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Generation of Electricity by Stirling Engine from Sunlight's Heat

[1] Nabeel Habeeb, [2]Athul Thomas , [3]Jimmy George, [5]Jibin P Joy , [5]Jerry T. Kurian, [6]Mr Sreenadh B
[6]Assistant proffessor of Electrical and Electronics Engineering
Amal Jyothi College of Engineering,Kanjirappally
[1] nabeelhabeeb93@gmail.com, [3]jibinjoyayur007@gmail.com, [5]jerrytkurian@gmail.com

Abstract: **The Solar energy is a green and cheap resources available to us. But its use is not deployed to the maximum. In another perspective, it is only confined to photovoltaic generation systems. This paper explains about a Stirling engine run by sunlight's heat. Hence when an alternator is coupled to this engine electricity is generated. A Stirling engine is basically a heat engine that operates by cyclic compression and expansion of air or other gases, the working fluid, at different levels such that there is a net change in heat transfer which will produce the mechanical work. Stirling engine uses only two pistons for operation. The heat energy from sun is concentrated by a computer controlled dish collector which uses a mirror or Fresnel lens. This Stirling engine is coupled with a generator to produce electricity. The generator used here is a linear alternator. Linear alternators contain less moving parts. Provision for storing sunlight's heat is implemented when it is not available is by using salt storage system. Another alternative for providing heat when sunlight is not available is by heating up the household or domestic wastes. It has the ability to use any burnable fuel like wood, straw, agricultural wastes other cheap and readily available combustibles. The reason behind this is that Stirling engine is sensitive to heat energy. Stirling engine has high efficiency (40%). Also it is noted for its quiet operation and less maintenance. It is important to switch to non-conventional energy resources as there is price hike and scarcity of conventional source. Sunlight powered Stirling engine generator has the capability of becoming an non-conventional energy generation.**

I. INTRODUCTION

One of the ways of meeting increasing demand of power is by producing power ourselves without depending on government. We can even sell excess of electricity if connected to the grid. This paper focusses on the self-generation of electricity by making use of solar powered stirling generators.

We were depending on conventional fuels such as coal, diesel, nuclear for meeting increasing power demand. Coal, which is the major resource for power production will last hardly for another 155 years. So, we need to find another alternative fuel for production of power. The everlasting and clean source of energy production is from solar power. Here comes the importance of Solar Powered Stirling engines.

A Stirling engine is a heat engine operating by cyclic compression and expansion of air or other gas, the working fluid, at different temperature levels such that there is a net conversion of heat energy to mechanical work or more specifically, a closed-cycle regenerative Heat engine with a permanently gaseous working fluid, where closed-cycle is designed as a thermodynamic system in which the working fluid is permanently contained within the system, and regenerative describes the use of a specific type of internal heat exchanger and thermal store, known as the regenerator. It is the inclusion of a regenerator that differentiates the Stirling engine from other closed cycle hot air engines. This motor does not have parts like

STATOR or ROTOR but it has just a piston, cylinder a displacer which produces the motoring action, which will be coupled with an alternator to produce power. The suns energy is focused using Solar Beam Concentrator. One Solar Beam Concentrator can produce peak 10 kW/hour. If we focus an average of 8 hours of sun per day, you would achieve 80 kW power generation in a day.

II. SOLAR STIRLING ENGINE GENERATORS.

A solar Stirling Engine (or Hot Air Engine) takes advantage of the fact that concentrated sunlight is a fantastic heat source, and as such can be used to generate electricity more efficiently than photovoltaic solar panels. The Stirling Engine was developed in order to offer an alternative to the frequently explosive early steam engines. Basically a closed cylinder containing a piston and helium, nitrogen or hydrogen gas is heated at one end by concentrated sunlight, and cooled at the other end by air or water

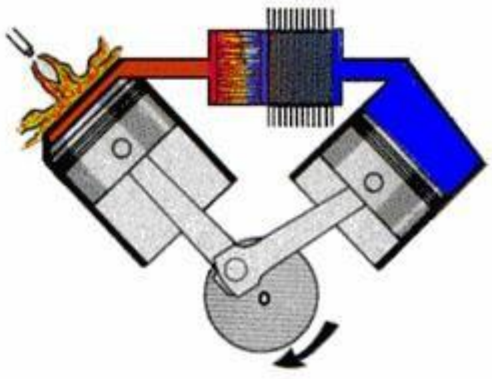


Fig 1 . Stirling Engine.

As the gas expands and cools with the movement of the piston, a generator can be driven to produce electricity. (If the engine is run in reverse then it produces a cooling effect acting as a 'Stirling cooler'.)

With a Stirling engine combustion occurs outside the engine which made it much safer and less likely to explode. Stirling Engines did not catch on in the nineteenth century because of the costs of manufacture despite exceptional efficiency of almost 50% in some cases.

III. OPERATING PRINCIPLE.

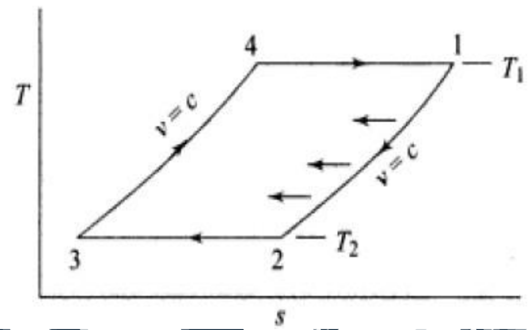
Stirling engine works on the principle of stirling cycle. The idealized Stirling cycle consists of four thermodynamic processes acting on the working Fluid:

1Isothermal Expansion. The expansion-space and associated heat exchanger are maintained at a constant high temperature, and the gas undergoes near-isothermal expansion absorbing heat from the hot source.

2. Constant-Volume (known as isochoric) heat-removal. The gas is passed through the regenerator, where it cools, transferring heat to the regenerator for use in the next cycle.

3. Isothermal Compression. The compression space and associated heat exchanger are maintained at a constant low temperature so the gas undergoes near-isothermal com- pression rejecting heat to the cold sink.

4. Constant-Volume (known as isovolumetric or isochoric) heat-addition. The gas passes back through the regenerator where it recovers much of the heat transferred in 2,heating up on its way to the expansion space.



While considering the practical cycle, we can explain this engine working in the following manner:

Process 1 : The first step is an isothermal expansion process. The expansion-space and associated heat exchanger are maintained at a constant high temperature, and the gas undergoes near-isothermal expansion absorbing heat from the hot source. Most of the working gas is in contact with the hot cylinder walls, it has been heated and expansion has pushed the cold piston to the bottom of its travel in the cylinder. The expansion continues in the cold cylinder, extracting more work from the hot gas

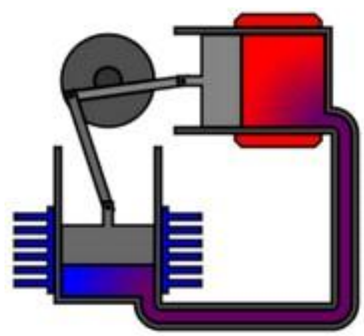


Figure 2: Gas at hot end(red cylinder) expanding isothermally by absorbing heat from the source

Process 2 : The second step is constant volume(known as isochoric) heat removal. The gas is passed through the regenerator, where it cools transferring heat to the regenerator for use in the next cycle. The gas is now at its maximum volume. The hot cylinder piston begins to move most of the gas into the cold cylinder (refer fig 3),where it cools and the pressure drops.

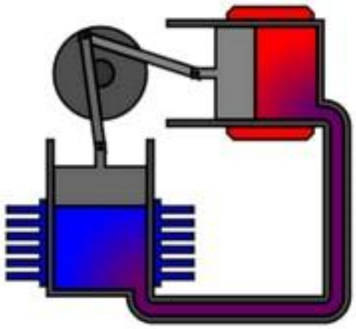


Fig 3 : Gas moving from hot end to cold(blue cylinder) end at constant volume.

Process 3: The third process is Isothermal Compression. The compression space and associated heat exchanger are maintained at a constant low temperature so the gas undergoes near-isothermal compression rejecting heat to the cold sink. Almost all the gas is now in the cold cylinder and cooling continues(refer fig 4). The cold piston,powered by flywheel momentum (or other piston pairs on the same shaft) compresses the remaining part of the gas.

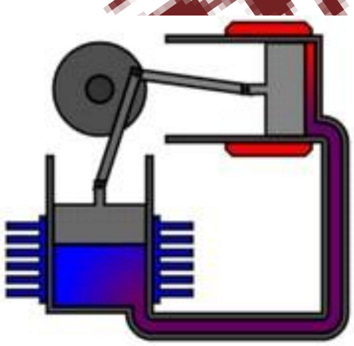


Fig 4: Isothermal compression of the gas from cold end to hot end

Process 4 : The fourth process is Constant Volume (known as isochoric)

Heat addition. The gas passes back through the regenerator where it recovers much of the heat transferred in isovolumetric heat removal, heating up on its way to the expansion space. The gas reaches its minimum volume, and it will now expand in the hot cylinder (refer fig 5) where it will be heated once more, driving the hot piston in its power stroke.

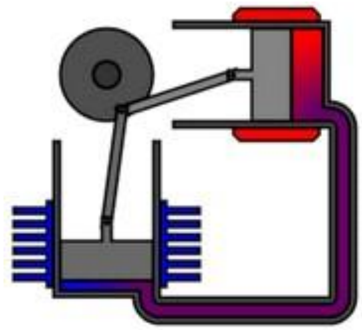


Fig 5 Gas expanding isochorically in hot end

CONCLUSION

This paper discusses about the importance of stirling engines for producing electricity from solar power. This invention could really change the world because the current method of delivering electricity is extremely insufficient. A new power plant will typically burn natural gas, but there are a lot of losses between the power station and your house. It would be much more efficient to generate the power at your house by making use of renewable sources. Thus we can be generating power on our own and atleast compensate our additional needs thereby sharing the power with our neighbours and leaving way for the future generations to make use of the resources because ENERGY SAVED IS ENERGY PRODUCED. This is an eco-friendly power production and it can be said that Stirling engine is a "extra green, extra quiet, extraordinary."

ACKNOWLEGMENTS

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