A Device for Electricity Generation Using Alternative Renewable Energy Sources

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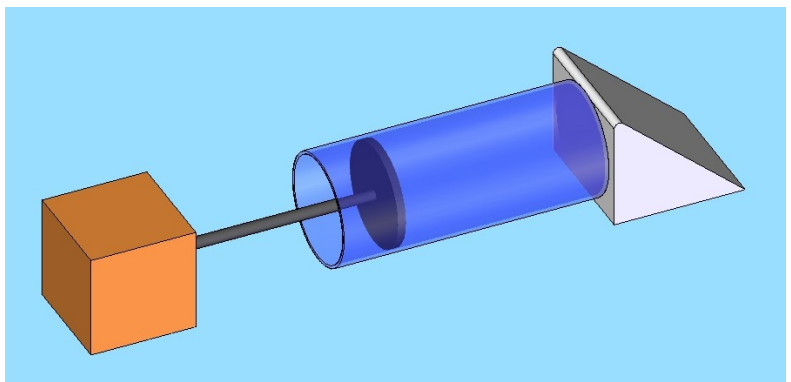
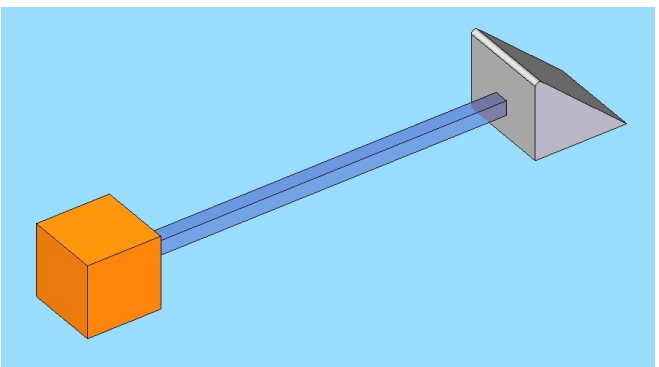
- **Abstract.** This study is devoted to developing a new method of electricity generation using an alternative source of renewable energy. It is obvious that day and night temperatures are different. This difference forces matter to expand and contract periodically. The forces arising from the everyday thermal expansion and contraction of solid and liquid materials can be considered such a source. Based on this phenomenon, the possibilities of creating an electricity-generating device are discussed hereon. Theoretically, it is possible to design a machine using solely solids or liquids, but this requires materials and high-volume vessels that can sustain extremely high pressures and mechanical loads and the accuracy of the details should be very high, which would lead to exorbitant costs. A combined model allowing a reduction in costs is discussed in this work. The constructional dimensions and the principle of functioning of a prototype that can produce *100 kWh* are presented. The techniques explored to develop more powerful machines using this novel method are attractive in light of renewable sources of energy.

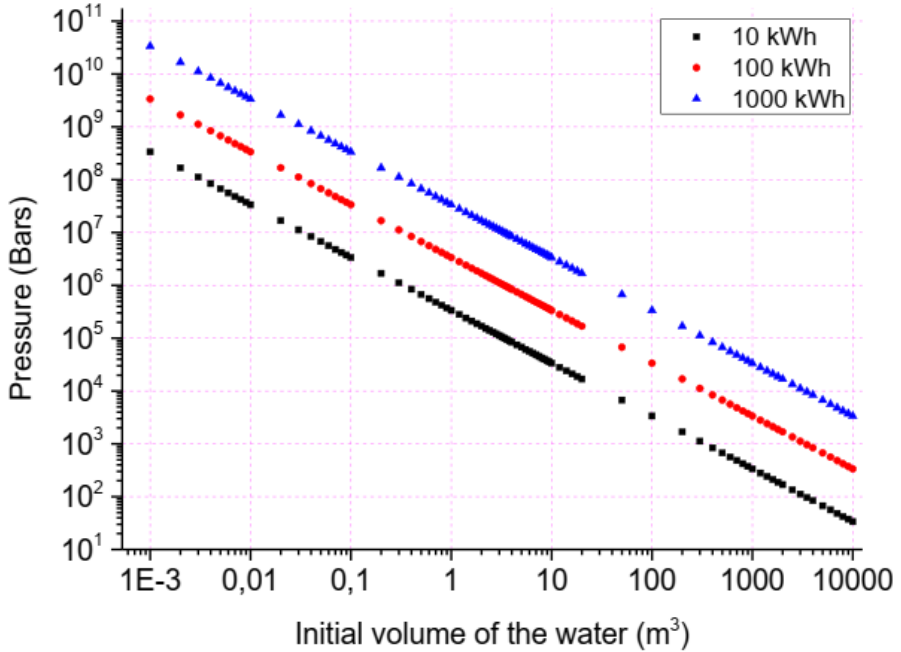
- Human development depends on energy consumption. A major part of consuming energy is produced using natural fuel today. On the one hand, we are depleting natural resources, while on the other, we are devastating the ecology. The estimated share of renewable energy in global electricity production was 26.2% at the end of 2018 according to a report. Existing renewable sources cannot be used everywhere and at all times due to the limitations of their origin and the principles on which their devices operate. Thus, a quest for new renewable sources of energy is encouraged.
- Huge forces can arise from the thermal expansion and contraction of liquid and solid matter. Finding ways to use these enormous forces to produce useful energy is the aim of our investigation.
- The work performed by liquid (Figure in the left) and solid (Figure in the right) thermal expansion can be expressed as moving the load respectively.





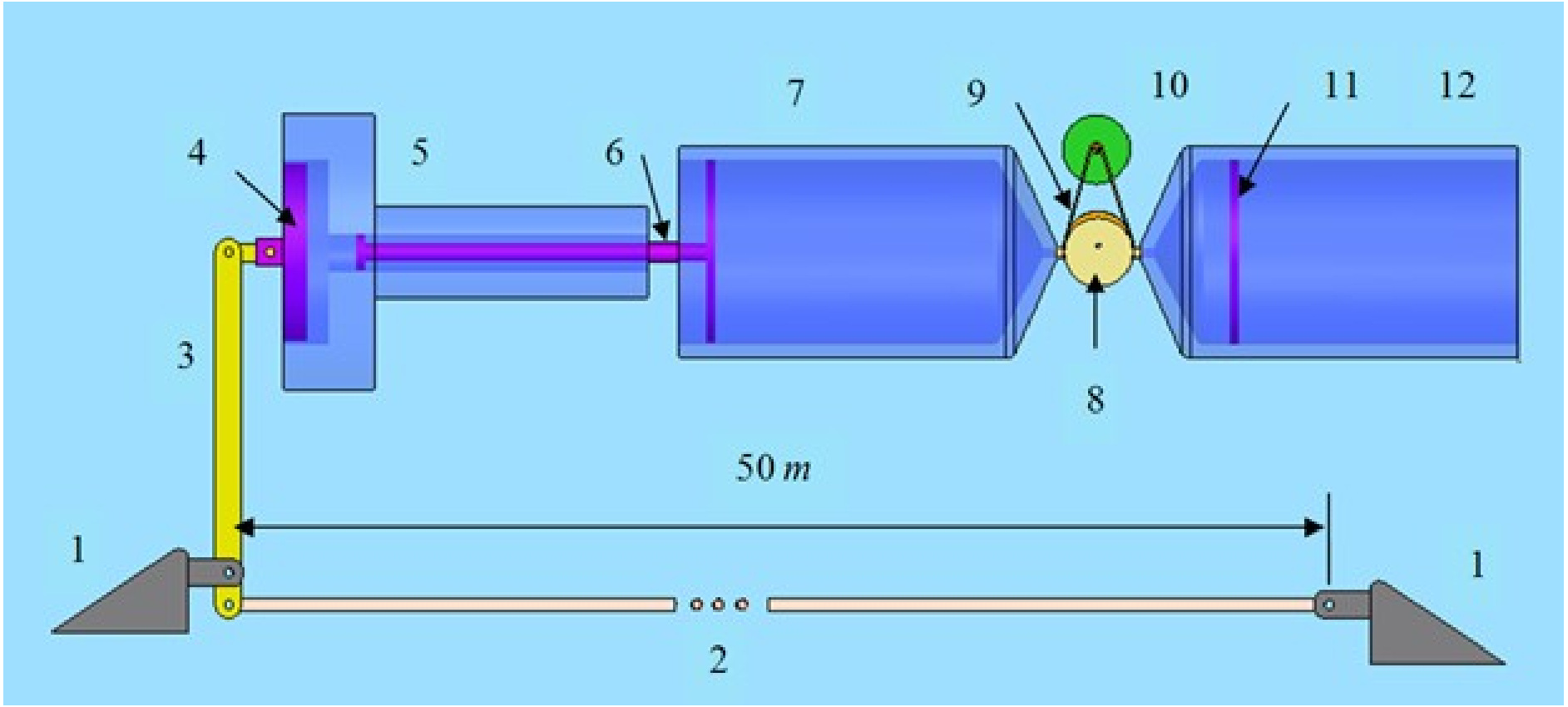
Use of liquid expansion

- The work performed is $W=PV_0\beta\Delta T$, where $\Delta V=V_0\beta\Delta T$. Figure shows the relationship between the pressure and the initial volume of the liquid in the cylinder for the devices of 10, 100 and 1000 kWh power, calculated using the last equation, where the volume expansion coefficient is $\beta = 2.14\cdot10^{-4}\ ^oC^{-1}$ and $\Delta T=50\ ^oC$. As it can be seen from the Figure, that setting up vessels with such volume to hold the stated pressures is not feasible while considering the recovery of costs. Moreover, it was experimentally determined in our previous work that liquid works well in expansion, but its performance is less than desirable in the contraction process owing to the weak attractive forces between liquid atoms.



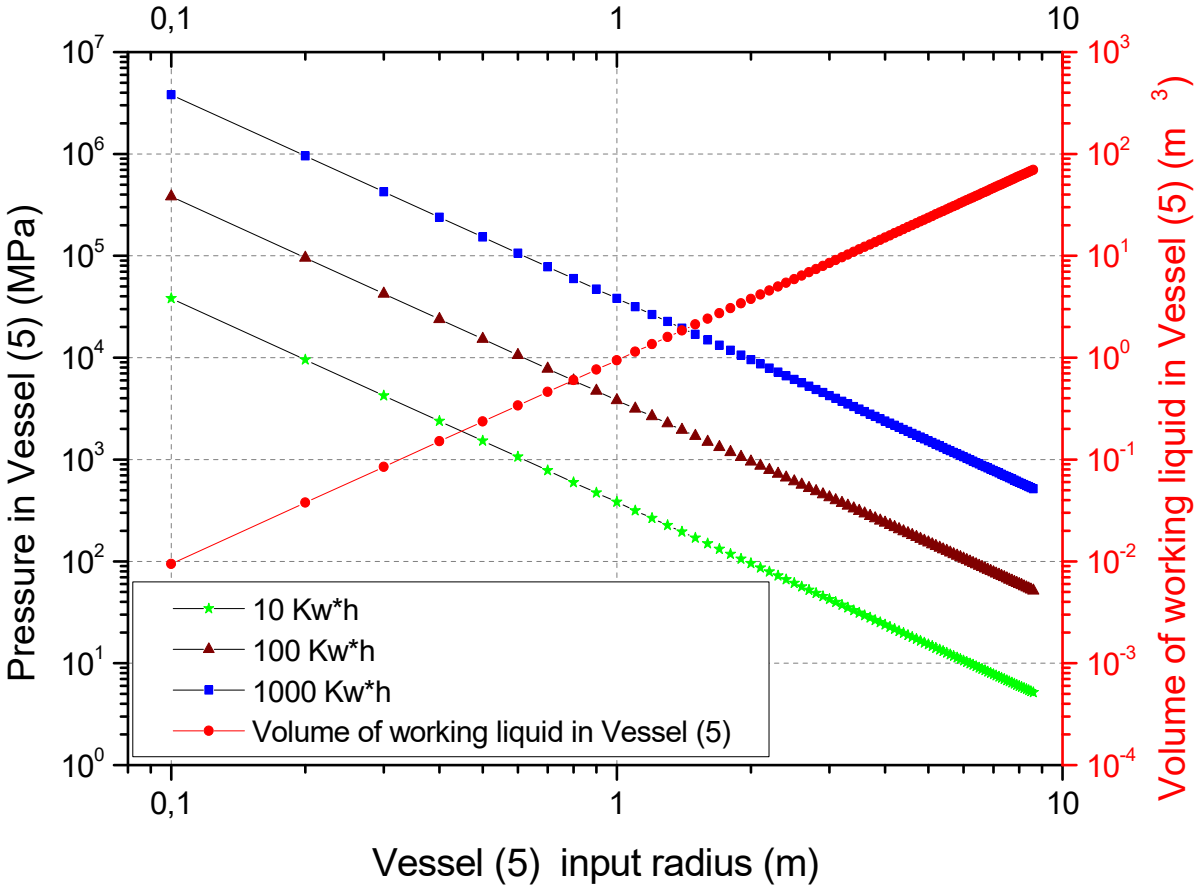
Use of solid expansion

- The work done is expressed by Equation $W=F\Delta l$. The linear expansion is defined as follows $\Delta l=\alpha L_0\Delta T$, where $\alpha=12\cdot10^{-6}\ ^oC^{-1}$ is the linear expansion coefficient of steel, L_0 is the initial length of the steel rod and ΔT is the change in temperature. Now, work can be written as follows: $W=F\alpha L_0\Delta T$.
- The main problem is how to accelerate the slow motion of the end of the steel rod by thermal expansion. The device that can solve this problem is suggested in this work.



- CAD of the device. 1 – towers, 2 – steel rod, 3 – first-class lever system, 4 – high-pressure piston, 5 – high–pressured vessel, 6 – two-side piston, 7 – low-pressure cylinder, 8 – transducer, 9 – gear train, 10 – generator, 11 – free-moving piston, and 12 – reservoir.

- The dependence of the pressure (for different powers) and volume of the working liquid on the input radius of the vessel (5) is presented in Figure. The pressure can be decreased by increasing the radius at the input but this will lead to an increase in the volume of the working liquid. For example, increasing the input radius twice decreases the pressure four times and increases the volume of the working liquid four times.
- The working liquid in the high-pressure vessel (5) and low-pressure cylinder (7) performs additional work by thermal expansion and provides extra power. Such a supplementary power can help compensate for the losses and increase the efficiency of the device.



- Dependence of the pressure (for different powers) and volume of the working liquid on the input radius of the vessel (5).

CONCLUSIONS

- Setting up the device using solely the liquid thermal expansion and contraction phenomena requires high-volume vessels that should be able to sustain very high pressures, which is expensive and difficult to realize. In the case of using the thermal expansion and contraction of only solid material, the problems will include their small coefficients of thermal expansion compared to liquids, the impossibility of using the volume expansion, and very slow displacement velocity, which is difficult to accelerate. If both liquid and solid materials are used in combination, one can find reliable and cost-effective compromise variants of the device for different magnitudes of power.
- The principle of the working of the device, designed using both solid and liquid materials, is presented. The small but powerful displacement will be transformed into high pressure and this pressure is transformed into liquid flow through the transducer. The latter transforms the flow into a circular motion and transfers this to the generator, which produces the electricity.
- The new type of device, which uses a renewable energy source, requires high pressure vessels. The pressure in the vessel (5) can be reduced by increasing its diameter: if the radius r_1 input increases twice, the pressure P_1 decreases four times. On the other hand, decreasing the pressure leads to the increased volume of the working liquid, which is related to energy losses.
- As the processes of thermal expansion and contraction are very slow, transforming them into fast enough linear or circular motion requires modern and very accurate techniques. It is important to find the optimal and compromise values of multiple operating parameters, such as the length of the steel rod, the pressures in the vessel (5) and in the low-pressure cylinder (7), the diameters of the vessels, the volume of working liquid, the flow rate, and the speed of angular velocity of the shaft of the generator in creating the new type of renewable energy source. However, such a complex task can be simplified noticeably if we develop the high-pressure and high-volume cylinders: the power of the device is in direct proportion to the pressure, which can be sustained by the system. So, by increasing the pressures in the vessel (5) and cylinder (7) by 10 times, the same device can generate 1000 kW energy per hour.