Design & Development of Novel Flexure Bearing For 3 KW Free Piston Stirling Engine

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Abstract- *Flexure Bearing is non-conventional suspension system , it provides wear-free, frictionless clearance seals. Flexure bearing has more reliability and life as compared with contact type seals. Flexure bearings are mostly used in linearly driven cryo-coolers. In Stirling engine we have linear free piston for which we are designing and developing a flexure bearing which will act like a spring axially and in radial it will act as bearing to allow relative motion. For designing any flexure bearing three main parameters are considered, maximum Stresses, Its Stiffness, and its fatigue Life. As per requirement of stiffness and its stroke deflection, flexure is designed. Its model is prepared with CATIA V6 R19 and its Analysis for the deformation and stress is done on ANSYS 15.0. Then its stiffness is calculated experimentally and compared with ANSYS results. Stresses are calculated experimentally using Strain Gauges and compared with the results.*

Keywords- Flexure Spring, Stiffness, Finite element Analysis

I. INTRODUCTION

Stirling engine is an example of external combustion engine it is now days widely used for distributed generation application. Stirling is a closed thermodynamic cycle as the working fluid is confined inside a cylinder and doesn't come out of the cylinder. Unlike other internal combustion engines where the fuel is burnt inside the cylinder and piston movement is a result of the expansion due to combustion inside the cylinder, in Stirling engine heat is transferred to the fluid from hot end of the cylinder walls which causes expansion of the fluid and pushes the piston in the cylinder. At the other end of the cylinder there is coolant which absorbs the heat from the working fluid which causes the contraction of the fluid and thus the cycle continues and piston moves to and fro. And this to and fro motion of piston causes rotation of prime mover. In short, A Stirling cycle machine is a device, which operates on a closed regenerative thermodynamic cycle, with cyclic compression and expansion of the working fluid at different temperature levels.

Stirling engine technology has been used at a wide range of applications for the last many years, like vehicle propulsion, gas fired heat pumps, air- craft propulsion, auxiliary power stations, sub-marine power generation. The most common application of Stirling engines which is under development is distributed generation for base load or backup powers. Stirling engines have relatively high thermodynamic efficiencies, as they require only heat. Stirling engines have high fuel-flexibility and also allow better control of emissions. Regardless of these benefits, IC engines are more popular and mostly used in power generations and transportation because of their size and weight.

The Stirling engine has several advantages over internal combustion engines are:

1. Low amount of emission as fuel at heat source can be burnt in controlled manner
2. Less noise due to absence of valve and internal combustion.
3. Any type of heat source can be used as fuel sources, like combustion of fossil or biomass fuels, concentrated solar heat, and high-grade waste heat from industrial processes,
4. Stirling engines have higher theoretical efficiencies.

Problem Statement- The present work is done for designing and development of the Flexure Bearing for Stirling Engine of the power 3 KW with following specification-

- Stroke of ±10 mm
- High stiffness
- Infinite fatigue life
- Total stiffness requirement of the engine is 2, 00,000 N\m

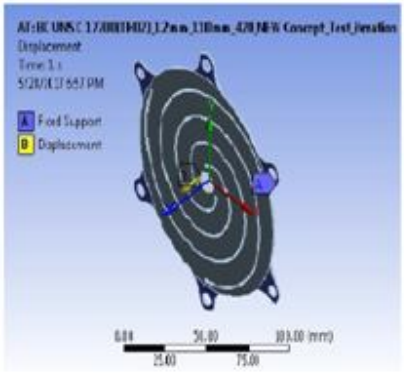

Fig- Boundary conditions for analysis

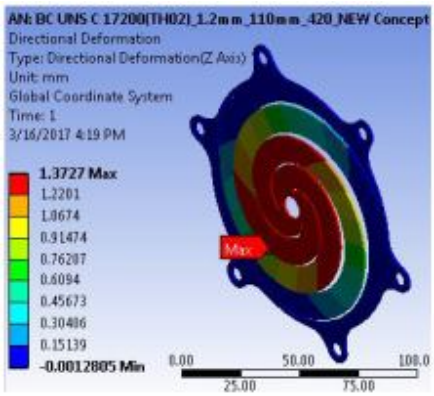

Fig- Force- 4.96N, Displacement- 1.37mm

II. EXPERIMENTAL RESULT VALIDATION

Stiffness result Validation

Fig- Setup for stiffness Calculation

Figure shows the experimental setup to measure stiffness of flexure bearing. In which simple dead weight method is used. The pan is attached to the centre of the flexure bearing with the help of screw. The weights were gradually increased and the deformation of the flexure was measured using Depth Gauge. Measuring tip of the depth gauge is placed so that it touches the flat surface of the screw.

III. CONCLUSION

A conclusion may review the main points of the paper, Do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

IV. APPENDIX

Appendixes, if needed, appear before the acknowledgment.

V. ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in American English is without an “e” after the “g.” Use the singular heading even if you have many acknowledgments.

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