AHP MINI PROJECT

GENERATING ELECTRICITY FROM TRACTION MOTOR USING STIRLING ENGINE

Mentor: Dr., Babu Narayanan

Team Members:

Mukesh Kannah K – 20EUMC070
Nithish Kumar R – 20EUMC079
Praveen Babu S – 20EUMC089
Pravin B – 20EUMC091

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Introduction

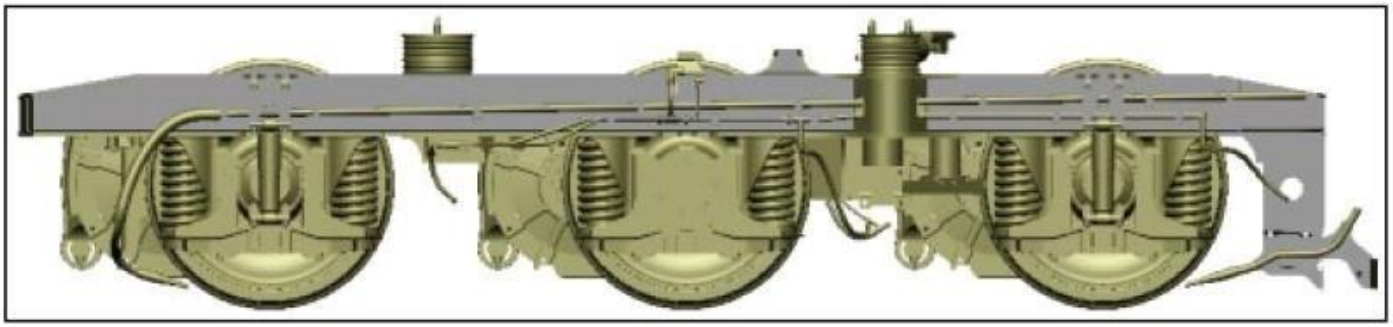
The first several pages will attempt to describe the terms in everyday language, keeping numbers to a minimum and avoiding formulas and jargon. I apologize in advance for my loose use of language and imperfect analogies. The second section is for those with a technical background. There are no doubt errors of various kinds and superior optimizations for elements of the system. Feedback would be most welcome – please send to 20eumc070@skcet.ac.in, 20eumc079@skcet.ac.in, 20eumc089@skcet.ac.in and 20eumc091@skcet.ac.in. I would like to thank my excellent compadres at both companies for their help in putting this together.

- The **Stirling Engine Generator** is a sealed high efficiency "heat engine" that is driven by the radiant energy supplied from the sun or any other source of external heat.
- Invented by Robert Stirling, hence its name, nearly two hundred years ago, the *Stirling cycle engine* is a type of solar engine, or sun motor, which operates using the principal of thermodynamics alternating between the hot and cold temperature cycles of a working gas.
- The "Stirling Engine" consisted basically of an externally heated, usually by the sun, hot-air engine controlled by what Robert Stirling termed as an "economiser" that absorbs and releases heat to and from an enclosed internal air space.
- When the air (or some other form of working gas) inside this enclosed space is heated it expands, and when it is cooled it contracts.

Constraining the Problem

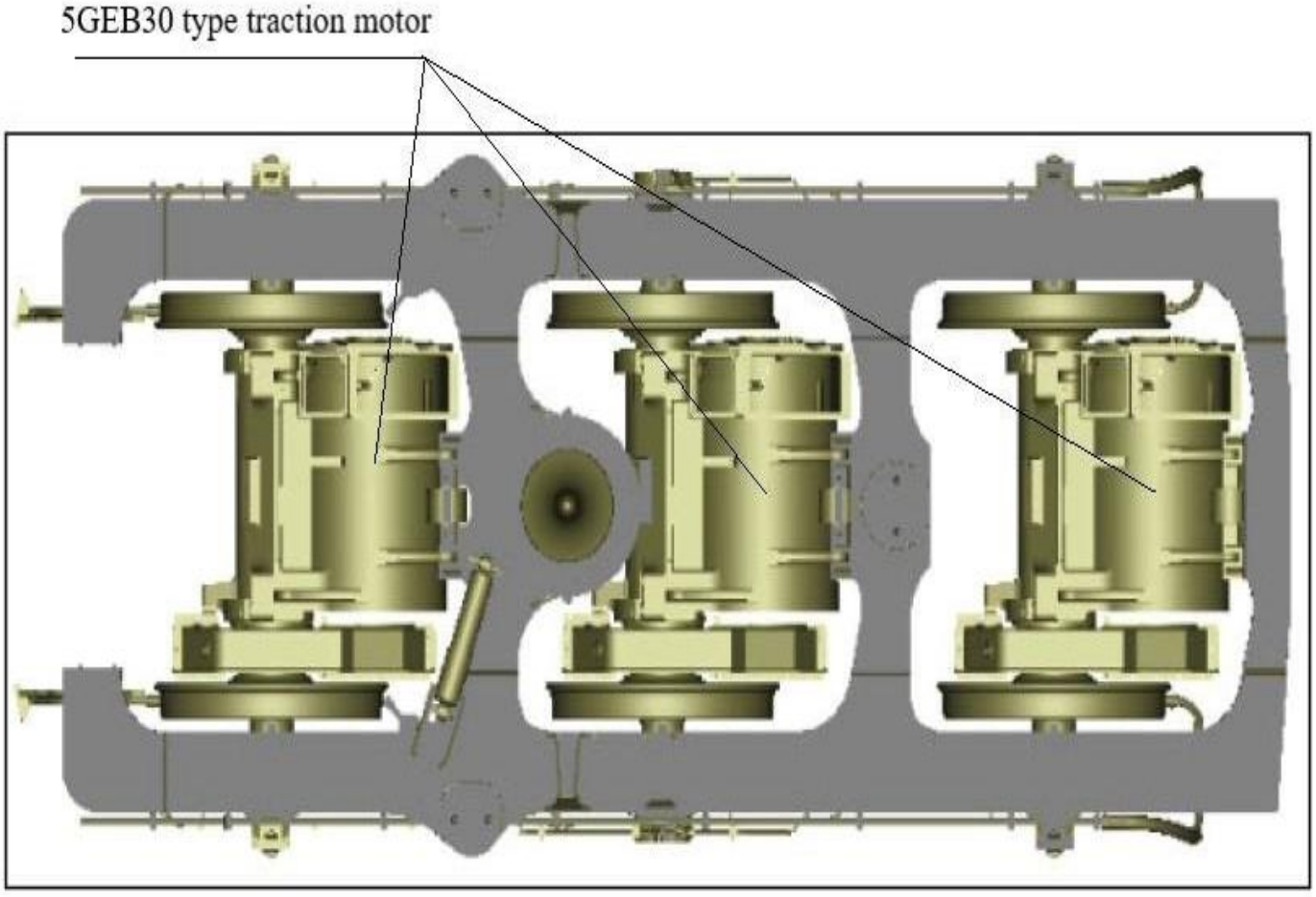
Heat produced by electric motors, no matter what type (AC single or 3 ph, DC, Brushless DC, Reluctance, Stepper) is the **power loss that has to be dissipated by the motor**.

Here we gone see HEAT dissipation from the train traction motor. Then we can able to use that heat as a heat source for stirling engine by this we can able to generate electricity for every compartments in train (by the success ratio, we can able to incorporate in flights and ships also) .

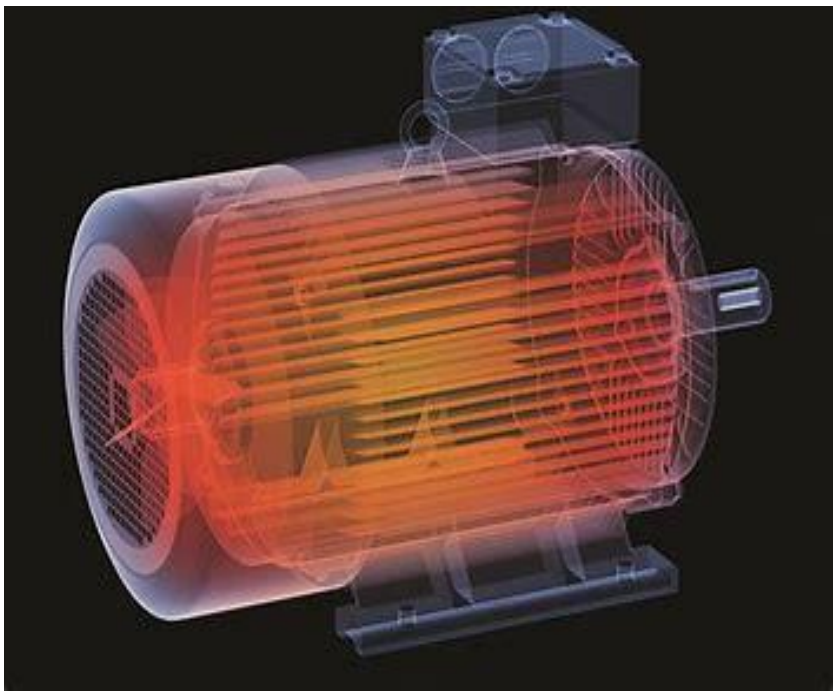


TE33A locomotive bogie, side view

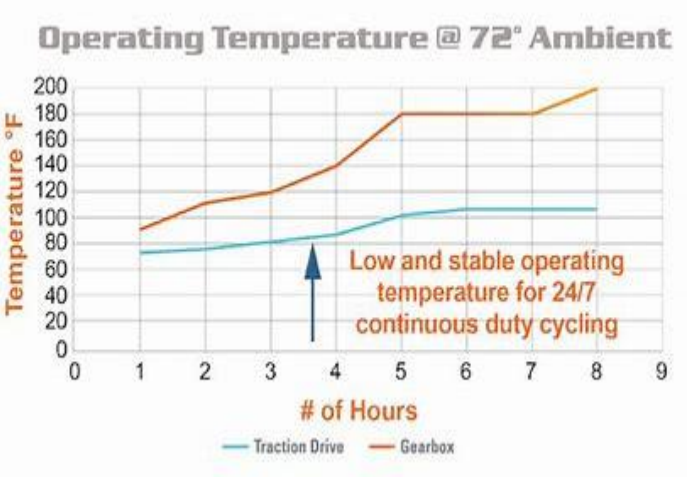
Place we can able to take heat and to place the stirling engine

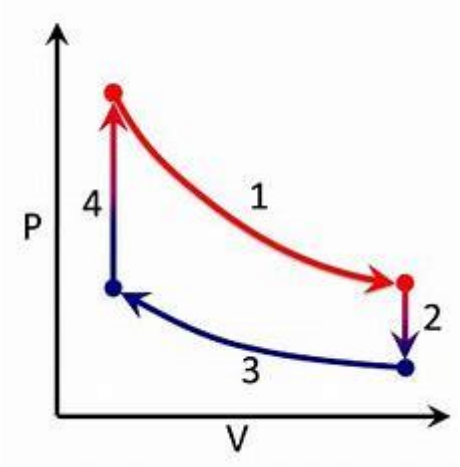


TE33A locomotive bogie, top view



Temperature rise in motor

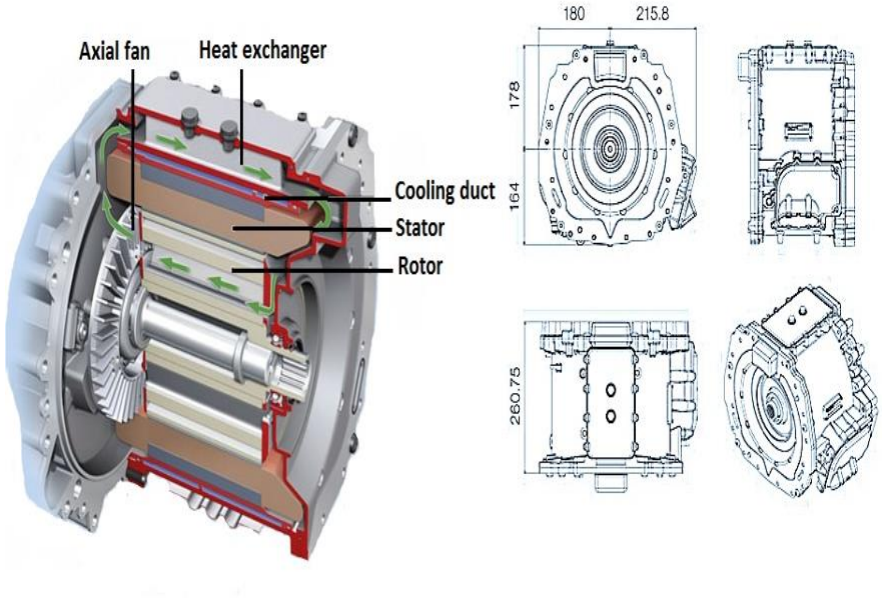




How to get much more heat

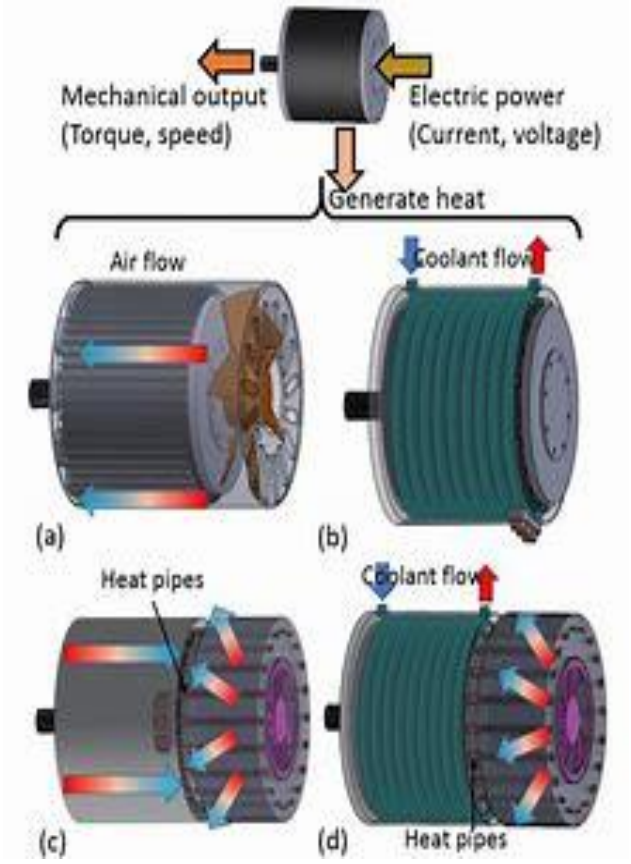
The stirling engine has to be placed at the top of the traction , the heat can be transferred by conduction and convection

Convection can be achieved by the copper pipes. we have to remove or place the copper pipe winding



PERMANENT MAGNET SYNCHRONOUS MACHINE CONSTRUCTION (PSM)

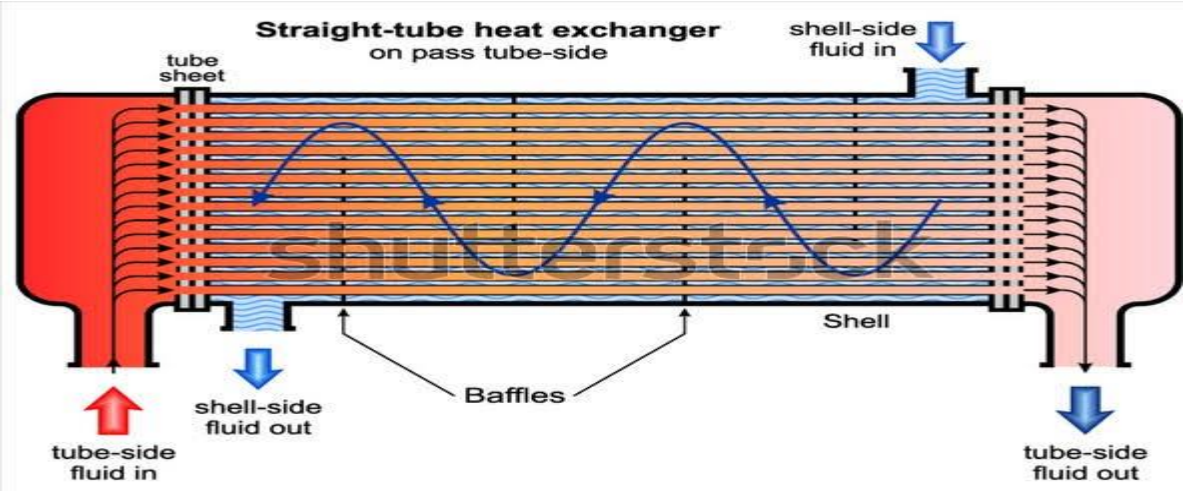
inside the motor at behind the motor internal parts , before the cooler parts Then the heat can be transferred from all the traction motors through this copper pipe line system



Copper pipe

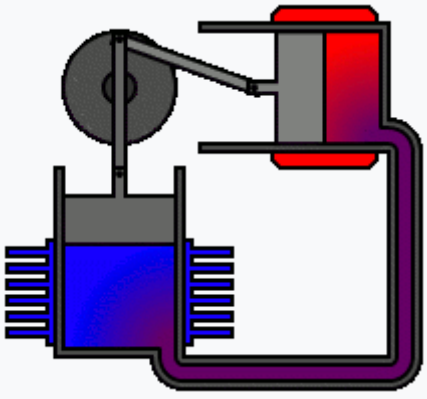
Here we using the copper pipes for winding the motor surface,

Because- copper is a good conductor of heat and also low chemical reactivity .It has ability to withstand in that place.



Types of stirling engine;

Alpha

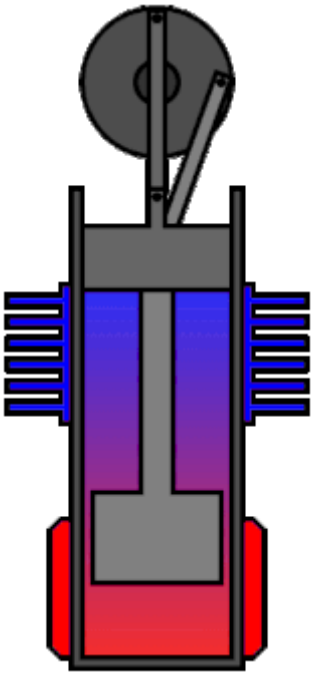


- Alpha-type Stirling engine. There are two cylinders. The expansion cylinder (red) is maintained at a high temperature while the compression cylinder (blue) is cooled.
- The passage between the two cylinders contains the regenerator
- An alpha Stirling contains two power pistons in separate cylinders, one hot and one cold.

- The hot cylinder is situated inside the high-temperature heat exchanger and the cold cylinder is situated inside the low-temperature heat exchanger.
- This type of engine has a high power-to-volume ratio but has technical problems because of the usually high temperature of the hot piston and the durability of its seals.
- In practice, this piston usually carries a large insulating head to move the seals away from the hot zone at the expense of some additional dead space.
- The crank angle has a major effect on efficiency and the best angle frequently must be found experimentally.
- An angle of 90° frequently lock.

A description of the process is as follows:

1. Most of the working gas is in the hot cylinder and has more contact with the hot cylinder's walls.
2. This results in overall heating of the gas.
3. Its pressure increases and the gas expands.
4. Because the hot cylinder is at its maximum volume and the cold cylinder is at mid stroke (partial volume), the volume of the system is increased by expansion into the cold cylinder.
5. The system is at its maximum volume and more gas has contact with the cold cylinder.
6. This cools the gas, lowering its pressure. Because of flywheel momentum or other piston pairs on the same shaft, the hot cylinder begins an upstroke reducing the volume of the system.
7. Almost all the gas is now in the cold cylinder and cooling continues. This continues to reduce the pressure of the gas and cause contraction. Because the hot cylinder is at minimum volume and the cold cylinder is at its maximum volume, the volume of the system is further reduced by compression of the cold cylinder inwards.
8. The system is at its minimum volume and the gas has greater contact with the hot cylinder.
9. The volume of the system increases by expansion of the hot cylinder.



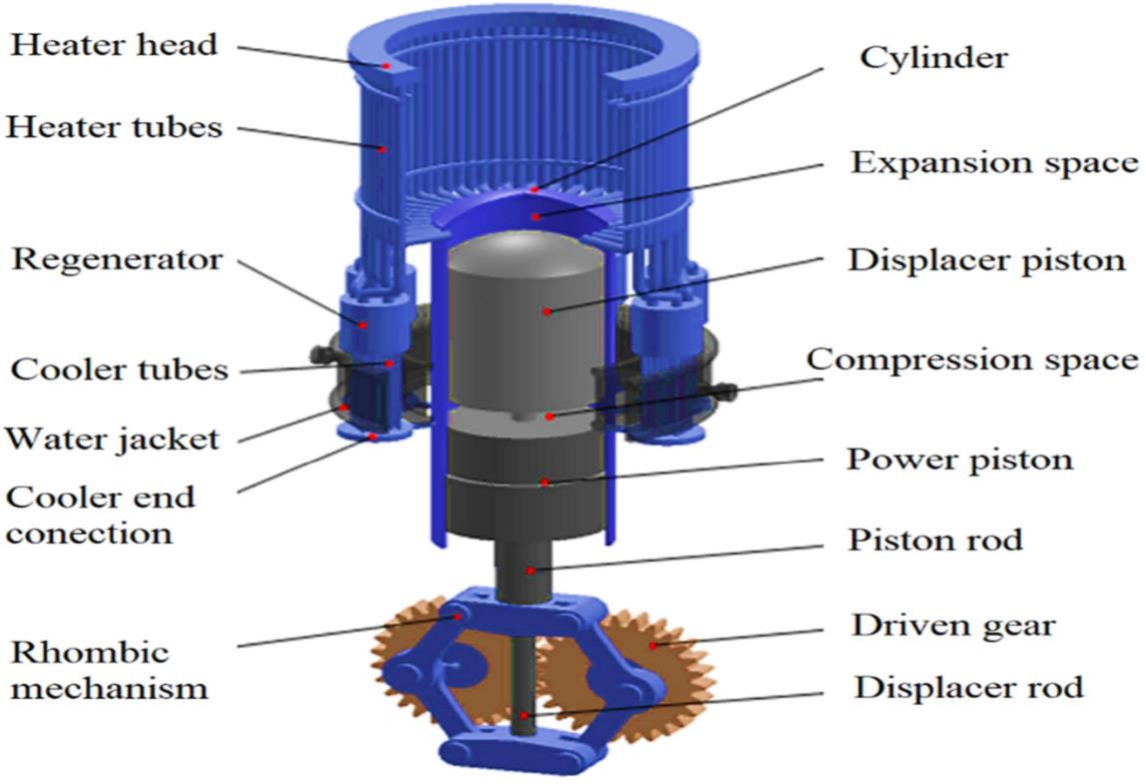
Beta

- Beta-type Stirling engine, with only one cylinder, hot at one end and cold at the other.
- A loose-fitting displacer shunts the air between the hot and cold ends of the cylinder.
- A power piston at the open end of the cylinder drives the flywheel
- A beta Stirling has a single power piston arranged within the same cylinder on the same shaft as a displacer piston.
- The displacer piston is a loose fit and does not extract any power from the expanding gas but only serves to shuttle the working gas between the hot and cold heat exchangers.
- When the working gas is pushed to the hot end of the cylinder it expands and pushes the power piston.

- When it is pushed to the cold end of the cylinder it contracts and the momentum of the machine, usually enhanced by a flywheel pushes the power piston the other way to compress the gas.
- Unlike the alpha type, the beta type avoids the technical problems of hot moving seals, as the power piston is not in contact with the hot gas.Power piston (dark grey) has compressed the gas, the displacer piston (light grey) has moved so that most of the gas +kis adjacent to the hot heat exchanger.

Gamma

- A gamma Stirling is simply a beta Stirling with the power piston mounted in a separate cylinder alongside the displacer piston cylinder, but still connected to the same flywheel.
- The gas in the two cylinders can flow freely between them and remains a single body.
- This configuration produces a lower compression ratio because of the volume of the connection between the two but is mechanically simpler and often used in multi-cylinder Stirling engines

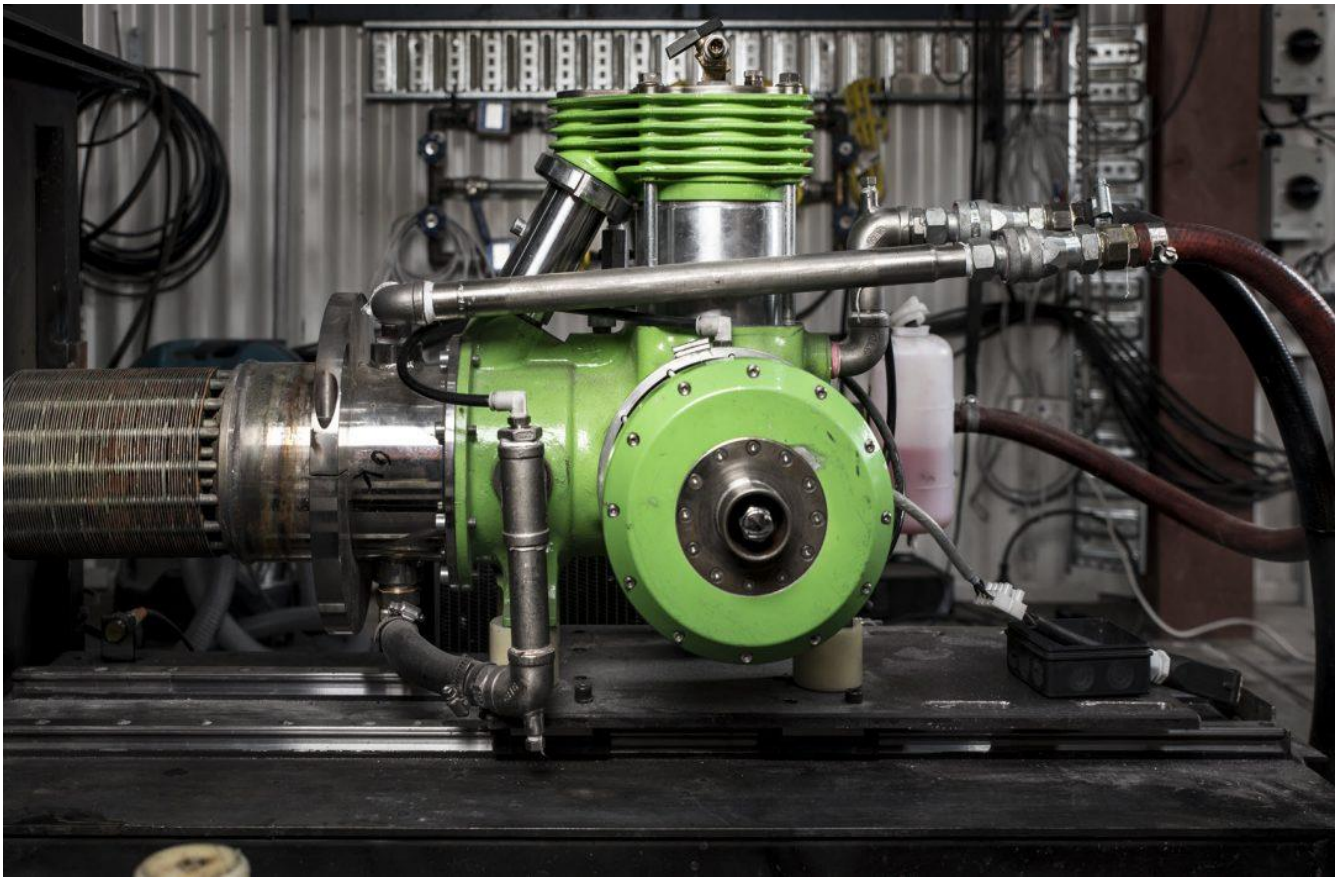


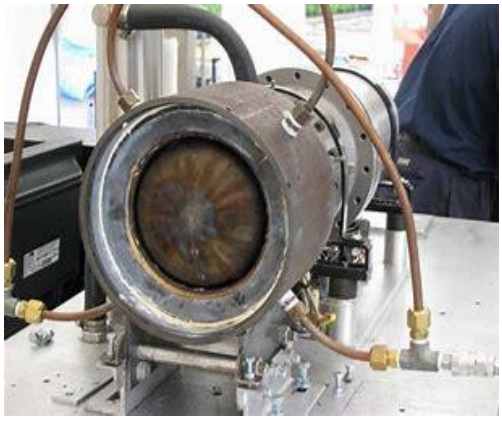
Efficient Engine ;

Here we going to use the gama type engine

Because- It has a high efficiency

Pictorial representation of the engine





To getting a good work output from engine

The engine has been working based up on the temperature difference. The good efficient engine have the best temperature difference.

Here we can achieve the temperature difference by the cooling system. We can use water and exhaust fan to have a good temperature difference. Then we can use the HVAC for the engine to get highest temperature difference.

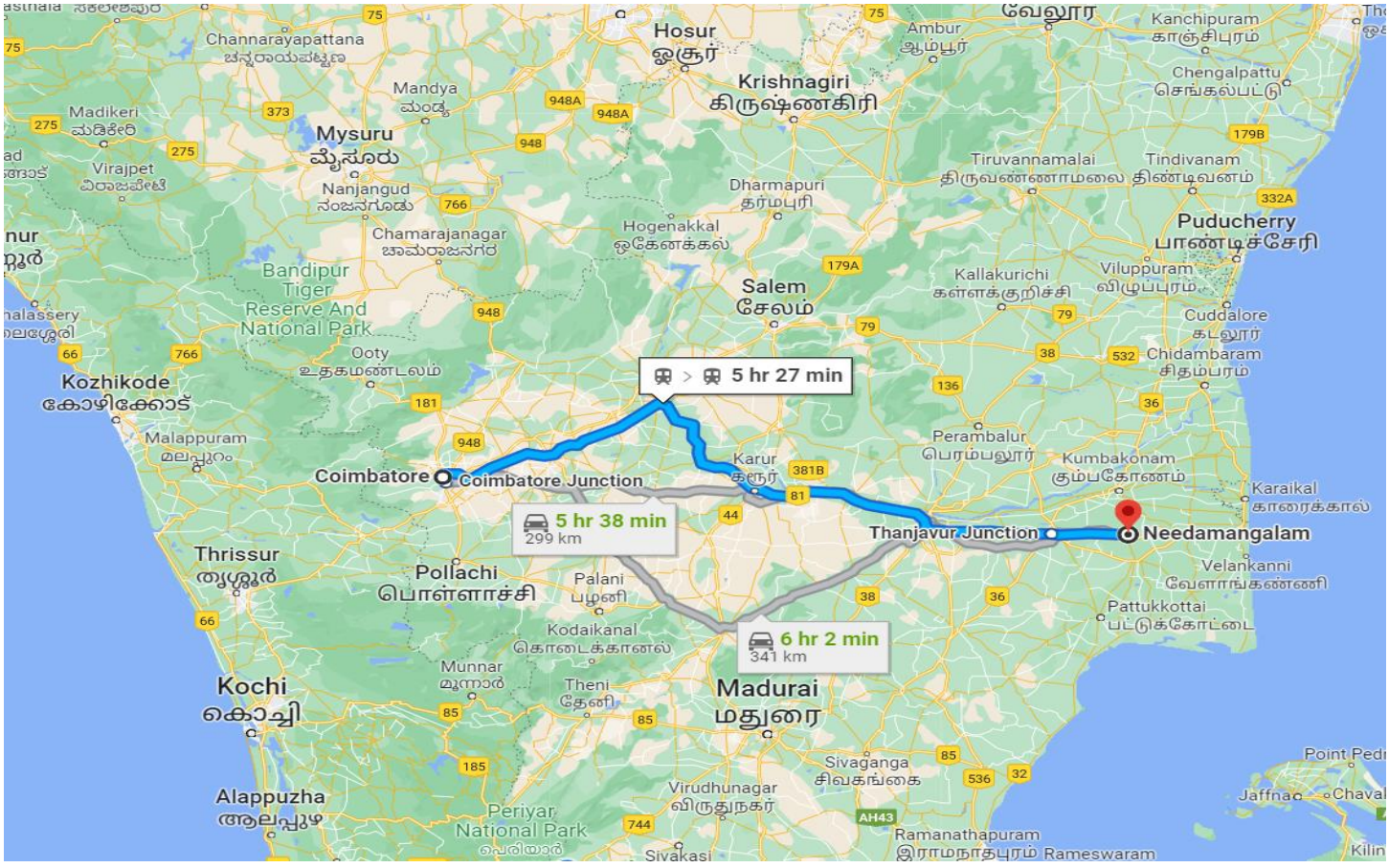
What is a LTD Stirling engine?

Similar to a typical Stirling engine an LTD Stirling engine runs when one part of the engine is heated and another part is cooled. LTD is short for Low Temperature Differential. When a Stirling engine has a Low Temperature Differential it means that it can run when the warm side is not much warmer than the cool side. Put another way, the difference between the warm and cool side is very small. Some LTD engines can run on as little as 1/2˚ C.

Power needed;

16616 train (CHEMMOZHI EXP)

This train travel from Coimbatore to nidamangalam and its consist of total of 16 coaches. It has 10 sleeper coaches, 1 third ac coach and 1 first ac cum second ac coach



No of fans and light in a coach-30

Calculation:

Light consumes 1.2 KWhr per day
Fan consumes 1.68 KW hr per day

- Train contain an average of 20 coaches
- Each coach contain 30 fan and 20 lights.

Total energy consumption of fan in a train=20*30*1.68=1,008 units

Total energy consumption of light in a train=20*20*1.68=480 units

For Generator:

- ✓ Output power=400KW
- ✓ N=1800 rpm
- ✓ Power,P=2*3.14*N*T/60
- ✓ T=2.122KN.m.

Specification of Stirling Engine for 40KW Engine:

- Shaft output=40KW
- Bore = 140mm
- Stroke = 74mm
- No. of cylinder = 4
- Speed = 1015 rpm
- Mean Pressure = 4MPa
- Working gas : Helium
- Maximum heater temperature = 953K
- Engine Weight = 1200kg
- Engine Length = 1.3m
- Width = 0.8m
- Height = 1.2m

Specification of Stirling Engine for 65KW Engine:

- Shaft output=65KW
- Bore = 330mm
- Stroke = 175mm
- No. of cylinder = 2

References

[1] https://en.wikipedia.org/wiki/Stirling_engine

[2] https://timesofindia.indiatimes.com/city/chennai/s-rly-saves-rs-1cr-per-month-by-drawing-power-from-overhead-lines/articleshow/66112406.cms.

[3] The engine continued to run until the temperature difference between the source and sink dropped to 15 °C