

METHOD TO IMPROVE THE ENERGY EFFICIENCY OF HOUSEHOLD REFRIGERATING APPLIANCE

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Abstract. *The article describes a method of increasing domestic refrigerator energy efficiency due to the intensification process of removing heat process out of a refrigerator unit. The modern fans were proposed to cool a refrigerator surfaces and a condensing unit regarding to the ambient temperature, a condenser and an evaporator temperatures; control cooling method of main sealed subsystems (compressor and condenser) as the main thermal loads.*

Keywords: *domestic refrigerator unit, energy efficiency, a condensing unit, control cool condenser system, air cooling surface, condensing unit.*

One of the main electrical appliances in most houses is a domestic refrigerator intended for the producing artificial cold and long or short-term food storage.

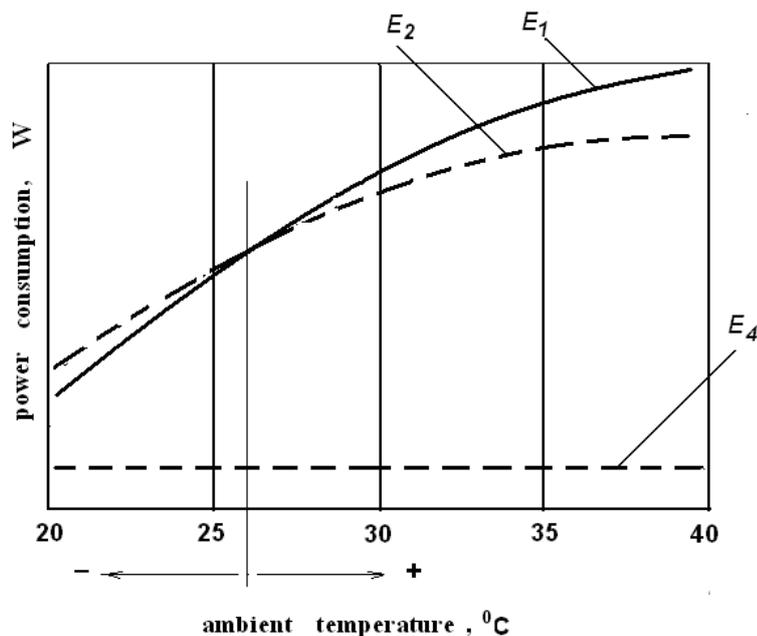
In accordance to the Russian Federation program "The Energy efficiency and energy development" [1] we need to pay more attention to the requirements of designing, creating and using energy-efficient electrical appliances including domestic refrigerators.

The researches concerning the ways of increasing domestic refrigerators compression as energy efficiency means [2, 3] have demonstrated that improving some refrigerator's units can significantly reduce the consumption operating power. It is established that the reducing power compression of refrigerator consumption at 8 - 10% can be achieved by improving the operating process of heat evaporator and the condenser transference [4, 5].

There are various research papers concerning refrigerators' design improvement are likely to increase energy efficiency [6, 7, 8].

One of the ways of increasing the compression efficiency of domestic refrigerator is to appeal to a cooling condenser surface process which increases the coefficient of the refrigerant and a refrigerator device, thereby reducing the total power consumption [9]. However, the fan cools refrigerator condenser surface and increases the overall power consumption of the refrigerator, since the cooling efficiency of the condenser can be compensated by a fan operating energy costs. Therefore, such method of increasing energy efficiency of domestic refrigerator unit is considered to be ineffective until the present time so it is hardly popular way of energy efficiency.

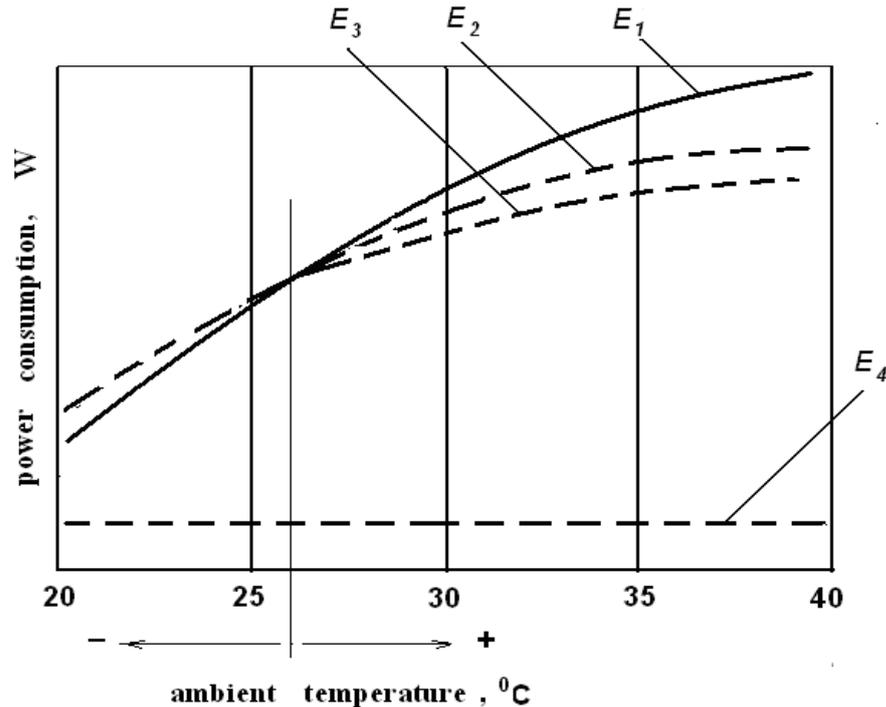
The results of studies [6, 10] have demonstrated that the power consumption of the compressor depends on the ambient temperature. Examples of such dependencies are illustrated in Figures 1 and 2.



Picture 1. The dependence of the refrigerator power consumption from ambient temperature with the refrigerator condenser, E1 - refrigerator power without surface condenser, E2 -refrigerator power fan-with surface condenser E4 – fan power consumption

Picture 1 shows that some refrigerators do not need a forced process of cooling a capacitor surfaces, it can be used only when the ambient temperature is above a certain limit. It was established experimentally, that for example, for a refrigerator «INDESIT D-653" the limit temperature is- 25 ° C. It is obvious that at the temperature below this limit, a forced air to cool condenser surface as fridge cooling process is not advisable. We have proposed a new way of improving energy efficiency in a refrigerator unit by a single as simultaneous cooling process of condenser surface and compressor surface [9].

The theoretical ground for the idea is based on a rational air flow usage operating from the fan to cool the major subsystems of the sealed unit (a compressor and a condenser), the process of cooling these systems will lead to reducing a refrigerator unit power consumption. Figure 2 shows the dependence of the power consumption due to the fan energy consumption. It can prove the using airflow to depend on the fan cooling the compressor and the condenser surfaces and thus this process can additionally reduce specific energy consumption in contrast to refrigerator unit and cooled surface condenser of a refrigerator.



Picture 2. The dependence of refrigerator power consumption from ambient temperature with condenser and compressor cooling. E1 -refrigerator power without condenser surface cooling, E2 – refrigerator unit power with a condenser, E3 – a compressor refrigerator and condenser power of a fan, E4 – a fan power consumption

All these facts can prove that, it is necessary to develop different refrigerator unit constructions to provide simultaneous cooling of condenser surface and the compressor surface.

To ensure rational control of a fan air flow it is advisable to measure the condenser surface temperature in the refrigerator unit or the evaporator temperature of and / or the ambient temperature, and as a result of the temperature measurements it is necessary to control or switch the fan on /or off [10]. It was established experimentally that the most energy efficient ways of controlling on / off fan is a method when a switching on / off is consistent process of the on / off compressor.

The proposed method of improving refrigerator unit energy efficiency is quite effective when limit temperatures of a-controlled fan drive is enabled or disabled. Capacitor case may have different forms, for example, a plate or-tube form. A coolant compressor and a condenser can be designed as a compact condensing unit disposed in the lower part of the domestic refrigerator. The fan may be configured as axial or centrifugal.

The capacitor body surface is situated in its upper part or in the outgoing condenser conduit and / or is fixed on the evaporator surface temperature sensors by the fan control switching on / off modes.

The refrigerator fan is switched off when reaching a certain surface temperature limit of the condenser or coolant temperature, while the evaporator fan control system is being activated to achieve desired temperatures. Depending on the heat load and ambient temperature, the frequency and durability of fan cycles may be variable.

Thus, a well known cooling method when a fan cooling air flow to a condenser can cool a compressor surface.

A Developed method of increasing the refrigerator unit energy efficiency will allow us to:

1. Increase the intensity of the condenser and the compressor surfaces cooling.
2. Optimize the heat transfer process of working sealed unit to environment.
3. Reduce refrigerator unit energy consumption.

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СПОСОБ ПОВЫШЕНИЕ ЭНЕРГЕТИЧЕСКОЙ ЭФФЕКТИВНОСТИ БЫТОВОГО ХОЛОДИЛЬНОГО ПРИБОРА

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Аннотация. В статье приведено описание способа повышения энергетической эффективности бытового холодильника за счет интенсификации процесса отвода тепла от холодильного агрегата. Предложено использовать современные вентиляторы для обдува поверхностей компрессорно-конденсаторного блока БХП с учетом температуры окружающего воздуха, температур конденсатора и испарителя; предложен способ управления процессом охлаждения основных подсистем герметичного агрегата (компрессора и конденсатора) с учетом тепловой нагрузки.

Ключевые слова: бытовой холодильный прибор, энергетическая эффективность, компрессорно-конденсаторный блок, система управления охлаждением конденсатора, обдув поверхностей компрессорно-конденсаторного блока.