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КӨЛІК – ЭНЕРГЕТИКА ФАКУЛЬТЕТІ

«КӨЛІК ЖӘНЕ ЭНЕРГЕТИКАНЫҢ ӨЗЕКТІ МӘСЕЛЕЛЕРІ: ИННОВАЦИЯЛЫҚ ШЕШУ ТӘСІЛДЕРІ» IX ХАЛЫҚАРАЛЫҚ ҒЫЛЫМИ-ТӘЖІРИБЕЛІК КОНФЕРЕНЦИЯСЫНЫҢ БАЯНДАМАЛАР ЖИНАҒЫ

СБОРНИК МАТЕРИАЛОВ IX МЕЖДУНАРОДНОЙ НАУЧНО – ПРАКТИЧЕСКОЙ КОНФЕРЕНЦИИ: «АКТУАЛЬНЫЕ ПРОБЛЕМЫ ТРАНСПОРТА И ЭНЕРГЕТИКИ: ПУТИ ИХ ИННОВАЦИОННОГО РЕШЕНИЯ»

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В сборник включены материалы IX Международной научно – практической конференции на тему: «Актуальные проблемы транспорта и энергетики: пути их инновационного решения», проходившей в г. Нур-Султан 19 марта 2021 года.

Тематика статей и докладов участников конференции посвящена актуальным вопросам организации перевозок, движения и эксплуатации транспорта, стандартизации, метрологии и сертификации, транспорту, транспортной техники и технологии, теплоэнергетики и электроэнергетики.

Материалы конференции дают отражение научной деятельности ведущих ученых дальнего, ближнего зарубежья, Республики Казахстан и могут быть полезными для докторантов, магистрантов и студентов.

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HEAT ENGINE FOR CONVERTING SOLAR ENERGY INTO MECHANICAL AS AN EFFICIENT WAY TO PRODUCE IT

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Abstract. The research is important to solve the energy producing problem in the field of energy supply. The paper introduces the new model (scheme) of heat engine for converting solar into mechanical energy and demonstrates its working process. The aim of the article is to show the machine's complete safety for the environment and the prospects, availability, inexhaustibility of the energy source. Much attention is given to develop the structure of engine scheme. And to provide theoretical concepts the device was analyzed in details. The results have shown that the machine efficiently converts solar into mechanical energy by moving the piston. Quantitative results also have shown that the device does not interfere with functioning. Summing up, it can be concluded that the new model of heat engine can be used in practice.

Key words: heat engine, solar energy, mechanical energy, energy conversion.

Introduction. Conversion of solar radiation energy into heat (using a thermodynamic cycle that leads to the movement of an electric generator) which can be used for immediate consumption of solar energy or for generating electricity, is a profitable way to supply consumers with different levels of energy depending on its simplicity. Interest in this area of solar energy using has been growing all over the world in recent years. Solar energy can be converted into thermal, mechanical, and electrical energy, and used in chemical and biological processes. Solar energy in heating and cooling systems of residential and public buildings, installations that modify occurring at low, medium, high temperatures are used in technological processes [1].

Despite all the benefits of solar energy, its use is the most expensive by far. Therefore, it is necessary to improve existing solar energy conversion technologies in order to increase efficiency and reduce costs.

The aim of the study is to develop the new model of a heat engine for converting solar into mechanical energy and to show complete safety for the environment and the prospects, availability, inexhaustibility of the energy source.

The novelty of this paper is the new model (scheme) of converting solar energy into mechanical energy.

Expected outcomes. By the novelty of this research, we can increase the output power and efficiency of heat engines.

Theoretical value. This research will make a contribution to the energy field and can be used as a source for other researches.

Practical value. This paper can be used by researchers and engineers who work in the solar energy field.

Theoretical analysis. Until today scientists continue to prove that solar energy as a low-potential source is a worthy competitor to traditional energy sources. In this way, the above-listed advantages of solar radiation which is known as an alternative energy source extensively show the future prospects of solar energy.

Over the years, much research have been conducted to efficiently store solar energy and convert it into electrical or mechanical energy. In this regard, the implementation of various types of integrated photovoltaic systems (IPV), integrated photovoltaic-thermal systems (IPVT), solar collector and concentrate concentrator can be considered remarkable and applied works [2-5]. But these engineering technologies for converting solar energy into other types have a number of disadvantages such as complexity of the design, low power generation, need for huge territories, expensive construction materials and etc. So researches should continue to improve these "minuses".

A combination of two or more thermodynamic cycles can be used in practice to increase the efficiency of the heat exchange process in heat engines. Currently, there are different types of thermoelectric materials [6] that convert heat into electrical energy, but their output power and their efficiency are extremely low [7]. This clause prevents their use in most industrial applications. Electrochemical heat engines are other devices that convert heat energy into electrical energy [8]. Despite the income from using TREC (thermally regenerative electrochemical cycle) heat engines have not lost their value: they are environmentally efficient compared to electrochemical systems and easy to design and maintain. Therefore, to convert solar energy into work or electrical energy it is necessary to proceed using heat engines. Here it is necessary to research ways to increase the efficiency of heat engines which would increase their competitiveness.

Research process. The diagram of a heat engine for converting solar energy into mechanical energy is shown in figure 1. It has two mechanical devices N_1, N_2 – crank mechanisms with a centrifugal pump. They turn the translational movement of the cylinder rod into the rotational movement of the pump blades. The pumps drive the coolant in right and left pipelines. Moreover, the velocity of the liquid v is always directed clockwise regardless of the direction of movement of the rod. When a piston moving up the valves k_1, k_4 are open, and the valves k_2, k_3 are in the closed position. When a piston moving down the valves k_1, k_4 are in the closed position, and the valves k_2, k_3 are open. Switching valves occurs when the piston reaches the upper and lower extreme points.

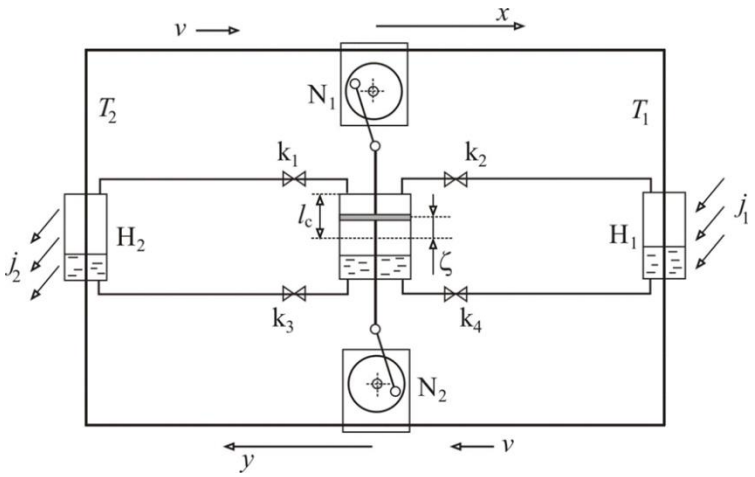

Figure 1 - The scheme of the heat engine

Thermostats H_1 and H_2 are in good thermal contact with the pipelines and they simultaneously generate steam or transfer it to a liquid state depending on the temperature.

The pressure in a cylindrical chamber depends exponentially on the temperature. Relatively small changes in temperature can lead to a significant increase in pressure over a short period of

time and, as a result, the same increase in the speed of the piston. Therefore, a steady and smooth movement of the piston requires a resistance force. In this model, this force is taken into account by the coefficient k and the factor $d\zeta/dt$.

The Euler-Kramer method with the second precision mode is used to solve the equations. The full program code for digital simulation of the entire machine was written in C++.

The operation of the thermoregulation system depends on the geometric dimensions of the chamber and the physical properties of the light boiled liquid. A cyclopentane (C_5H_{10}) uses as a coolant. Its molecular weight μ=0,07 kg/mol, pressure is 760 mm Hg in T_b=49,26 °C, phase transition heat L=391kJ/kg, density ρ=726 kg/m^3.

Below in figures 2-4 the results of modeling a thermomechanical system with a coolant cyclopentane (C_5H_{10}) are presented.

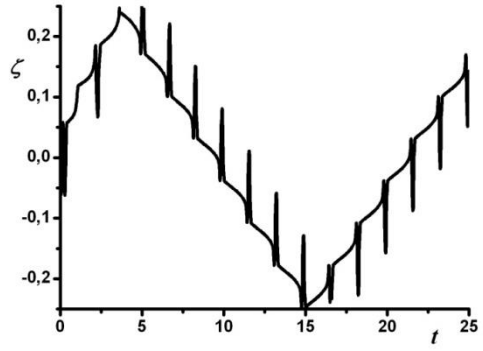

Figure 2 - Time dependence of ζ

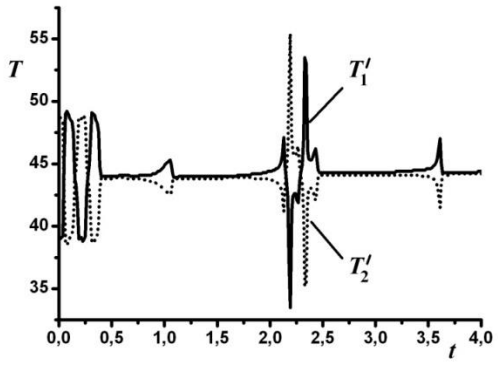

Figure 3 - Time dependence of T_1' and T_2' (°C)

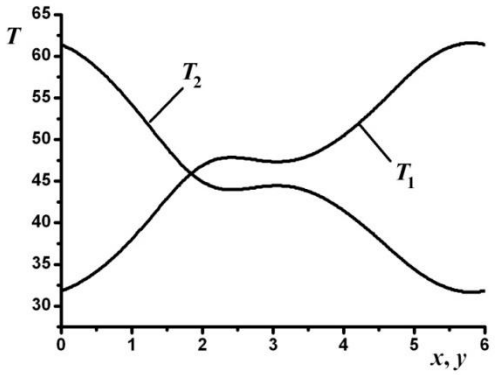

Figure 4 - Temperature distribution (°C) along the pipeline contour at time t=25 sec

At the entire calculation stage strong and almost periodic fluctuations in the pressure in the chamber are observed (figure 3), the piston (figure 2) and the speed of the coolant. Similar fluctuations occur at each fixed point of the pipeline contour, in particular, at the locations of thermostats (figure 3).

The convergence of T_1' and T_2' (figure 3) means heating the cold part of the system and a relative slight cooling of the hot part. That is the thermoregulation system as a whole performs its function.

Figure 4 shows the spatial distribution of the coolant temperature along the system contour at time t=25 s.

According to the selected reference points of the *x, y* coordinates, the final temperature value T_1 (x=6) corresponds to the initial temperature value T_2 (y = 0). Conversely, the final value of T_2 (y=6) corresponds to the initial value of T_1 (x=0). Thus in figure 4 shows the distribution of the coolant along the closed pipeline line of the thermoregulation system. In due time this shows its working ability.

Rapid changes in pressure and temperature can occur in the machine but they are small in amplitude: pressure differences are at the level of 20-30 kPa and this cannot lead to emergency consequences.

Conclusion. As mentioned in theoretical analysis chapter currently only a tiny fraction of solar energy is used due to the fact that existing converters have a relatively low efficiency and they are very expensive to produce. However, we should not immediately give up an almost inexhaustible source of a clean energy. The review of modern methods of converting heat energy with a low potential was conducted in this paper. Whereas the aim of this research was to develop the new scheme of a heat engine for the production of useful work from the solar energy, it is proposed in this paper in research process chapter. A model of operation of this machine and a software code for solving the model equations has been developed. Then the necessary analysis was carried out, its efficiency was shown. Rapid changes in pressure and temperature can occur in the machine but they are small in amplitude and this cannot lead to emergency consequences. The machine can be used in practice.

Solar energy could cover all the imaginable energy needs of mankind for thousands of years to come. Therefore, the overall share of solar energy was and will remain quite modest, at least in the foreseeable future. In order for solar energy to be competitive there needs to be research to increase battery capacity and power, more research into the concentration of solar rays on panels in order to increase their efficiency and reduce the payback period. The rapid development of solar energy with the use of innovative global technologies is the main competitor and in 2050 will prevail in the market of energy-friendly technologies which will provide all the needs of the population with electric energy by the end of the century.

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ИССЛЕДОВАНИЕ ИСТОРИИ РАЗВИТИЯ ЭЛЕКТРОСНАБЖЕНИЯ ОТ АЛЬТЕРНАТИВНЫХ ИСТОЧНИКОВ

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Подготовка молодых кадров имеет огромное значение для нашей республики. В настоящее время в свете последних решений руководства необходимо обращать внимание на межпредметную связь. Ранее многие ППС при чтении лекций и проведении практических занятий старались связывать материал с текущими предметами. Однако, жизнь требует от молодого специалиста при написании научной статьи рассматривать материал не только в предметном аспекте, а уметь увязать с проблемами сопутствующих предметов: где мы находимся, какую нишу занимаем, какова история развития науки отрасли, по которой бакалавр, магистрант получает образование.

В данной статье автор отразил развитие перспектив использования зеленой энергетики для энергообеспечения небольших предприятий и аграрного сектора отдельных регионов страны.

Экологические проблемы планетарного уровня и вероятная перспектива истощения топливных и энергетических ресурсов Земли вызывают всемирный рост новой энергии на основе широкого использования возобновляемых источников энергии планеты: солнечной радиации, ветра, потоков воды, геотермальной энергии и т.д. А солнечная энергия на данный момент является самой перспективной. За рубежом строятся СЭС огромных масштабов, покрывают солнечными батареями крыши домов в частных секторах. Солнечная энергия питает многие портативные устройства [1].

Эти тенденции также отражены в Энергетической стратегии Казахстана на 2030 год. Стратегические цели использования возобновляемых источников энергии и местного топлива определенные в этом документе:

- уменьшение загрязнения природы и атмосферы, где это необходимо, для удовлетворения растущего потребления энергии;
- сокращение потребления ресурсов и добычи. Расход нефти, угля и неизбежное истощение его запасов;
- защитить людей от вредных выбросов за счет сокращения землепользования и снижения расходов на здравоохранение;
- снижение затрат на транспортировку электроэнергии и нефти;
- переход на новые виды источников энергии и отказ от традиционных ресурсов.

повышение надежности энергии, и ее передачи, благодаря внедрению новых технологий [2].

Согласно текущим оценкам, технический ресурс возобновляемых источников энергии (большинство из которых могут быть использованы в солнечной и ветровой энергии) составляет не менее 4,5 млрд. тонн условного топлива в год. Экономический потенциал