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Stirling engine in residential heating systems

The problem of energy conservation and conservation of wildlife in the 21st century is acute for all of humanity. Most of the electricity today is produced by nuclear and thermal power plants. While the energy industry does not completely switch to the use of renewable energy sources, our task is to use electric energy as rationally and economically as possible.

Stirling engine in a solid fuel boiler.

At present, in the heating systems of private houses, the gravitational circuit for supplying the heat carrier is widely used (heating system with natural circulation). It is extremely inconvenient, cumbersome and difficult to build. Gradually, this type of system displaces a more convenient and less cumbersome construction scheme, using a circulation pump for transferring the coolant in the circuit (forced circulation system). The advantages of such a system include the fact that its operation requires a smaller volume of coolant and, accordingly, pipelines of smaller diameter. However, there are drawbacks.

The power of circulating pumps, which are used in modern boilers, is about 100 W. To operate the pump, it is necessary to expend electrical energy. In most boilers, the circulation pump receives power from the 220 V network. This leads to additional costs, which are related to the power consumption. In order to abandon the power supply, I propose to use the Stirling engine as a circulation pump drive.

In the course of the calculations, I considered two possible schemes for switching on the Stirling engine.

The first scheme involves placing the Stirling engine heater in the area of supply of the heat carrier heated in the boiler, and the cooler in the return region of the coolant.

The efficiency of the Stirling engine can be determined by the efficiency formula for the Carnot cycle:

$$\eta=(T_1-T_2)/T_1$$

Where T_1- the temperature of the heater, T_2 - the temperature of the refrigerator, η - the efficiency of the engine.

The flow temperature of the coolant in modern solid fuel boilers ranges from 343K to 363K. The return temperature should be at least 333K, to avoid condensation. ΔT is usually set within 15K.

Let's accept T_1=353K, T_2=338K. Then:

$$\eta=(T_1-T_2)/T_1=(353-338)/353=0,04=4\%$$

The second scheme of the engine installation assumes placing the engine heater in the furnace area and the refrigerator in the return area of the coolant.

The temperature in the furnace of a solid fuel boiler depends on many factors, such as the type of fuel, the technical characteristics of the boiler, etc. For calculations, let us take the average temperature T_1=1073K, T_2= 338K. Then:

$$\eta=(T_1-T_2)/T_1=(1073-338)/1073=0,68=68\%$$

From the foregoing, it can be concluded that the second scheme for switching the Stirling engine into the solid fuel boiler is much more efficient than the first, since the efficiency of the installation increases manifold.

Such a calculation is only valid if, in addition to the temperature in the system, there are no more determining parameters (the system is ideal). In practice, many other thermodynamic parameters must be considered, one of which is the heat transfer coefficient α. It can be determined by the Newton-Richman formula:

$$Q=\alpha*F*\Delta T$$

Where Q is the amount of heat that is diverted from a surface having an area F. ΔT is the temperature head (the modulus of the temperature difference between the surface of the body and the liquid).

In practice, in order to obtain the most accurate results, it is best to use an average heat transfer coefficient α, calculating it using the formula:

$$\alpha=Q/(F*\Delta T)$$

Where average temperature values for the surface of the body and liquid are used to find the temperature head.

Based on the above calculations, we can conclude that the use of the Stirling engine solid fuel boilers is a promising direction in the work to improve modern heating systems. The given decision will allow to refuse use of a household electric system for maintenance of correct work of some types of systems of heating.

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