USING NON GAS ANALYZER METHOD ABOUT DIAGNOSING OF LEAKAGE OF THE REFRIGERATING AGENT FROM REFRIGERATING SYSTEM OF THE HOUSEHOLD REFRIGERATOR «NORD» - DH -239

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Abstract: In this work it is demonstrated the theoretical bases and results of experiments regarding distribution of temperature on a surface of the evaporator and in volume of the freezing chamber of the household DH-239 refrigerator (HR) working with isobutene. The values of temperature were received by means of computing algorithm of mathematical model [1] and defined experimentally, depending on a dose of filling are compared by isobutene of refrigerating system and ambient temperature. The action principle, the location of the sensor and settings of the device of automatic equipment signaling about leak of a coolant from the HR refrigerating system, are proved at various uptake of a temperature regulator, in the range of ambient temperature from 16 up to 43 degrees Celsius.

Keywords: household refrigerator, evaporator, isobutene, mathematical model, computing algorithm, filling dose, ambient temperature.

The world practice knows several ways of cooling agent leak ascertainment from refrigeration system. One of them is analysis of thermodynamic process changing in the system involved by decrease of pressure of working medium in the discharge line and/or increase of working time factor (WTF) of compressor [2]. But change of the mentioned thermodynamic characteristics can't be reliable indicator of cooling agent leaks from household refrigerator compressor system as increase of WTF can also be connected to worsening of transmission from condenser top. There is a method of cooling agent leaks ascertainment from refrigerating plants by reacting to trace contaminants in the atmospheric air in the places of their placement [3] with special portable devices – leak detectors.

None of the mentioned methods is acceptable for cooling agent leaks diagnosis in the household refrigerating equipment because of impossibility of its current prophylaxis service, including the use of portable leak detectors and gas analyzers, and absence of small recording devices, adapted to the construction of small refrigerating equipment.

The indirect confirmation of isobutene leak from compressor system of the working refrigerator can be decrease of isobutene boiling point and as a result decrease of temperature on the top of evaporator in freezing section of refrigerator.

The aim of this work is substantiation of bases of cooling agent micro leaks diagnosis from the refrigerating system of small refrigerating equipment and development of the device, signaling about leak in different positions of thermo regulator and ambient temperature.

For the achievement of this aim it's necessary to solve the following problems: to get data about temperature change on the top of evaporator depending on the dose of

refrigerating system filling and ambient temperature; substantiate the position of device sensor of automatics HRD, signaling about the leak.

For the solving of these problems we realized the researches with the use of experimental stand, the scheme of which is shown on the picture 1.

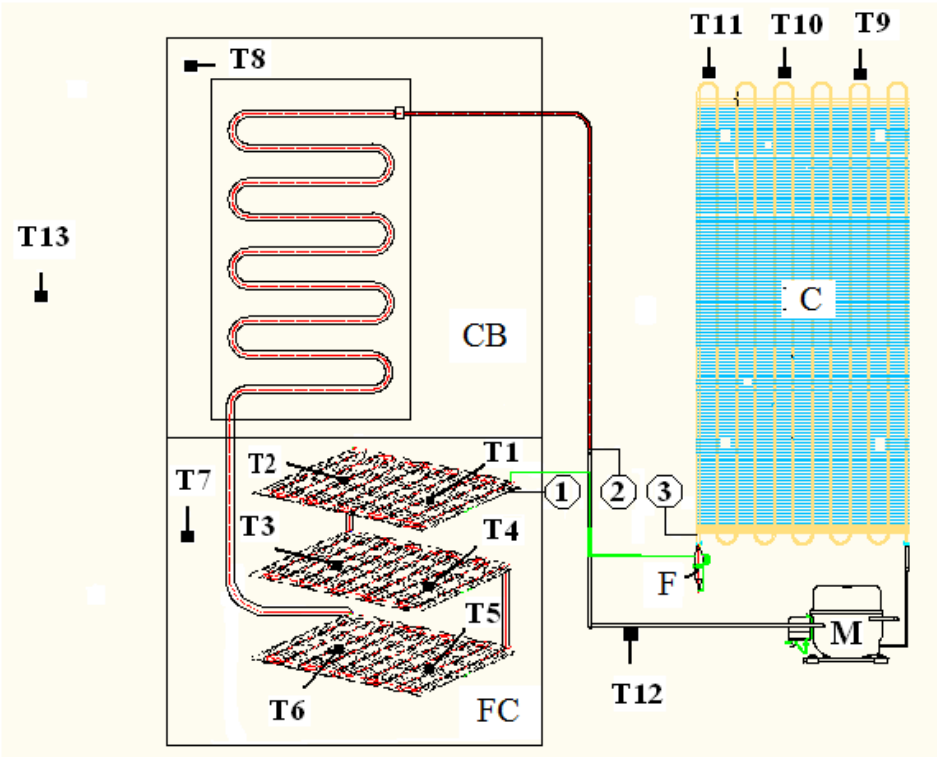

Fig. 1. Scheme of temperature sensors position (thermo pair) on the experimental stand: T1 – T6 – on the top of evaporator, T7 – in the volume of freezing camera, T8 – in the volume of freezing section, T9 – T11 – on the top of condenser, T12 – on the top of absorbing conduit, T13 – ambient HRD temperature. 1-2 – pressure-and-vacuum gage, 3 – manometer. CB – chill box, FK – freezer compartment, C – condenser, M – compressor, F – filter dehydrator.

The stand is created on the basis of the household refrigerator DH-239 [4], filled with cooling agent R600a (optimal mass of filling, fixed by the producing plant, - 38g). On the lines of absorption and discharge of refrigerator compressor system there are devices for measuring of pressure and temperature.

During experimental researches the following was recorded: the temperature on the top of evaporator and condenser, the temperature of absorbed cooling agent fume directly before compressor; the pressure in the entrance to the evaporator block and while going out, in the discharge line; electric energy consumption (supply meter is used).

The researches were done in the conditions of fixed outdoor temperature value: 16, 25, 32, 38, 43ºC, with thermo regulator settings, corresponding to minimal, average and maximal cooling. During researches isobutene was taken away from the refrigerating

system HRD in 1,5 g. After each letting out of isobutene from the refrigerating system the temperature and pressure were fixed, the daily electric energy consumption was determined, WTF was calculated. Taking isobutene out of the system was made with a help of the graduate during the stopping of the refrigerating device.

During the experiment we determined the zone of the freezer compartment evaporator, the top temperature of which corresponds to the temperature and pressure of isobutene on the saturation line. This zone for the model HRD DH-239 is situated between the sixth and the tenth screws of freezer compartment evaporator [5,6]. The sensitive element of the device of refrigerator automatics signaling about cooling agent leak can be placed on the shown zone of the evaporator (place of thermo pair position T3).

The analysis of these data shows that the temperature on the top of the freezer compartment evaporator depends on the doze of compressor system filling, ambient temperature and position of thermo regulator. Regardless of the thermo regulator setting the lowest temperature value on the evaporator top takes place with doze of filling about 32,0 g and ambient temperature 16ºC, but after taking isobutene out it starts to increase linearly.

If we decrease the doze of filling from 38,0g to 35,0g the temperature on the top of the evaporator goes down with thermo regulator settings: minimal from – 26,3 to 29,6ºC, average from – 27,7 to -30,9ºC, maximal from -29,8 to -32,8ºC.

These data show that the reduction of filling doze on 3 grams leads to reduction of the temperature on the freezer compartment evaporator on 3,3ºC, 3,2ºC, 3,0ºC corresponding to minimal, average and maximal settings of the thermo regulator. The results show that the temperature decrease on the evaporator top can be diagnostic indication of isobutene leak from refrigerating system.

With the aim of possibility of setting this device, the mathematical model and calculating algorithm were developed, which give the opportunity to predict the temperature value on the evaporator top and in the cooled volume with changing filling doze and ambient temperature. The temperature value we got in the fixed spots let us figure out its distribution with the use of finite-difference methods, temperature distribution in the chill box.

The finite-difference net with size of 50×100 was generated and the program product in language Delphi 2011 was made. With their help the temperature value on the freezer compartment evaporator of working HRD was analytically determined depending on the doze of its filling with isobutene and ambient temperature.

On the basis of data we got at the average setting of thermo regulator HRD and the data we got in the result of mathematical calculations, we compared and presented in the form of the graph (picture 2) the temperature changes on the evaporator top in the place of arrangement the thermo pair T3 at the ambient temperature from 16°C to 43°C, and also at different doze of filling of compressor system of the working household refregirating device DH-239 1,1’ (41,0g); 2,2’(39,5g); 3,3’(38,0g); 4,4’(36,5g); 5,5’(35,0g); 6,6’(33,5g); 7,7’(32,0g).

When decreasing the filling doze of cooling agent from 38,0g to 32,0g the temperature on the evaporator top in the place of fixation of thermopair T3 maximally decreases at the ambient temperature 16°C and will be -38°C according to the results of the experimental researches, according to the mathematical culculations – 38,7°C. Maximal value in the same conditions is got at the ambient temperature 43°C and will be

-28,9°C and -27,9°C. The same tendency of temperature change on the evaporator top also remains for the filling dozes of 41g, 39,5g, 36,5g, 35g, 33,5g, to wit with the ambient temperature increase the temperature on the freezer compartment evaporator top increases.

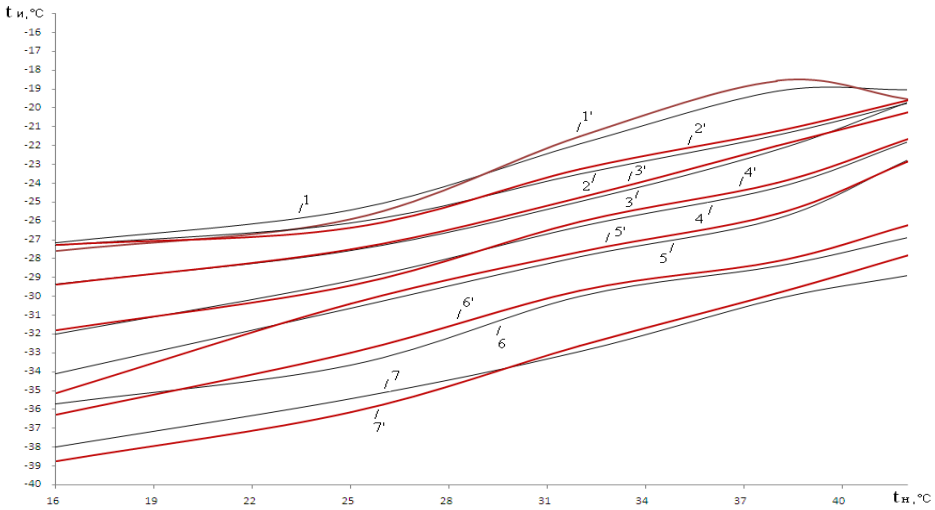

Fig. 2. The graphs of temperature change on the evaporator top in the place of thermopais T3 arrangment at the changing ambient temperature from 16°C to 42°C at the average thermoregulator setting. The graphs 1, 2, 3, 4, 5, 6, 7 – data we got in experimental way, 1', 2', 3', 4', 5', 6', 7' – data we got with a help of culculations at different dozes of filling. The graphs 1, 1' (41g); 2,2' (39,5g); 3,3'(38g); 4,4'(36,5g); 5,5'(35g); 6,6'(33,5g); 7,7'(32g).

The temperature values on the evaporator top determined in culculating way and experimentally, almost coincide regardless of the ambient temperature and filling doze of refrigerating system. Comparison of temperature values on the evaporator top got in culculating way and experimentally showed good similarity of the results. Maximal difference of experimental and culculating data is 3,5%.

The analysis of the data shows that the mathematical model of temperature prediction on the freezer compartment evaporator top is correct.

Thus we determited the place of arrangement of sensor device on the evaporator top signaling about microleak from the refrigerating system of the working refrigerating device.

We got the experimental data about temperature change on the evaporator top depending on the changing settings, filling doze of refrigerating system and the ambient temperature and they are compared with the results of mathematical culculations.

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