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MINIMIZE THE POWER LOSS IN PLAIN JOURNAL BEARING AND DESIGN OPTIMIZATION USING MATLAB

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Abstract - *The starting of a plain journal bearing is defined as the frictional moment that must be overcome by the bearing to start rotating. The maximum friction torque at start-up increases linearly with the static load. Maximum friction torque is more power losses generated. So minimizes the friction torque in start-up and energy and minimize power losses. The results of these studies and also to draw several general conclusions on the behavior of a plain journal bearing during start-up friction torque. Increasing the energy savings and minimize the power losses in start-up friction torque. In this studies are focused on minimize the power loss in plain journal bearing. Start-up journal bearing more power losses is generated. And used in MATLAB Software in solved this problem and for good result and plot various graph to be best result.*

Key words: *bearing, friction torque, optimization power loss.*

I. INTRODUCTION

The purpose of this study genetic algorithm is to utilize to optimally design a plain journal bearing to improve machine performance and to minimize power loss in start-up friction torque. The focus of this work is optimization of design variable in a hydrodynamic journal bearing. In hydrodynamic bearing has been the subject of several published studies. A brief review of paper on this topic is presented here. Hirani H. and Suh N.P. [5] was axiomatic design to provide inside of objective function and design variables. Such as radial clearance length to diameter ratio, oil viscosity, groove geometry, supply pressure and thus minimize oil flow power loss. Bouyer J. and Fillon M. [4] the start-up friction coefficient is a parameter which is very useful for engineers who design hydrodynamic bearing. It is most often issued from an approximation. And more general and deal with the transient thermal behavior in journal bearing as well as in thrust bearings. And other studies deal with the friction coefficient during running, at a fixed rotational speed. The aim of this study is to provide experimental measurements of the bush torque start-up of plain journal bearings, varying the specific pressure. Bouyer J. and Fillon Michel [3] the start-up friction coefficient in hydrodynamic bearings, used by engineers in the design of bearings, is most often issued from an approximation. Deal with the transient thermal behavior journal bearing as well as in thrust bearings. Hermanwant D. [6] explains genetic algorithm for novice in this filed. Also explains philosophy of genetic algorithm and its flowchart are described. Solving step by step numerical computation of genetic algorithm for simply mathematical equality problem will be briefly explained. Goldberg was inspired by Darwin's theory of evolution and developed genetic algorithm. And which states the survival of an organism is affected by rule "the strongest species that survives of an organism can be maintained through the process of mutation, crossover and reproduction. Darwin's concept of evolution is then adapted to computational algorithm to find solution problem called objective function in natural fashion. A solution generated by genetic algorithm is called a chromosome is composed from genes and its value can be solved. These chromosomes will undergo a process called fitness function to measure the solution generated by genetic algorithm with problem. The producing new chromosomes named offspring. A few chromosomes in the population that will maintain for next generation will be selected based on Darwinian evolution rule, the chromosome which has higher fitness value will have greater arability of being selected again in the next generation. The chromosomes value will converges to a certain value which is the best solution for the problem after several generations.

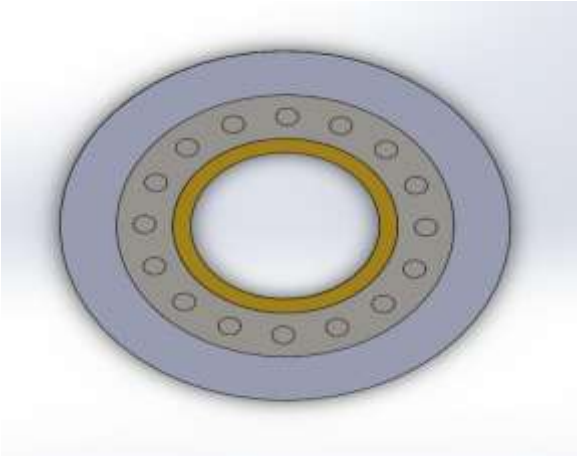

Fig- 1: Solid works 3D model of journal bearing

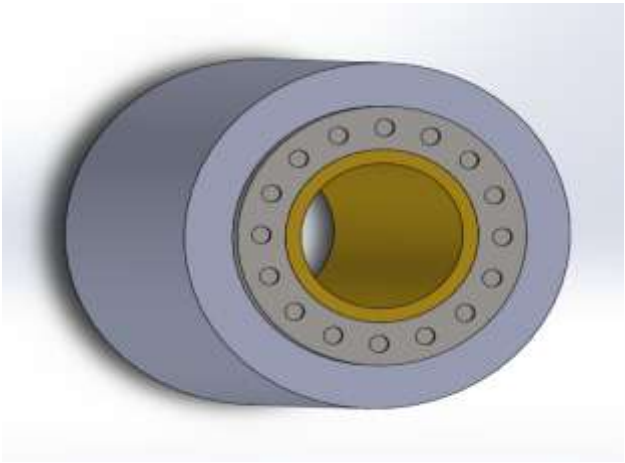

Fig- 2: Side view of 3D model of journal bearing

Fig-3: Side view of 3D model solid work of journal bearing

2. METHODOLOGY

The Evolutionary algorithm

The Evolutionary algorithm holds population of chromosomes, which evolve my means of selection and other operations like mutation and crossover. Every individual (chromosomes) in the population gets an evaluation of its adaptation (fitness) to the environment. In the terms of optimization this means, that the function that is minimize is evaluated for every individual. The selection chooses the best gene combinations (indiviulas), which through mutation and crossover should drive to better solution in the next population.

1. Generate initial population – in most of the algorithm the first generation is randomly generated, by selecting the genes of the chromosome among the allowed alphabet for the gene. Because of the easier computational procedure it is accepted that all population have the same number of inividuals.

2. Calculation of the values of the optimization function that we want to minimize.

3. Check for termination of the most optimization algorithms, it is possible to stop the genetic optimization by:

- Value of the function
- Stall generation
- Maximum number of iterations

4. Selection – between all individuals in the current population are chose those, who will continue and by means of crossover and mutation will produce offspring population. At this stage elitism could be used –the best individuals are directly transferred to the next generation. That the value of the optimization function is good.

5. Crossover – the individual chosen by selection recombination with each other and new individuals will be created. The focus is to get offspring individuals that inherit the best possible combination of the genes of their parents.

6. Mutation – Mutation means of random change of some of the genes, it is guaranteed that even if none of the individuals contain the necessary gene value for the extreme, it is possible to reach the extreme.

7. New generation – the elite individuals chosen from the selection are combined with those who passed the mutation and crossover, and from the next generation.

3. OPTIMIZATION DESIGN PROBLEM

3.1 Design Variable

The important physical properties of a journal bearing are oil viscosity μ, radial clearance C, journal Diameter, journal speed, journal length. The oil viscosity of a fluid can be defined qualitatively as its resistance to flow. This resistance is mainly due to internal friction and is a molecular phenomenon. The proper lubricant is an important in journal bearing design. The radial clearance in a journal bearing is an effect on load capacity and flow rate any operating an increase in radial clearance in journal bearing decreases the load capacity and increases the oil flow rate. Length and diameter in journal bearing increase in bearing length with increase in load capacity in journal bearing and oil flow decreases with increases in the length of bearing.

Table-1: list of inputs variable

Input variable	Range	Units
Oil viscosity	1-16	mPa
Radial clearance	35-70	μm
Diameter of journal	0.1	m
Journal speed	50	rps
Length of bearing	0.3	m

3.2 Objective Function

In this paper genetic algorithm used for axiomatic design of plain journal bearing in start-up. In order to validate the proposed objective function the value of variable (utilized by Hirani H.et.al [5]) were put into the objective function. This is provide the value of friction torque and minimize the value of power losses which were in the range of the result obtained by the above- mentioned group of investigators. This objective function is needed to be minimized to obtain minimum value of start-up friction torque in plain journal bearing under proposed constraints. The optimization for two variable problem genetic algorithm optimization technique and selection used fitness value based selection method used. In this optimization process initial population is 20. And probability of crossover is 0.7 and probability of mutation is 0.01.

Objective:-

$$T_f = \frac{4\pi^2 r^3 l \mu n}{c}$$

Subjected to: $1 \leq \mu \geq 16$, $35 \leq C \geq 70$ [1].

4. OPTIMIZATION USING GENETIC ALGORITHM

The variation in the friction torque start-up is investigated for several acceleration times. The maximum friction torque at start-up increase linearly with the increase in static load. In this case greater acceleration could indeed reduce the maximum torque at start-up. The maximum torque at 13-87 at start-up increases linearly with the static load. In this optimization process greater acceleration is reduce the maximum torque at start-up [5] optimized radial clearance falls in the range of 35-40 μm, even though selected design range was 35-70 μm. larger clearance reduce power loss.

In this two variable optimization problem required precision in four decimal places. In constraints design variable coding name.

Table-2: Constraints design variable coding name

Design variable vectors	Coding name
Oil viscosity	X(1)
Radial clearance	X(2)

In this optimization process 18 bits are required to represent x_1 as 2nd part of chromosomes.

Hence, the total length of chromosomes = 37 bits {18+19}.

Solving the optimization process, Constrain value is represented in MATLAB work place in table.

Table-3: Constrain value in MATLAB work place

Constrain Variable	Oil viscosity	Radial clearance
Name coding	X1	X2
Value	351×151 Double	351× 151 Double
Minimum value	1	35
Maximum value	16	70

Fitness value for this chromosomes = eval (x_1, x_2) = f (x1,x2).

5. RESULTS

The aim of the study in plain journal bearing minimizes the power loss and save the bearing. And presented results in some graph. And Convergence diagram selection function diagram for fitness value for two variable optimization process and find best results of minimizes power loss.

Table– 4: Optimization results for two variable problems

S.No.	Oil viscosity	Clearance	Friction torque
1	1	40.732	1.8187
2	1	66.539	1.1133
3	1	54.732	1.3535
4	1	69.985	1.0585
5	**1**	**69.997**	**1.0583**
6	1	51.951	1.42599
7	1	69.982	1.0585
8	1	69.687	1.0808

Fig.4 Convergence diagram score histogram for fitness value for two variable optimization (population 20, crossover probability 0.7) a histogram is a plot that number of individuals distribution of a set of continuous data. This allows the inspection of the data for distribution of two variable clearance and oil viscosity and minimization of start-up friction torque.

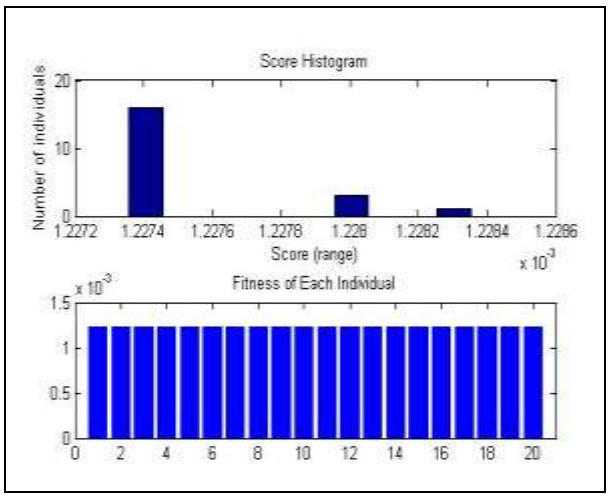

Fig- 4: Convergence diagram Score Histogram for fitness value for two variable optimization (population20, crossover probability0.7)

Fig.5 Convergence diagram selection function diagram for fitness value for two variable optimization process (minimization start-up friction torque) for hydrodynamic plain journal bearing. In this graph show and selection the number of children in two variable optimization process. And show the clearance and oil viscosity variable.

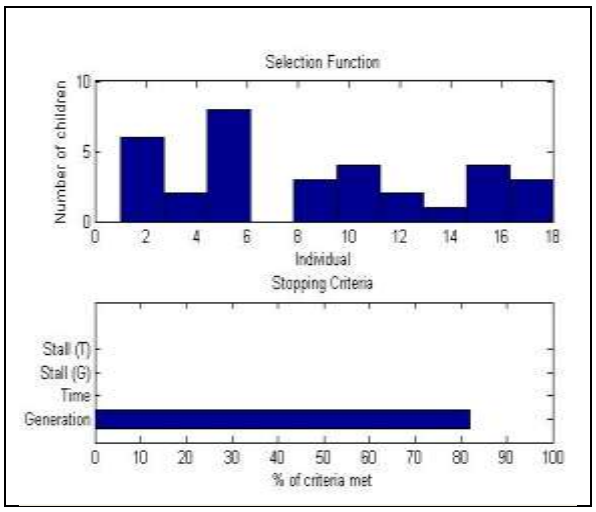

Fig-5: Convergence diagram selection function diagram for fitness value for two variable optimization processes.

Fig.6 Convergence diagram for fitness value (minimize start-up friction torque) for two variable (population size 20, crossover probability 0.7) in this graph two variable show in graph clearance and oil viscosity, in this graph oil viscosity is low and clearance value is high. And for best results this graph show current best individual.

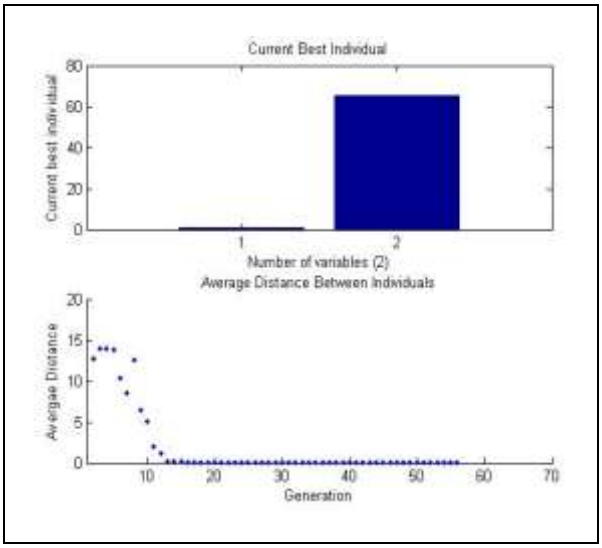

Fig- 6: Convergence diagram for fitness value (minimize start-up friction torque) for two variable (population size 20, Crossover probability 0.7)

6. CONCLUSION

The purpose of this study genetic algorithm is to utilize to optimally design a plain journal bearing to improve machines performance and to minimize power loss in start-up friction torque. The focus of this work is

optimization of design variable in a hydrodynamic journal bearing.

Minimize the start-up friction torque of plain journal bearing and minimize the power loss and save the machine and improve the journal bearing efficiency. Calculate the design variable (**1/69.997**) are generated and calculate the variable and minimum start-up friction torque **1.0583 N-m.**

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