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Sterling External Combustion Engine Solar Parabolic Collector

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INTRODUCTION

In sterling external combustion engine solar parabolic collector we are using two equipments that's way we have to learn about those two things

Those are,

- Sterling engine
- Solar parabolic collector

1.1 STERLING ENGINE:

A Sterling engine is a heat engine that operates by cyclic compression and expansion of air or other gas (the working fluid) at different temperatures, such that there is a net conversion of heat energy to mechanical work. More specifically, a closed-cycle regenerative heat engine with a permanently gaseous working fluid. Closed-cycle, in this context, means 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.

The inclusion of a regenerator differentiates the Sterling engine from other closed cycle hot air engines. Originally conceived in 1816 as an industrial prime mover to rival the steam engine, its practical use was largely confined to low-power domestic applications for over a century. The Sterling engine is noted for high efficiency compared to steam engines, quiet operation, and its ability to use almost any heat source. This compatibility with alternative and renewable energy sources has become increasingly significant as the price of conventional fuels.

2.1 STERLING ENGINE:

Here we need to discos a brief history of sterling engine and the development of that engine in this world.

2.1.1 Invention and early development:

The Sterling engine (or Sterling's air engine as it was known at the time) was invented and patented by Robert Sterling in 1816. It followed earlier but was probably the first put to practical use when, in 1818, an engine built by Sterling was employed pumping water in a quarry. The main subject of Sterling's original patent was a heat exchanger, which he called an "economizer" for its enhancement of fuel economy in a variety of applications. The patent also described in detail the employment of one form of the economizer in his unique closed-cycle air engine design in which application it is now generally known as a "regenerator".

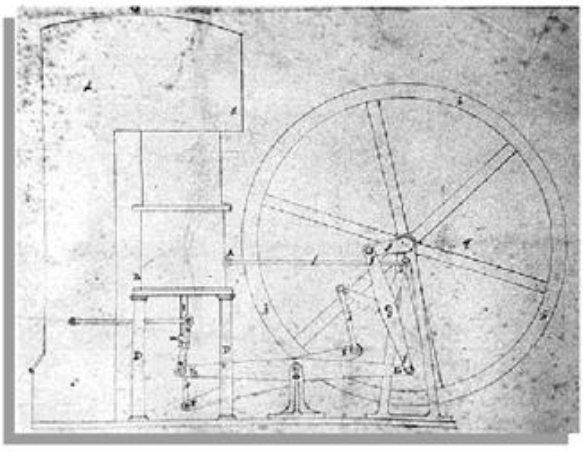

Figure 2.1: Illustration from Robert Sterling's in 1816

Subsequent development by Robert Sterling and his brother James, Though it has been disputed, it is widely supposed that as well as saving fuel, the inventors were motivated to create a safer alternative

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to the steam engines of the time,[15] whose boilers frequently exploded, causing many injuries and fatalities. The need for Sterling engines to run at very high temperatures to maximize power and efficiency exposed limitations in the materials of the day, and the few engines that were built in those early years suffered unacceptably frequent failures (albeit with far less disastrous consequences than a boiler explosion) — for example, the Dundee foundry engine was replaced by a steam engine after three hot cylinder failures in four years. The distribution of the total duration of bright sunshine in India ranges form 2500 to 3600hrs/Year. The global solar radiation of nearly 27 MJ/m²/day is available on a horizontal surface over arid and semi arid regions. During monsoon and winter months the global solar radiation falls to 10 to 20 MJ/m²/day. Nearly 10% of area of the country receives global radiation exceeding 20 MJ/m²/day and about 70% of the area 17 to 20 MJ/m²/day. These are favorable regions for harnessing solar radiation. The desert zones of the earth are having highest insulation. Arid and semi arid regions of the country comprise 10% and 30% respectively of the area of the whole country.

The average solar radiations (MJ/m²/day) in some cities in India are given.

STATION	WINTER DEC-FEB	SUMMER MAR-MAY	MONSOON JUN-SEP	POST MONSOON OCT-NOV
PUNE	19.2	25.2	18.2	18.3
CHENNAI	18.9	24.3	19.9	16.6
KOLCUTTA	15.7	21.6	16.4	16.1
NEW DELHI	15.2	24.1	20	17.6

Table 2.1 The average solar radiations (MJ/m²/day) in some cities in India are given.

HEAT ENGINE

In thermodynamics, a heat engine is a system that converts heat or thermal energy to mechanical energy, which can then be used to do mechanical work. It does this by bringing a working substance from a higher state temperature to a lower state temperature. Heat engines are broadly classified in to two types those are,

- Internal combustion engine
- External combustion engine

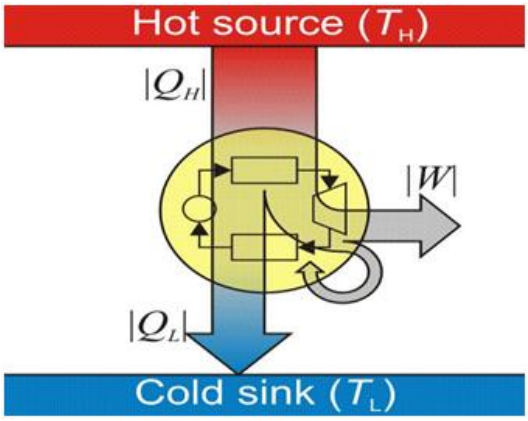

Figure 4 HEAT ENGINE

3.1 Internal combustion engine:

Internal combustion engines (ICEs) are so named because the combustion occurs internally inside the engine (intuitive). For example, gasoline engines of the Otto cycle design used in motorcycles, lawnmowers, and automobiles. Another characteristic of internal combustion is the action of expanding gases contacting the internal engine parts directly to produce mechanical action from the chemical energy of the fuel.

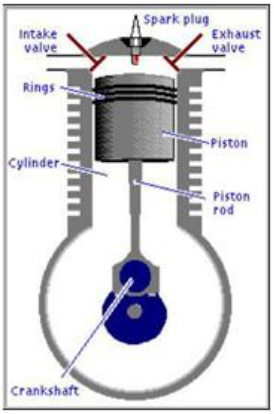

Figure 4.1 STERLING ENGINE

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3.1.1 WORKING:

There are only two strokes involved namely the compression stroke and the power stroke, they are usually called as upward stroke and downward stroke respectively. A Stirling engine is a heat engine that operates by cyclic compression and expansion of air or other gas (the working fluid) at different temperatures, such that there is a net conversion of heat energy to mechanical work. There are two major types of Sterling engines that are distinguished by the way they move the air between the hot and cold sides of the cylinder:

1. The two piston alpha type design has pistons in independent cylinders, and gas is driven between the hot and cold spaces.

2. The displacement type Sterling engines, known as beta and gamma types, use an insulated mechanical displacer to push the working gas between the hot and cold sides of the cylinder. The displacer is large enough to insulate the hot and cold sides of the cylinder thermally and to displace a large quantity of gas. It must have enough of a gap between the displacer and the cylinder wall to allow gas to flow around the displacer easily.

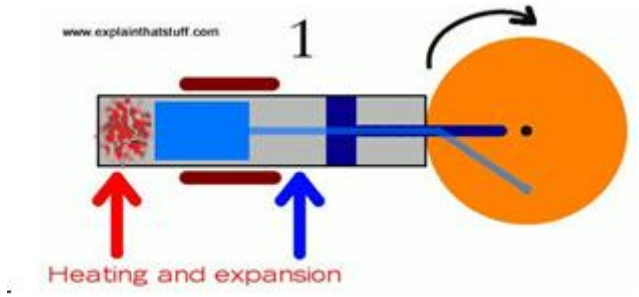

Figure 6.4 isothermal compression d. Isochoric heat-addition:

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.

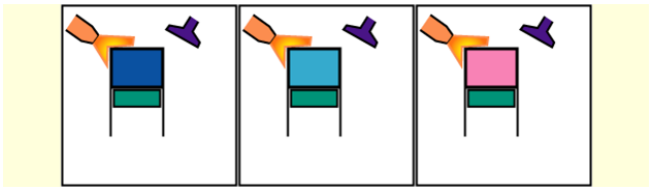

Figure 6.5 isochoric heat addition

7.1.2 THE DISPLACER FUNCTION:

The realization of an engine such as the one described above would be difficult : kindle the burner, extinguish it, sprinkle, then stop cooling, with many successive thermal shocks….

This is why one will introduce an artifice providing solutions to these problems: the displacer. This last modifies neither the pressure nor the volume of gas, but requires it to be nearthe hot source located at the top, or near the cold source located at the bottom.

7.1.2.1 Explanations through drawings:

Isochoric heat addition:

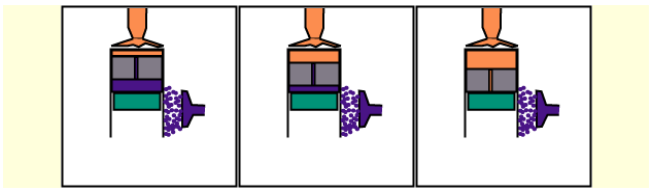

Figure 6.5 isochoric heat addition

The volume remains constant, but the displacer, while going down, sends the gas from the lower part (cold) to the top (hot).

Isothermal expansion:

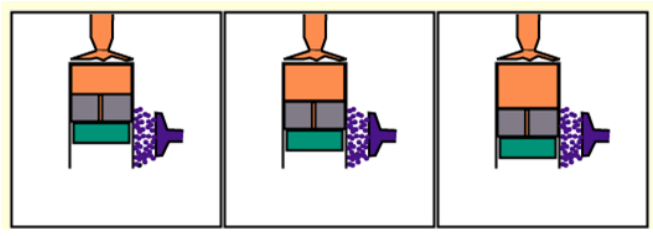

Figure 6.2 isothermal expansion

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The displacer follows the engine piston during the expansion so that the gas remains in contact.
The cycle efficiency:

The efficiency of the engine is equal to the ratio between the recovered mechanical energy Wnet and the heat Qtotal that is required to provide. The latter is provided during the isochoric heating and during the isothermal expansion.

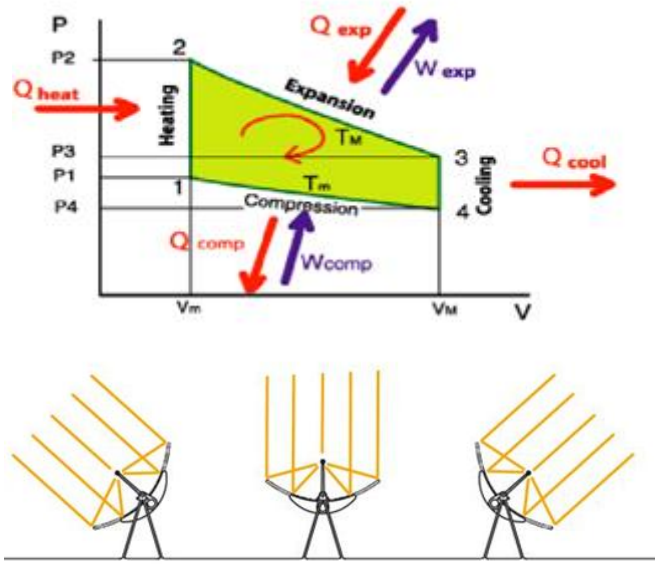
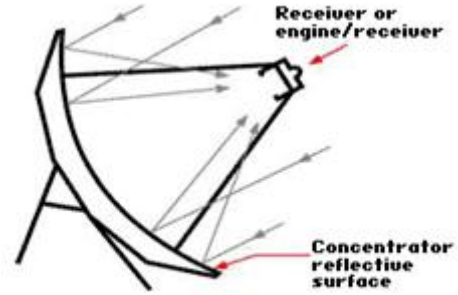


Figure 7.1 parabolic collector

The parabolic mirrors of PTMx solar troughs focus the sun rays on the receiving tube to heat the working fluid up to temperatures which are not reacheable by traditional solar collectors. During the day, thanks to an automatic system, the mirrors rotate around the main axis to track the sun, thus maximising the thermal gains. In case of bad weather and during night the mirrors close to the stowing position.

7.3 Combination of both:

In our Project, the type of concentrating system that is possible to use in a heating application is the parabolic dish. This has a bowl shaped reflector that focuses the sun onto a relatively small receiver **LIST OF MATERIALS**



Sl. No.	PARTS	Qty.	Material
i.	Frame Stand	1	Mild Steel
iii.	Gate Valve	1	M.S
iv.	Bearing with Bearing Cap	1	M.S
v.	STERLING ENGINE	1	–
ix.	Bolt and Nut	-	M.S

Table 9.1 LIST OF MATERIALS

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