INCREASING THE ENERGY EFFICIENCY AND TECHNOLOGICAL SAFETY OF SOLAR WATER HEATERS TO ENSURE SANITARY REQUIREMENTS AND INDOOR MICROCLIMATE

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Abstract

The main part of this article describes the solution of the technical problem of creating a solar water heater device that allows to increase energy efficiency while ensuring safety, sanitary requirements and indoor microclimate. Information is given about the proposed device and method for eliminating leaks on heat-transfer pipes and their connections by automatically sealing poisonous (antifreeze), limiting the risk of its possible ingress into heated water for domestic needs. The report also provides a brief rationale for introducing a new discipline into the educational process related to the tasks under consideration.

Keywords*:* solar water heater, antifreeze, sealant, expansion barrel, heat transfer system, storage tank

I. Introduction

The rapid development of technology and the intensive growth of the population gave rise to intractable problems for mankind. Among them, the main place is occupied by the relationship between man and the environment, as well as technology. Over the past one hundred and twenty years, the population has increased more than 4 times, and the volume of production over 20 times. Due to the anthropogenic impact on the environment, serious problems have arisen in nature and society. At present, in all regions of Azerbaijan, as well as throughout the world, the risk of infectious diseases and pandemics is not sufficiently reduced.

The purpose of this work is to improve the efficiency, reliability and safety of human health in the operation of solar water heating installations intended for the preparation of hot water. There are many schemes of solar water heating installations, arranged basically on the same principle of operation.

II. Existing devices and methods

To describe the developed method and device for ensuring safety, consider the selected basic piping scheme for a standard installation for preparing hot water. Known installation for hot water using solar energy. For the round-the-clock use of this solar water heating installation, it is made of two contours. Where in the primary circuit there is a solar collector, which is a heat exchanger with antifreeze. The primary circuit consists of solar collectors, piping system, pump,

expansion tank and coil heat exchanger. Due to the fact that high temperatures are possible in solar collectors, the pipelines are made of copper pipes and connected by hard soldering.

The serpentine heat exchanger is built into the storage tank. The antifreeze used as a coolant circulates through the pipelines of the primary circuit and the heat received from the solar collector is transferred to the water in the boiler. The device has an expansion tank (hermetic container) made of metal, in which there is a supply of coolant in case of thermal contraction during fluid circulation. If the coolant, expanding when heated, creates too much pressure in the system, then the hydraulic tank compensates for this. And with a decrease in the amount of antifreeze, due to evaporation and cooling, it contracts, a vacuum is created in the system and the pipes bend inward. All this reduces the reliability of the system.

To achieve this goal, a lot of designs and methods on this issue are considered. Of these, the closest and most appropriate, in terms of technical essence, is the well-known design of a simple carburetor, which is described in the book [2]. So, this scheme of the simplest carburetor consists of a float chamber with a float, a jet with a sprayer, a diffuser and a throttle valve. Fuel enters the float chamber from the tank through a pipeline. The chamber contains a float that acts on the locking needle. When the fuel reaches the limit level in the float chamber, the float presses the needle against the seat, cutting off fuel access. When the fuel level drops, the float is released and fuel enters the chamber. During operation of the engine in the suction stroke, a vacuum is formed in the mixing chamber due to the downward movement of the piston. Due to the difference in atmospheric pressure in the float chamber and reduced pressure in the diffuser, fuel flows out of the atomizer hole. The advantage of this principle of operation is that it can be used in another way to automatically add sealant to antifreeze when repairing emergency cracks and leaks in the primary circuit of a solar water heater.

There is known a method for sealing a leak in the core of a cooling radiator using shaping adhesive compositions, which consists in the fact that a rubber gasket is applied to the supposed radiator leak, lubricated with a layer of oil so that after curing the compound it can be easily separated without damaging the coating. From above, thin-walled tubes with increased thermal conductivity are inserted into the damaged area of the radiator and filled with a shaping adhesive composition with fillers having increased thermal conductivity, which maintains the high thermal conductivity of the repaired section of the radiator. The main disadvantage of this method is that the radiator leak must be degreased with acetone, blown with compressed air, dried, auxiliary materials must be used, and this repair method cannot be applied without disassembly.

It is known a vehicle with an internal combustion engine and a method for preventing the failure of such an engine during the operation of vehicles, consisting of an engine stop mechanism, an alarm, a coolant pressure drop indicator. failure of the engine is carried out by automatic shutdown on the signal of the pressure drop of the coolant (antifreeze). The main disadvantage of the known device are high operating and maintenance costs, low reliability. In addition, the elimination of an emergency problem in this way is generally impossible.

It is known as RF patent No. 2462604 Expansion tank, which contains a channel with an outlet for liquid filling, a cover, the first and second expansion chambers, respectively, to contain the liquid that circulates in the first and second system. This expansion tank has the ability to fill liquid from two separate systems. The main disadvantage is that this tank cannot be used to mix the liquid from the two systems at the right time, for example, mixing antifreeze and sealant during pipe cracks.

III. Developed device and recommendations

After the analysis, it should be noted that the goal is realized due to the fact that, as in the well-known device for round-the-clock use, the solar installation system is made double-circuit

where in the primary circuit the solar collectors are a heat exchanger in which antifreeze is used. Antifreeze is poisonous and quickly penetrates through micro cracks. If it gets into the heated water available in the boiler, drinking water is poisoned. To implement the new idea, a solar water heater was chosen as the basic device, which contains a coil heat exchanger built into the storage tank, consisting of copper pipes connected by hard soldering. As a result of forced circulation of antifreeze in the primary circuit, the water in the storage tank is heated. This process has the risk of emergency deviations in the heat transfer circuit, due to the possible occurrence of cracks in copper pipelines due to high temperatures in the system. However, unlike the closest analogue, the basic solar water heater, the device uses a method to prevent possible emergency deviations in the process of heating water and to prevent the ingress of toxic antifreeze into the boiler tank. As a leak prevention unit for copper tubes of the coil, a float chamber vented to the atmosphere having a float with a needle valve and atomizer is used. They are functionally connected to the expansion tank. When an emergency leak occurs in the primary circuit, there is a decrease in pressure-discharge in the expansion tank; the sealant entering the float chamber through the sprayer is mixed with antifreeze and closes the crack in the coil of the copper pipeline and in other damaged areas of the coolant circulation line. Timely supply of sealant to the coolant circulation system is carried out automatically by a special unit functionally included in the primary circuit of the solar water heating installation.

The technical result is to prevent the leakage of antifreeze in the heat transfer system during operation of the solar water heater and to ensure safety in cases of cracks and leaks in the pipes. The analysis of technical solutions in this area did not reveal any similar to the declared one.

The way to ensure safe operation is that during operation, if poisonous antifreeze enters the domestic water in the boiler, the hot water supply path to the consumer is automatically blocked. Overlapping occurs during rarefaction, when the sealant inlet valve (expansion barrel air valve) opens, it closes the contact and the signal enters the electric valve for shutting off the hot water supply at the outlet of the storage tank. Another variant of the technical solution to the problem of ensuring the operation of this valve is that a hydraulic sensor is installed on the circulation line of the coolant-antifreeze with the transmission of an electric signal to the valve for shutting off the supply of hot water to the consumer. Since the minimum allowable circulation pressure is set in the heat transfer system of the antifreeze circuit, then a decrease in pressure below the permissible level occurs as a result of a liquid leak due to microcracks and non-densities in copper pipes. In this case, the disturbing signal is recorded by the sensor, transmitted to the valve, and the hot water supply path is blocked.

By using the hydraulic sensor latch signal, the task of ensuring the operation of the sealant inlet valve can also be solved by another option. If the hydraulic sensor has determined that there is an antifreeze leak, it sends an electrical signal to the sealant inlet valve, it works and opens. Due to the pressure difference between the mixing chamber and the expansion tank, the sealant is poured into the antifreeze circulation line to eliminate the leak.

The essence of the technical solution is illustrated in Figure 1, which illustrates a schematic diagram of the proposed method and device.

The device works as follows. To heat the water in the boiler, ball valves 3 and 4 are opened, designed to turn on / off the heat exchanger from the storage tank. The flow of solar radiation falls on the surface of the solar collector 20, there is a direct heat transfer of solar energy to the heat receiving surface of direct heating, and then the coolant-antifreeze is heated. As a result, due to the heat exchanger (coil) placed in the tank of the storage tank 19, water is heated. Cold water from the cold water supply system through the check valve 14 and tap 2 enters the boiler. Heated water with the heat of antifreeze circulating through the copper pipes of the coil through tap 1 is supplied to the consumer. Taps 7 and 8 are designed to shut off the pump. Valve 7, together with valves 9 and 10, is used to fill antifreeze. The ball valve 12 is designed to release air through the air outlet 17 in the process of filling the system with coolant. In the well-known basic solar water

heater, also for these purposes, there is a safety valve 16 at 6 bar and an air outlet valve 5 of the secondary circuit. The valve 11 is used as a drain valve when draining the coolant-antifreeze. During preventive and technical work, the water from the storage tank is drained using tap 6.

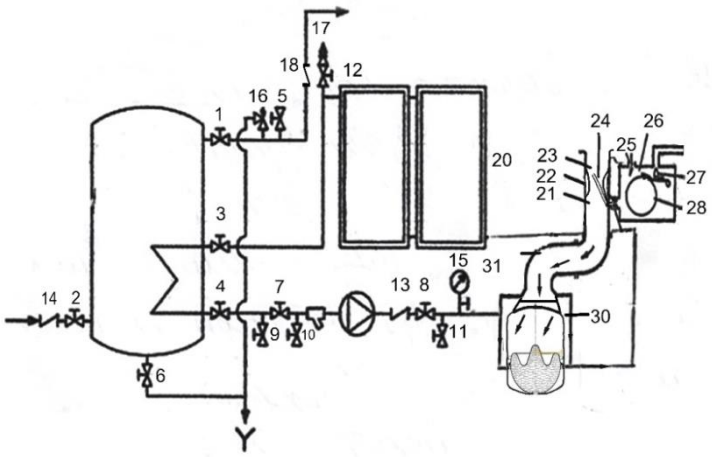

Figure 1: *Schematic diagram of the proposed water heater*

Check valve 13 eliminates the possibility of reverse circulation. The primary circuit has a solar collector 20, an expansion tank 30 with a lid 30 and a sealant supply unit, a pressure gauge 15, a pump, taps, a heat exchanger-coil, a safety valve 31 on the expansion tank 30 set to the maximum pressure of the system. One of the features of the water heating system with a heat carrier-antifreeze is the presence of a special expansion tank, which contains antifreeze and is connected by pipes to the main part of the system. When the antifreeze is heated, if an excess appears, then the excess liquid is discharged into the expansion tank 30. When the volume of the coolant liquid decreases, for example, when it cools, the inlet valve opens and the liquid from the expansion tank returns to the heating system. Thus, a constant volume of circulating fluid is maintained in the system. Another feature of the heating system is the method of preventing antifreeze from entering the storage tank with water when cracks appear in the copper tubes of the coil located inside the boiler through which circulation occurs. In some cases, it is necessary to cut off the heat exchanger from the storage tank. For this, ball valves 3 and 4 are used.

The pressure of the expansion barrel's air chamber during normal operation must correspond to the operating pressure of the unit. The establishment of a constant pressure of the coolant-antifreeze is carried out with cold solar collectors with the circulation pump not working. Insufficient pressure leads to the fact that it is impossible to determine the timely supply of sealant to eliminate leaks in places where cracks appear. A unit is functionally connected to the expansion barrel for filling and supplying sealant in case of cracks in the copper pipeline of the primary circuit. With a critical pressure drop in the air part of the expansion tank chamber due to antifreeze leakage in the event of a crack or damage to the heat-carrying copper pipes, the sealant enters the float chamber 26 from the tank through the pipeline. The chamber contains a float 28, which acts on the shut-off needle 27. When the sealant reaches the limit level in the float chamber 26, the float 28 presses the needle 27 to the seat, stopping the access of the sealant. If a vacuum (pressure reduction) occurs in the expansion tank due to a malfunction, then the sealant, sprayed, mixes with the circulating antifreeze. The circulating liquid at the leak site closes the crack with the help of a sealant by a chemical reaction. When the sealant level decreases, the float 28 descends and opens the access of the sealant to the chamber 26. The greater the sealant flow, the lower its level and the greater the flow area for the sealant is created between the needle and the seat 27. The end of the sprayer 24 is brought out into the narrowest part of the diffuser 22. Therefore

diffuser 22 increases the vacuum at the atomizer 24 that appears when damaged. The air pressure difference between the float chamber 26 and the diffuser 22 creates the conditions for leakage from the sprayer 24 of the sealant. Due to the chemical reaction in the places of cracks, micro-slits are closed and emergency leakage of antifreeze in the primary circuit of the solar water heater is prevented.

When solving the problems of ensuring the microclimate of premises, a wide variety of areas for accounting for climatic factors are determined. Almost all technical issues are related in one way or another to climate, taking into account weather conditions, temperature, radiation, wind and other characteristics. Engineers and technicians involved in indoor microclimate systems need to have a perfect knowledge of meteorology and climatology, which are an integral part of solving the problems of designing, building and operating communal systems, that is, all the necessary acquisition of which should be provided for in the programs of the new discipline *Communication (communal) climatology. Particular attention in the program should be given to the theory of geography, statistical and reference data of metrological stations in Azerbaijan.

IV. Conclusion

1. In research and design, higher and secondary technical educational institutions that work to improve solar water heating installations, it is advisable to expand the scope of research aimed at reducing the technological risks of emergencies and increasing energy efficiency in ensuring sanitary requirements and indoor microclimate.
2. In the curricula of higher and secondary technical educational institutions involved in the training of personnel in engineering and communication systems, to provide a new discipline “Communication (communal) climatology”.

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