FABRICATION AND TEST OF GAMMA-TYPE STIRLING ENGINE

[1]Abhijit Samanta, [2]Brezhnev Fernandes, [3]Arham Zamindar, [4] Saad Khan, [5] Rishabh Dubey

[1]Professor, [2]Student, [3]Student, [4] Student, [5] Student

[1]Department of Mechanical Engineering,
[1]Shree L.R. Tiwari College of Engineering, Thane, India

Abstract : Stirling engines are more reliable than other engines. This is due to the fact that the working gas is a closed system with no exhaust. All that is required for these engines to run is an initial force and a temperature differential. While there are different engines varying in their types and sizes, hence we will be introducing a small gamma type Stirling engine. This is to prove that even this design can achieve continuous motion at a given low temperature difference. The project intends in constructing a working model of an improvised Stirling engine, which will operate with minimal temperature difference as possible.

I. INTRODUCTION

Stirling engine is a basic form of external combustion engine that can operate with different heat sources. This engine was the first invented regenerative cycle heat engine Robert Stirling patented the Stirling engine in 1816. These engines were simple and safe in its operation, running more or less silently on different heat sources. The era of the Stirling engine was concluded by the rapid progressive development of the internal-combustion engine and the electric motor.

In 1937, the Stirling engine was effectuated to an immense state of technological development by the Philips Research Laboratory in Eindhoven, Holland, and has been under continuous progression since then. The initial focus of work was on the enhancement of mini thermal-power electric generators for telecommunication devices and synonyms equipment used in rural areas.

The Stirling engine was a success by the introduction of newer materials, such as stainless steel. Another vital role in success was played by having significant knowledge of thermal and fluid physics.

Kolin tested a number of low temperature differential (LTD) Stirling engines. In 1983, he introduced a stereotype working on the principle of temperature difference between the hot and cold ends of the displacer cylinder as minimum as 15°C. Senft's analysis in LTD Stirling engines had an outlandish low temperature difference of 0.5°C.

In 1997, Iwamoto et al. differentiated between the performance of a LTD Stirling engine and HTD Stirling engine. They presumed that the efficiency was 50% of Carnot efficiency of LTD Stirling engine at its adjudged speed.

In 2005, Kongtragool and Wongwises investigated, theoretically, the power out-turn of the gamma-configuration LTD Stirling engine and notified that the mean-pressure power formula was most efficient for LTD Stirling engine power out-turn estimation.

In 2007, Kongtragool and Wongwises published output of two LTD Stirling engines experimented using LPG gas burners as the source of heat. The introductory engine was a twin-power-piston engine which was then followed by a second four-power-piston engine. They presented the engine output, thermal output, inclusive of Beale's numbers.

Recently, Kongtragool and Wongwises bestowed the output of a twin-power-piston Stirling engine energized by a solar simulator. The heat source was a solar simulator made from a 1000 W halogen lamp.

Because of little research in this area, therefore, a Stirling engine of gamma type is fabricated and tested in this study. This engine is experimented with electric heater as the source of heat with air at atmospheric pressure.

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II. LITERATURE REVIEW

D.G. THOMBARE, S.K. VERMA 2006

Conclusion- In near future, solar powered engine and helium air powered engines have the potential of wide acceptance.

Ruijie Li, Lavinia Grosu, Diogo Queiros-Conde 2016

Conclusion-To improve regenerator geometry, to reduce conduction loss using isolating material and to decrease clearance leakage in this engine.

S. Alfarawi ,R. AL-Dadah , S.Mahmoud 2016

Conclusion- There is direct relation between increase in power and phase angle to an optimum value ultimately leading to its decrease. The dead volume is observed to pose negative effects on engine indicated power.

Wen-Lih Chen 2016

Conclusion- Phase is very influential on engine performance. Indicated power and efficiency both are improved as gap width between displacer and displacer cylinder becomes smaller. Increase in dead volume only introduces negative effect on the engine performance.

Gwyddyon Fenies, Fabien Formosa, Julie Ramousse, Adrien Badel 2015

Conclusion- Three optimization parameters are, possible reduction of the dead volume in the chamber, increasing the resonance frequency of the mechanical part, along with reduction in the stiffness of the spring or increasing the mass of the mechanical parts.

III. COMPONENTS

Sr. no.	Components	Materials used
1.	Regenerator	Aluminium
2.	Crank shaft	Stainless steel
3.	Displacer	Aluminium
4.	Displacer cylinder	Aluminium
5.	Displacer connecting rod	Silver steel
6.	Frame	Steel
7.	Flywheel	Aluminium
8.	Power piston	Mild steel
9.	Power cylinder	Aluminium
10.	Power piston rod	Silver steel
11.	Heater	Ceramic

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IV. WORKING

In this, the fabricated Stirling engine model will be working on the heater as the heat source. When the engine is turned on the hot source equipped with the hot cylinder end starts which in turn starts heating the cylinder wall due to which the gas inside the hot cylinder end also starts heating. The displacer which is at hot end of the cylinder moves towards the cold end due to the heating of the gas that produces molecular disturbances in the gas which in turn expands the gas. This motion of the displacer causes increase and decrease in pressure within its own cylinder. The pressure is high when the majority of the air is over the hot side of the engine and low when the majority of the air is on the cold side of the engine. This increase and decrease in the pressure are transferred to the power cylinder by means of a small passage. The low pressure at the passage sucks the power cylinder and high pressure pushes the power cylinder. The displacer piston is set to be 90° ahead of the power piston through the crankshaft.

V. CONCLUSION

A gamma type Stirling engine is fabricated and tested. Result from this whole study indicates that the torque of the engine, shaft power, brake thermal efficiency, speed, and temperature of heater wall gradually increases with increase in the heat inputs. That is, it can be concluded that the maximum engine torque and shaft power of the engine rises with rise in heater wall temperature.

REFERENCES

[1] D.G. Thombare, S.K. Verma 2006

[2] Ruijie Li, Lavinia Grosu, Diogo Queiros-Conde 2016

[3] S. Alfarawi ,R. AL-Dadah , S.Mahmoud 2016

[4] Wen-Lih Chen 2016

[5] Gwyddyon Fenies, Fabien Formosa, Julie Ramousse, Adrien Badel 2015

[6] Kongtragool B, Wongwises S. 2005

[7] Kongtragool, B., Wongwises, S. 2007

[8] Mathew Alphonse, R. Ramesh Kumar, M. Senthil Kumar, K Karthik 2017