat pulled into the adsorption circuit is equivalent to the heat produced by the engine cooling system. Cooling liquid of the engine is replaced by lithium bromide liquid.

3. Measurement system

Construction work of the energetic plant with a non-conventional combustion engine has already started. The measurement system of the equipment is to be assembled soon. All important quantities on parts of the energetic system will be measured in order to evaluate the engine working state, temperature distribution, pressure distribution and thermal balance of the system.

The quantities measured on the combustion engine:

⇒ Torque by a strain-gauge sensor of the force.
⇒ Rotational speed of the combustion engine crankshaft by the position of incremental sensor (that has 3600 impulses per revolution).
⇒ Temperatures measured by thermocouples of K and J types: temperature of intake air, temperature of oil, temperature of cooling liquid in the inlet and outlet,

temperature of compressed air behind the blower, temperature of exhaust gasses in front of and behind the turbine.

⇒ Pressures: atmospheric pressure, air pressure behind the blower, pressure differences on the flow meter diaphragm in inlet piping, pressure in the lubricating system.

⇒ The fuel pump control rod position.

⇒ Fuel consumption measured by the mass method (measurement of consumption time).

⇒ Torque by a strain-gauge sensor of the force.

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⇒ The fuel pump control rod position.

⇒ Fuel consumption measured by the mass method (measurement of consumption time).

The quantities measured on the refrigerant circuit:

⇒ Flow of the LiBr cooling liquid.

⇒ Temperatures in all important places for evaluation of the thermal balance with utilisation of thermocouples of K type.

⇒ Under-pressure in the desorber that functions of a vaporizer.

⇒ Pressure of cooling liquid in the engine in a place behind the electric pump.

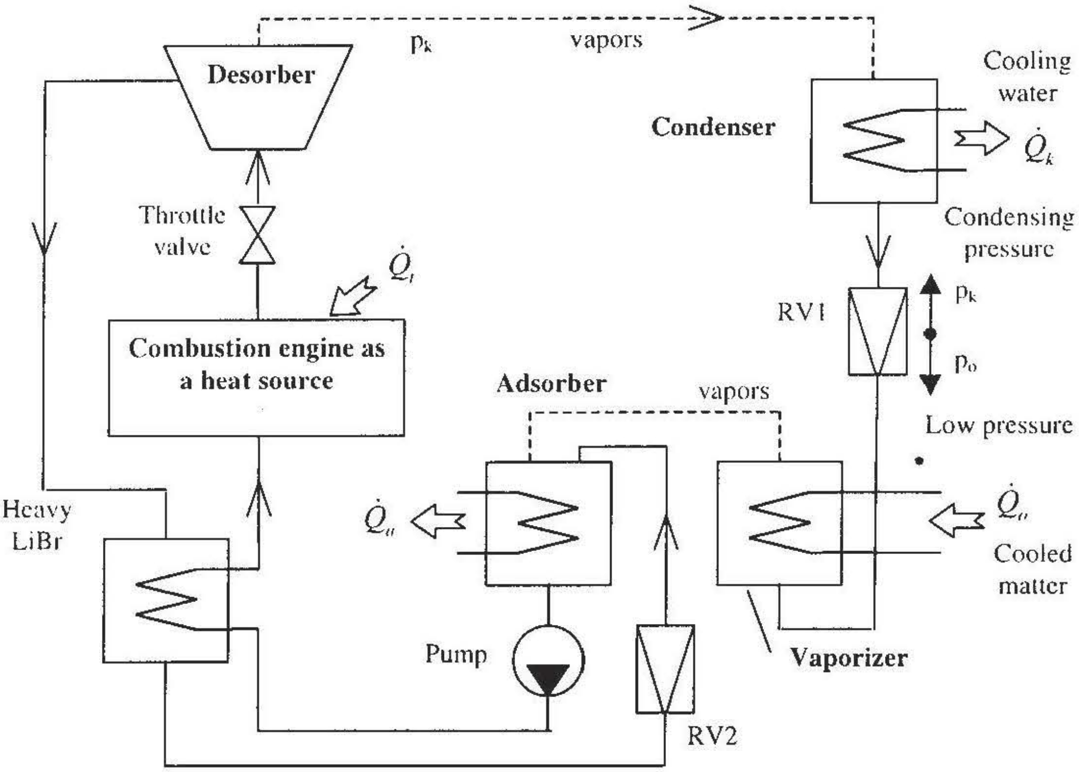

Fig. 1. Preliminary diagram of the solved adsorption refrigerant system

The special software for computer measurements and control of the test bench is being developed. The work is divided into two stages:

1. Stage (debugging of the problems regarding data acquisition)

At the beginning it is necessary for the measurement software to be able to record at least the following data:

⇒ Analog inputs on measurement cards (engine torque, temperatures, pressures, voltage).

⇒ Digital input from the incremental sensor of rotation.

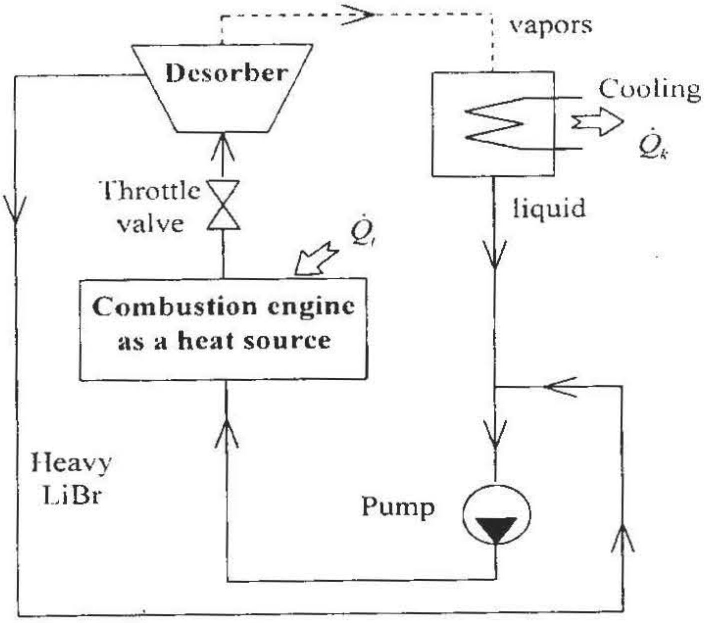

Fig. 2. Diagram for functionality testing of evaporation in a first phase of the project

More detailed specifications the software has to meet in the first stage:

1.1. The software must allow for choice off a suitable sampling rate in order to enable the following:

⇒ Measurement of steady modes of the engine where a low sampling rate is sufficient

⇒ Measurement of very fast dynamic modes, such as engine run down, engine run up where a high sampling rate is necessary.

The sampling rate would be optional for instances in an interval from 0.2 Hz to 20 kHz.

1.2. There must be a choice possibility of the impulse number for evaluation of the crankshaft running speed. The used sensor has 3600 impulses per one revolution. This demand is similar to that one in the previous paragraph.

⇒ When unevenness of the crankshaft running will be measured, the running speed must be evaluated very fast.

⇒ For measurement of the steady state a higher impulse number would be sufficient for engine speed evaluation.

1.3. The software must allow for defining ranges of measured temperatures, pressures and so on.

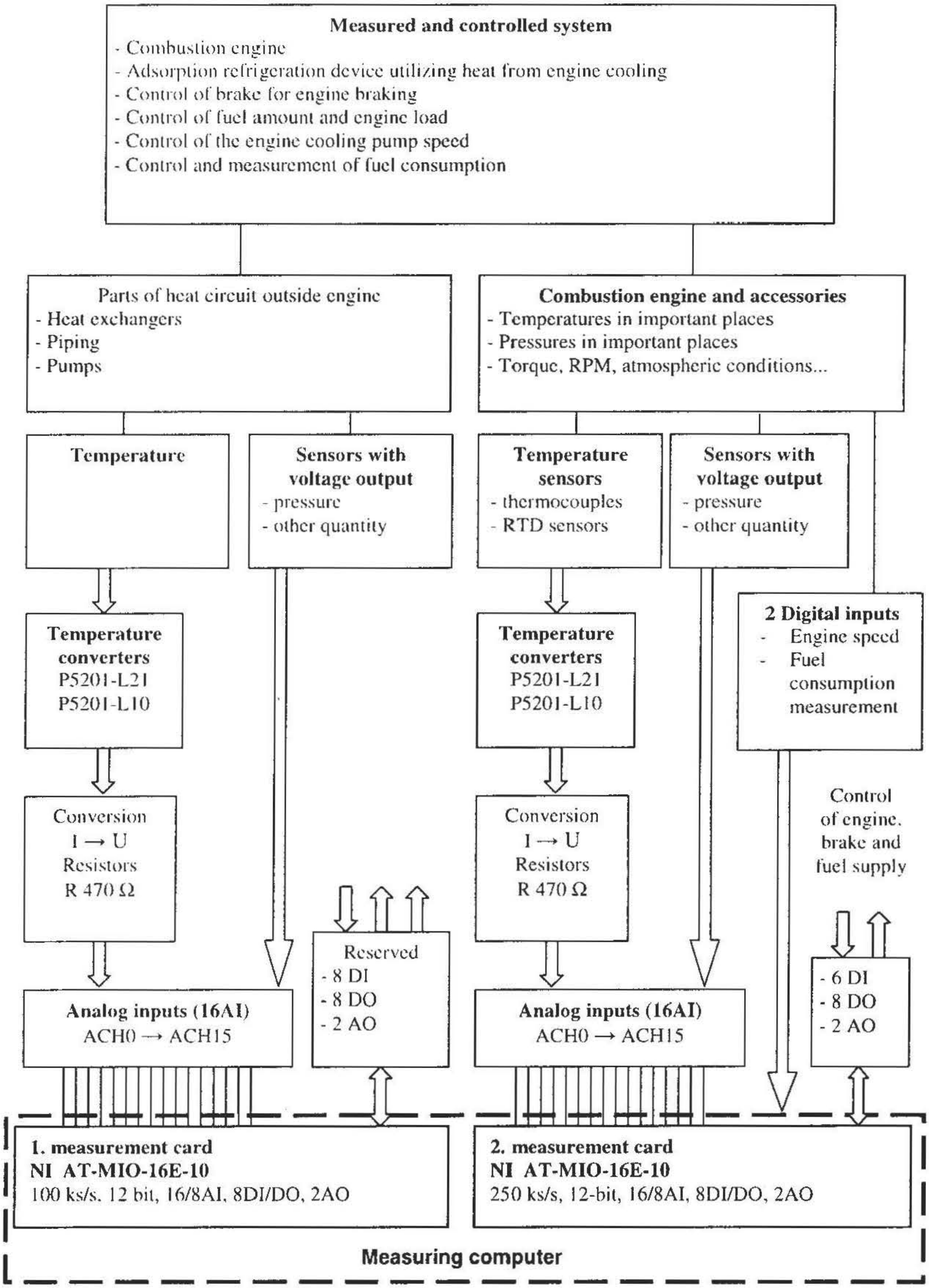

Fig. 3. Measuring components diagram

1.4. The software must allow for saving measured data on the disk in a suitable format, for instance "xls" or "csv", to enable additional manipulation with data.

1.5. The software would enable to determine appropriate quantities from the measured data. For instance the engine power from the torque and rotational speed, air flow from the measured pressure difference on diaphragm, reduction of the measured parameters onto normal conditions, etc.

2. Stage (debugging of the problems regarding control)

After the first stage has been successfully completed the issue of control is to be dealt with:

2.1. Evaluation and control of fuel consumption measurement (measurement of the consumption time on the base of impulses from weight, fuel valve control, change of the fuel mass for measurement). On the base of the fuel heat value the software will directly calculate a specific fuel consumption and overall efficiency of the engine.

2.2. The software should perform brake control by checking the excitation current. It must provide the following:

⇒ Maintain the constant engine speed (on the base of the real measured value),
⇒ Maintain the constant engine torque.

2.3. The software should be able to control and measure the fuel rod of pump.

2.4. The software should be able to statistically process the quantities.

2.5. The software should be able to control the whole test by the given procedure. The modes and their duration will be defined before the measurement.

4. Conclusion

The solved refrigerant equipment is still in a phase of development. The suggested measurement system can monitor all significant system parameters, especially parameters of the combustion engine. The measurement system can be changed or adapted in the future according to the results of the tests that will be aimed

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