DESIGNING OF TRANSPORT ABSORPTIVE REFRIGERATING APPARATUSES FOR CONTINUOUS REFRIGERATOR CHAIN

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Abstract

We present the method for designing absorptive refrigerator devices on transport means as a part of continuous refrigerator chains, which summarizes researches and elaborations in different fields of thermal physics and refrigerator engineering.

KEYWORDS

Continuous refrigerator chain, absorptive refrigerating devices, absorptive aggregates, designing.

INTRODUCTION

The creation of the transport refrigerating devices of small productivity is actual for modern economy of farmers and agricultural workers of Ukraine.

Such apparatuses may be used for delivering of cool and frozen agricultural products to the markets and also for work in continuous refrigerator chain, for example, as apparatuses for primary freezing processing of milk and products, received from milk directly in the place of their production. The native and foreign producers propose transport refrigerators on the basis of compressive refrigerator machines. These apparatuses, as a rule, are fixed on separate transport facilities and do not suit small agricultural producer because of high cost and productivity.

Interesting decision in this area can be found with the help of heat using refrigerator machines. Creators of such machines in many countries of the world were not once dealing with the question of using them on transport. As a rule, it was supposed that for the work of such apparatuses as a main source of energy we must use flow of heated combustion products of internal combustion engine. Effect from use of utilizing heat aggregates on transport is connected with fuel saving for driving of traditional refrigerator compressive aggregate.

During last years when designing new refrigerator models one takes into consideration negative influence of transport compressive refrigerator systems on environment due to considerable from escape through incompactnesses of stuffing-box condensations.

In contradiction to compressive systems the refrigerator machines working with the help of heat use natural working liquid – water (steam injector) and ammonia – water solution (absorptive), which are natural components of natural environment and do not cause formation of global warming and ozone layer depletion [1].

Of particular interest on transport among heat using refrigerator machines are apparatuses on the basis of absorptive refrigerator aggregates (ARA). The working liquid of absorptive refrigerator aggregate is ammonia-water solution (AWS) with addition of inert gas – hydrogen or helium. In ARA there is no electromechanical pumping equipment and transference of working liquid components are made in gravitation regimes which greatly increases reliability of work and resource and allows to work without current sources.

The distinguishing peculiarity of ARA is the work of their heat-dissipated elements in natural convection regime without external incentives of circulation. This autonomy, reliability and increases operational resource of refrigerator, but compels creators to produce high enough pressure in order to get mass-overall parameters. So, in ARA models intended to work in temperate climate operational pressure is 20 bar and in the tropical climate – 30 bar. As has been shown by practice of using absorptive refrigerators on transport during many years and a lot of specific scientific researches [2], in connecting with changeability of influence, presence of jolting and slopes during movement of a vehicle does not provide critical influence on the work of ARA – refrigerator apparatus efficiency is retained practically on the level of work in the stationary conditions.

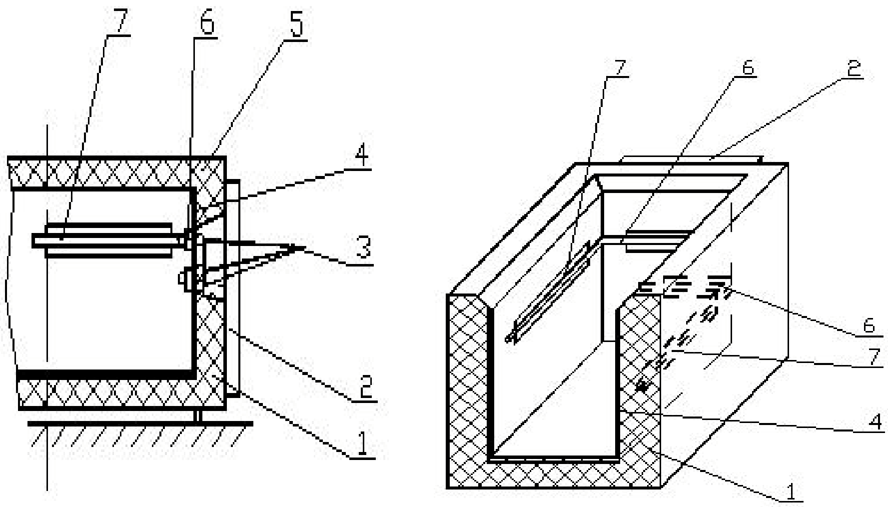
Nevertheless, despite of the presence of such perspectives, ARA finds slight application in composition of refrigerator devices on modern vehicles. Such sources of energy as torch devices and sources of constant electric current (12 and 24 V) are used [3, 4].

As has been shown by the analyses, such situation is connected with absence of a system approach in creation of new models in this area of technique.

The aim of this work is elaboration of methods of designing transport refrigerators on the basis of ARA and later on methods of designing transport absorptive refrigerators.

METHODS OF DESIGNING

This method assumes presence of construction of “chest” type heat isolated refrigerator chamber, shown in Fig. 1.



a) b)

Fig. 1. Refrigerator chamber of a “chest” type with ARA butted walls: a) – side view; b) – section. 1 – head isolation of refrigerator chamber; 2 – ARA; 3 – ARA evaporator; 4 – internal aluminium case; 5 – lid; 6, 7 – condenser and evaporator of a heating tube; 8 – actual chamber volume

Refrigerator chamber is equipped with module removable ARA whose evaporators refrigerating capacity is from 15 to 50 V and which are installed in heat isolated blocks [5]. Construction of “chest” type chamber allows to improve essentially operating characteristics of refrigerator apparatus so far as a main unfavorable influence of air exchange when the gates are open, is connected not with cool air escape but with flow of warm wet air from outside surroundings . Moisture is condensed on evaporator surface and freezes forming firstly a hoar frost layer and then an ice crust. In this care thermal resistance between evaporator and air in the chamber is increased the latter leads to operation period increase in the cooling (refrigerator) aggregate id.est. growth of the coefficient of the working period takes place and, consequently energy loss is increased during exploitation . Block construction of ARA evaporator allows to apply additional evaporating condensation head transforming devices (low temperature heating tubes and thermosiphones), which have low internal thermal resistance and are able to secure heat transformation on large distances.

There is some experience of using shaped low temperature heating tubes, produced according to SPA technology of applied mechanics (Russia ,Theleznogorsk town) in original refrigerator chamber constructions of “chest” type with actual volume 180 dm^3 (“Stugna” – 101” AML – 180) [6].

This construction has two ARA, installed in side walls of a “ chest” and in chambers with 0,650 x 0,700 m dimensions four heating tubes (two for each refrigerator apparatus) were installed with 0,200 m condensation zone and 0,300 m evaporation zone .

During designing in general case we consider the source of heat energy which is situated at some considerable distance (1 …5 m) from the heat feeding zone (generator assembly) of ARA. We suppose that generator apparatus is installed either directly on the vehicle or on a vehicle trailer (Fig. 2, 3).

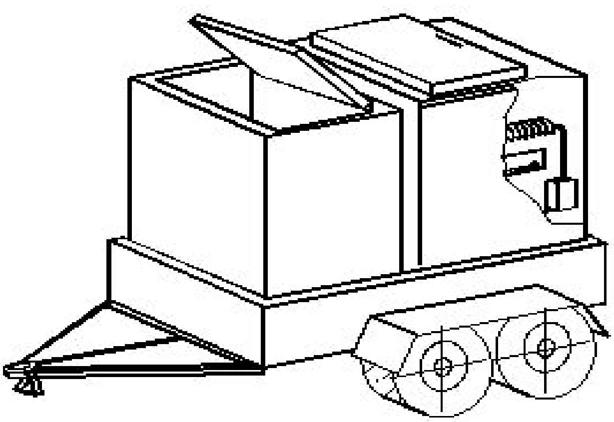


Fig. 2. Variant of refrigerator chamber installing with ARA on a trailer of a puss anger car

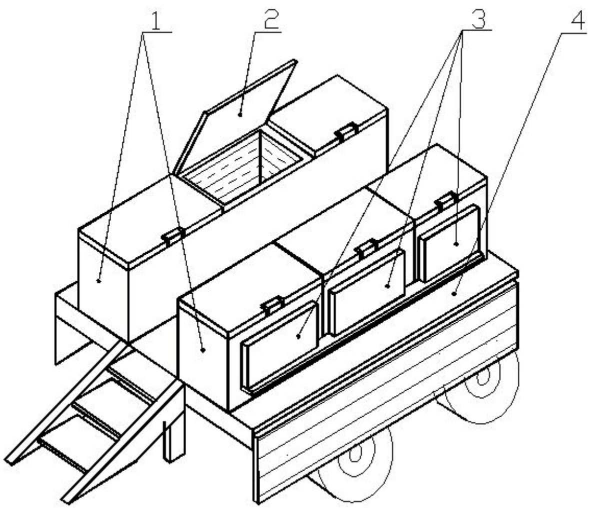


Fig. 3. Variant of refrigerator chamber installation with ARA on the trailer of high capacity car: 1 – refrigerator apparatuses; 2 – lids of refrigerator apparatuses; 3 – ARA; 4 – heat feeding main

In the first case it is supposed to install one or two refrigerator chambers which have a total volume from 360 to 720 dm^3. Such constructions may be used, for instance, for delivery frozen and cool products to agricultural markets ,ice cream to the zones of rest (to sea and river beaches) etc .

In the second case problems are solved in connection with primary refrigerator processing of plants (tomato , strawberry) and of animal original (river and lake fish) directly in the procurement places. Summary volume of refrigerator chambers is supposed to be from 1500 to 10000 dm^3.

In the second case two schemes are considered – the scheme with autonomous cooling blocks (Fig. 3),which contains from four to ten refrigerator chambers [7] and the scheme with one refrigerator chamber equipped with module demountable ARA [8] (Fig. 4).

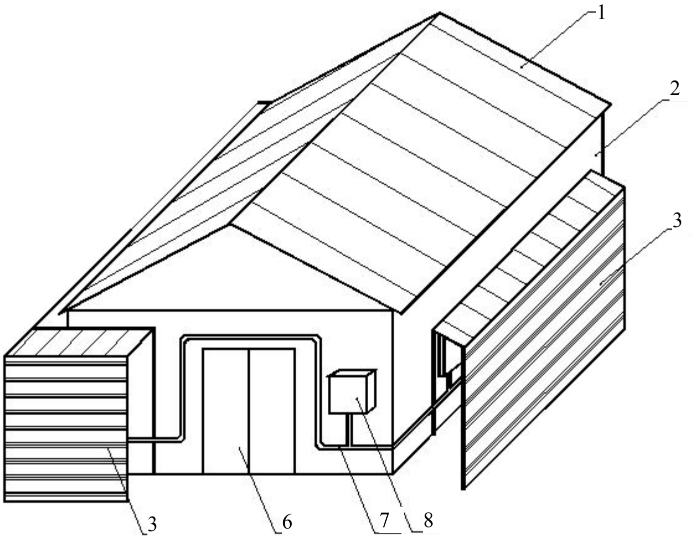


Fig. 4. Use of domestic premises as a refrigerator chamber: 1 – roof; 2 – side walls; 3 – sun protection panels; 4 – ARA; 5 – main of feeding energy; 6 – doors

Designing methods suppose organization of heat relation between feeding of heat to ARA and the flow of heated combustion products with the help of special intermediate heat transmitting devices (evaporating thermosyphones, contour heating tubes etc.)

The demands to intermediate heat transmitting devices are connected with the secure of feeding heat load in the necessary for ARA work temperature level.

For ARA with air cooling of heat dissipating elements in the regime of natural convection and under the temperature of surrounding air which equals 32 ºC, temperature in the zone of heat feed must not be lower than 170 ºC.

Temperature of flow of combustion products in modern vehicle engines equals 290 …350 ºC [9].

So, additional intermediate heat feeding device must meet requirements in minimum quantity of heat (60…70 W) when temperature is 120…180 ºC. The top limit of the load due to heat may be taken as 150 W – it happens when delegator cannot cope with cleaning of ammonia steam from water steam and ARA capacity is lowered [10].

As basic heat supplier of heat feeding device we consider water, which possesses optimal heat physical characteristics witching the given temperature diapason.

The work of the internal combustion engine of the vehicles is characterized by variability in time and it leads to parameter changes of the flow of combustion products and, consequently , to the changing of heat load volume in the zone of heat feeding of ARA. The stabilization of heat feeding designing methods consider possibilities for utilization heat from accumulator, for example, with phage transition (by melting) [11].

For raising efficiency of ARA work in represented methods we consider possibility of forced blow of heat dissipating elements (absorber, condenser, deflegmator) as at the expense of utilizing fans with electric drive (during the movement of a vehicle) and also with a drive from the hot gases (at the stop).

This arrangement acquires special actuality in the countries with tropical climate.

One of the key moments of the methods is choice of heat isolating parameters, as temperature level in refrigerator chamber is determined by correlation of two quantities – heat blows from environment and refrigerating efficiency of ARA.

During elaboration two types of refrigerator chambers are considered: specialized refrigerator chamber with fixed temperature level (freezing, cooling and chambers for bruit and vegetable storage) and universal chambers which work within wide temperature diapason – from minus 18 to plus 12 ºC.

CONCLUSIONS

Proposed methods allow on the basis of generalization and analysis of results of researcher and elaborations in thermophysics and refrigerator engineering to formulate initial data and carry out designing of real refrigerator and vehicle models on the basis of ARA , produced in Vasilcovsky refrigerator plant .

In perspective we consider questions of utilization for the ARA work not only energy of heated gas flow from the vehicle engine , but also the possibility of using sun radiation energy with the help of original constructions of flexible light leaders [12] which is particularly actual on the stops and in addition allow to economize fuel .

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