RESEARCH OF HEAT–AND–POWER ENGINEERING CHARACTERISTIC CHANGES OF FREEZING BOX EVAPORATOR UNDER THE WORK OF HOUSEHOLD REFRIGERATOR DH–239

Gorin A.
Demin M., Kudrin A.

Donetsk University of Economics and Trade named after M. Tugan–Baranovsky
Demin M., e–mail: demin.m@mail.ru

Abstract: By means of thermographic shooting experimental studies of distribution of temperature on a surface of the evaporator of the household DH–239 refrigerating appliance working at isobutane depending on a dose of filling of refrigerating system are carried out. The received results can be used for definition of the possible location of the sensor of the device signaling about emergency work of HHR.

Keywords: the household refrigerator – the evaporator – isobutane – thermographic shooting

Earlier researches of working conditions of refrigerating machine HRD with the filling dose of cooling agent which was fixed by the plant–producer and then changed showed that one of the signs of isobutane microleaks from the compressor system is fall of its boiling point, and as a consequence, fall of the temperature on the surface of refrigerator evaporator. This regularity can be considered as fundamental in the work principle of automatics device, signalizing about freezing system depressurization. It is stated that factors which influence the temperature of the surface of working refrigerator evaporator is its filling dose and ambient temperature [1,2].

The aim of fulfilled researches is study of thermal processes taking place on the surface of evaporator of freezing box of household refrigerator DH–239 under change of filling dose of refrigerating system. On the basis of the data which were got, the comparative evaluation of temperature fields on the surface of freezing box evaporator of working refrigerating machine was made for determination of location and adjustment of sensor of the device controlling the leak of cooling agent from refrigerating system.

For the achievement of the aim the following tasks were fulfilled: thermographic images of inner surface of freezing section were got and placement of the temperature fields on the surface of evaporator of freezing box under different filling doses of refrigerating system with izobutane was determined (41,0g; 38,0g; 36,5g; 35,0g; 33,5g; 32,0g); the area on the surface of evaporator of the freezing section with the most stable temperature for installation of the sensor of device controlling leak of cooling agent was determined.

For the realization of these tasks the researches were made using experimental stand made on the basis of household refrigerator DH–239 [3], filled with cooling agent R600a (the optimal mass of filling, fixed by the plant–producer – 38g). The devices for pressure of suction measurement and discharge, temperature on the surface of heat–exchange devices and conduits, were installed on the lines of suction and discharge of refrigerator compressor system.

Methodology of the experimental researches is the following. Six chromel–copel thermocouples blocked with measuring–calculating complex were fixed in the equal distance on the surface of the freezing section evaporator block consisting of three shelves. The results were given and fixed with a help of personal computer in every 2 minutes. The researches were taken in a heat chamber, certified by «Donetskstandartmetrologiya», under ambient temperature 25 ºC. Refrigerating device was placed in the heat chamber and filled with packages – imitators of food products. The temperature in the refrigerating section was measured in its geometrical centre by chromel–copel thermocouple. Under medium setting of thermoregulator HRD the medium value of the temperature in the refrigerating section was 4°C. At the same time the thermographic survey of temperature fields on the inner surface of the freezing section and external surfaces of evaporator, packages–imitators was taken. For this thermal imager «Micron–7600», permitting to fulfill infrared thermometry in temperature diapason from – 40°C to 120°C with mistake ± 2% was used.

Figure 1 shows image of experimental stand.

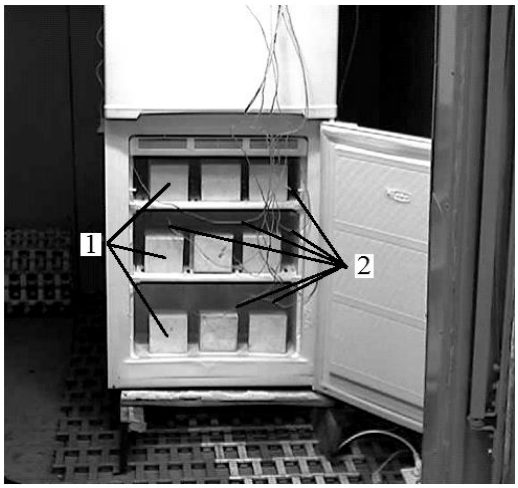

Fig. 1. Freezing section of HRD with installed packages–imitators 1 and thermocouples 2.

Analysis of the data gives the opportunity to determine dependence of the temperature on the surface of evaporator of filling dose of compressor system. In diapason of filling doses 38,0…32,0g the temperature on the surface of evaporator changes under medium setting of thermoregulator from – 27,2 to – 36,3°C. Temperature difference is 9,1°C. Under filling dose 33,5g temperature characteristics on the surface of evaporator reaches – 33,8°C. This filling dose can be regarded as critical as duty work factor of refrigerating machine becomes equal to one. Moving 4,5g of isobutane (filling dose 33,5g) away from the system is characterized by ceaseless work regime of compressor (DWF=1). With fall of filling dose to 32,0 g temperature on the evaporator surface falls to –36,3°C.

Picture 2 shows thermographic images of freezing section of HRD under work with different filling doses of cooling agent: 41,0g (а); 38,0g (в); 35,0g(г); 32,0g(е).

Survey was taken before compressor disconnection under fixed cyclic compressor work regime (under filling doses less than 33,5g compressor worked in the regime of disconnection absence).

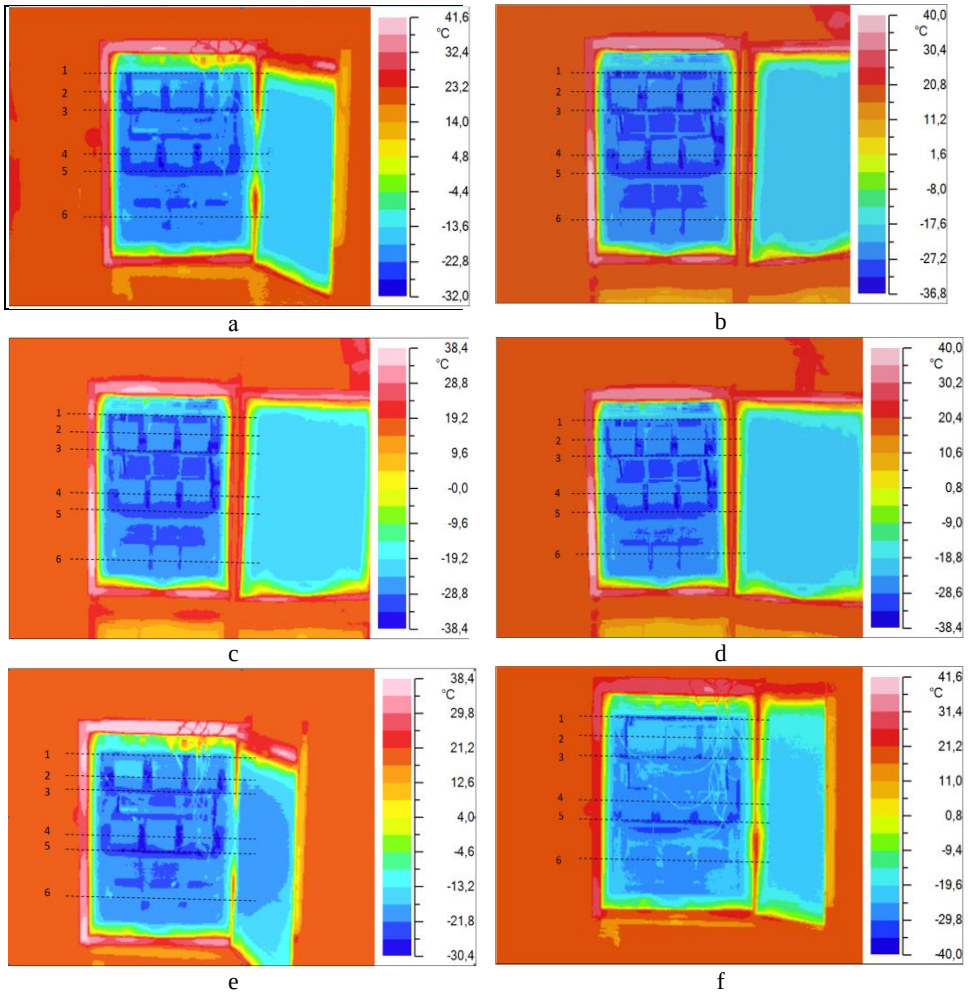

Fig. 2. Thermographic images with different filling doses of cooling agent 41,0g (a); 38,0g (b); 36,5g (c); 35,0g (d); 33,5g (e); 32,0 (f). Dotted lines: № 1 – upper shelf of freezing box evaporator; № 2 – packages imitators under upper shelf; № 3 – medium shelf of freezing box evaporator; № 4 – packages imitators under medium self; № 5 – lower shelf of freezing box evaporator; № 6 – packages imitators under lower shelf.

Under fall of filling dose the temperature on the surface of freezing box evaporator begins to fall, the most chilled are the evaporator coils placed on the medium shelf. Fall of the filling dose from 41,0 to 32,0g leads to the temperature fall on the evaporator surface from –25,8 to –36,3 ºC. But with the temperature fall on the evaporator surface its rise

takes place in the volume of freezing box and on the surface of packages imitators as a result of fall of cold–production of refrigerating system [4]. Under filling dose less than 36,5g the areas on the surface of packages imitators, the temperature of which exceeds –18 °C (pic.2 в–е) appear, at the same time DWF and electricity expense rise. Temperature fall on the surface of evaporator takes place as a result of fall of filling dose of cooling agent in the refrigerating machine, which leads to fall of its work effectiveness.

Thermographic images showed that the most stable temperature characteristics on the surface of evaporator, independently of filling dose, were fixed on the area corresponding to the medium shelf of freezing box (dotted lines 3).

Picture 2 shows thermographic images of freezing section of HRD under work with different filling doses of cooling agent: 41,0g (а); 38,0g (б); 36,5g (в); 35,0g (г); 33,5g (д) 32,0g (е). Survey was taken before compressor disconnection under fixed cyclic compressor working regime (under filling doses less than 33,5g compressor worked in the regime of disconnection absence).

On the basis of fulfilled experimental researches the data about temperature change on the evaporator surface depending of filling dose of refrigerating system with cooling agent were got. The graphics describing temperature changes taking place on the surface of freezing section evaporator were built. We determined the area of freezing section evaporator with the most predictable and stable temperature characteristics of its surface for supposed location of device sensor, signalizing about microleak of cooling agent (disconnection of refrigerator from electricity network, switching on light–sound signalization) from refrigerating system of working refrigerating device.

References

1. О влиянии дозы заправки компрессорной системы бытового холодильника хладагентом (изобутаном) на происходящие в нем термодинамические и теплофизические процессы. / В.В. Осокин, А.Б. Кудрин, М.В. Дёмин // Холодильна техніка і технологія. – Одеса, 2011.–№3(131).–С. 24–30.
2. О влиянии температуры окружающей среды на теплоэнергетические характеристики бытового холодильника. / В.В. Осокин, А.Б. Кудрин, М.В. Дёмин // Холодильна техніка і технологія. – Одеса, 2011. – № 1 (129). – С. 17–22.
3. Ландик В.И., Горин А.Н. Холодильные приборы NORD (устройство и ремонт). – Донецк: Норд–Пресс, 2009. – 268с.: табл., рис.
4. О термодинамической и теплофизической основе негазоонализаторного способа установления утечек хладагента из компрессорной системы работающего бытового холодильника – на примере ДХ–239, заправленного изобутаном/ В.В. Осокин, А.Б. Кудрин, М.В. Дёмин // Холодильна техніка і технологія. – Одеса, 2011. – № 4 (132). – С. 9–16.