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Investigation Of Performance Of Manufacturing Of A Two-Lobe Hydrodynamic Bearing Using CNC Machining

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Abstract– *This research focuses on the design, CNC manufacturing, and performance evaluation of a two-lobe hydrodynamic journal bearing. Hydrodynamic bearings play a vital role in supporting high-speed rotating machinery, and the two-lobe configuration offers improved stability and load-bearing capacity compared to conventional circular. Bearings.A Computer-Aided Design (CAD) model of the two-lobe bearing was developed and transferred to a CAM system for tool path generation. The bearing was fabricated using CNC machining to ensure high dimensional accuracy and surface finish. Performance evaluation was carried out using both experimental testing and numerical simulations, analyzing parameters such as pressure distribution, film thickness, load capacity, and thermal behavior under varying operating conditions.The results demonstrate that the two-lobe bearing exhibits better dynamic stability and reduced vibration tendencies. CNC machining proved effective in achieving the complex geometry with consistent quality. This study validates the suitability of CNC-manufactured two-lobe hydrodynamic bearings for advanced engineering applications.*

Keywords— *Two-lobe bearing, hydrodynamic journal bearing, CNC machining, performance evaluation, CAD/CAM, pressure distribution, fluid film, non-circular bearing design.*

INTRODUCTION

Hydrodynamic journal bearings are widely used in industries such as aerospace, automotive, and power generation. Among various designs, the two-lobe bearing offers superior stability due to its pressure modulation geometry. However, the complexity of its profile poses significant challenges in manufacturing. This study focuses on using CNC machining to precisely fabricate the two-lobe shape.

Extensive research has been carried out on multilobe journal bearings. Stanislaw Strzelecki [1] examined the influence of lobe geometry on the load-carrying capacity of two-lobe journal bearings. In further studies, Strzelecki and Sobhy M. Ghonheam [2] analyzed the behavior of dynamically loaded cylindrical journal bearings with recesses. Both researchers also contributed to the understanding of thermal issues in multilobe bearing tribosystems. Additionally, J. D. Knight and L. E. Barrett [3] proposed an approximate analytical method for multilobe journal bearings that incorporates thermal effects, validating their results through experimental comparison. Further investigations by Dr. G. Bhushan, Dr. S. Ratan, and Dr. N. P. Mehata focused on the impact of pressure dams and relief tracks on the performance of four-lobe bearing

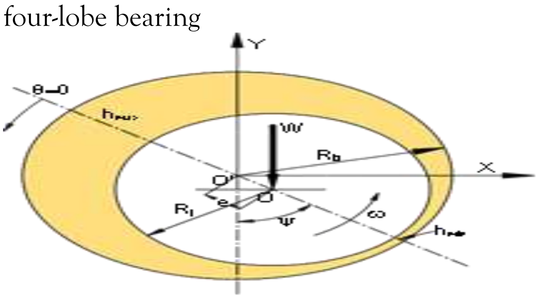

Fig1.SchematicofJournalbearinggeometry

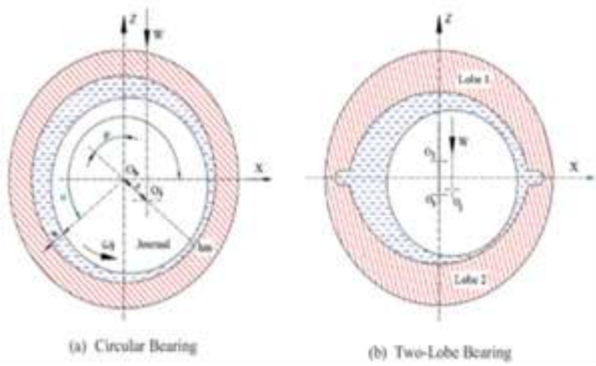

Fig2.Schematic Two Lobe Bearing

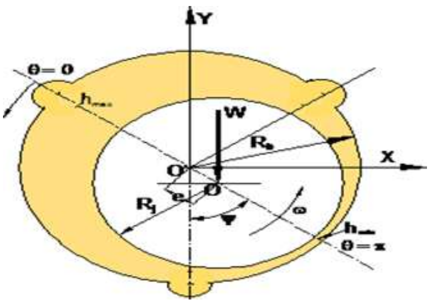

Fig3.Schematic Three LobeBearing

II.DESIGN AND MATERIAL SELECTION

Design of the Two-Lobe Bearing

The bearing was modeled using CAD software with the following specifications:

- Outer Diameter: 60 mm
- Inner Diameter: 40 mm
- Length: 50 mm
- Lobe Depth: 0.5 mm
- Lobe Angle: 120° spacing
- Material: Aluminum-bronze alloy (C95400)

III. CNC MACHINING PROCESS

CNC Machining Process

Material Preparation

- Raw cylindrical bar stock was cut to required length
- Face turning was performed for alignment and referencing

Machine Setup

- CNC Lathe with live tooling and 4-axis control
- CAM software (e.g., Fusion 360, Mastercam) used for toolpath generation

.Machining Steps

Rough Turning: Removed bulk material to near net-shape

- Contour Machining: Used form tools and multi-pass contouring to shape the lobes
- Boring Operation: Achieved internal geometry using a custom boring bar
- Finishing: Applied fine feed rates and reduced cutting depth for final profile
- Polishing: Honing and polishing for smooth surface finish (Ra < 0.4 µm)

Tooling Used

- Carbide inserts for roughing
- Diamond-coated tools for finishing
- Special form tool for non-circular geometry

IV. CNC PROGRAMMING USING G-CODE AND M-CODE

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%
O2000 (TWO LOBE BEARING - FINISH INTERNAL LOBE by using 4 axis machine)
G21 G40 G80 G90 (METRIC, CANCEL OFFSETS)
(Tool 1 - Lobe Profile Boring Tool)
T0101
G00 X45.0 Z2.0
G96 S120 M03 (Constant Surface Speed Mode)
G01 Z0 F0.15
(Engage to starting bore position)
G01 X39.5 F0.12
(Macro loop or subprogram call to create two-lobe profile)
M98 P3000 L1  (Call subprogram O3000 one time)
(Retract and return home)
G00 Z2.0
G00 X100.0
M05
M01
(End of main program)
M30
%
O3000 (SUBPROGRAM FOR TWO-LOBE PROFILE)
G91 (Incremental Mode)
(Example: move in X and C to trace a two-lobe shape, simplified)
G01 X-0.2 C60.0 F0.1
G01 X0.4 C60.0
G01 X-0.2 C60.0
G90 (Back to Absolute Mode)
M99
%
O0100 (CNC Turning centre ROUGH BORE FOR TWO-LOBE BEARING)
G21 (Metric)
G90 (Absolute Positioning)
G40 G80 G99
T0101 (Rough Boring Tool)
G96 S200 M03
G00 X45.0 Z2.0
G01 Z0 F0.15
G01 X38.0
G01 Z-50.0
G00 X45.0
G00 Z2.0
M05
M30
%
O0200 (2-LOBE BEARING PROFILE - 3-AXIS MILL)
G21 G17 G90 G40 G49
T1 M06 (6mm End Mill)
G00 G54 X0 Y0 Z5
S2000 M03
G43 H01 Z5.0
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G01 Z-5.0 F100
(Contour path for 2-lobe - simplified for illustration)
G01 X10 Y0
G03 X0 Y10 I-10 J0
G03 X-10 Y0 I0 J-10
G03 X0 Y-10 I10 J0
G03 X10 Y0 I0 J10
G00 Z5.0
M05
M30
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IV. QUALITY CONTROL AND TESTING

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. Quality Control and Inspection

- Dimensional Accuracy
- Measured using CMM
- Profile tolerance: ±0.01 mm
- Roundness and lobe depth verified with contour gauge and comparator
- Surface Finish
- Evaluated with surface profilometer
- Achieved Ra: 0.35–0.42 µm
- 4.3. Concentricity and Cylindricity
- Assessed using dial indicators and CMM probing
- Deviation within specified limits (< 0.02 mm)

V. RESULTS AND DISCUSSION

CNC machining proved highly effective for manufacturing the two-lobe bearing, delivering consistent geometry and high surface quality. The key challenges included toolpath planning for the non-circular shape and ensuring the integrity of the lobe transitions. Adaptive toolpaths and multi-axis strategies were crucial in achieving the required precision.

VI. CONCLUSION

This study confirms that CNC machining is a viable and efficient method for manufacturing two-lobe hydrodynamic journal bearings. The process enables the creation of complex internal geometries with tight tolerances and excellent surface finish. Future research may focus on automation, process optimization, and integration with in-situ performance monitoring.

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