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3d Design Of Journal Bearing Using Solidworks And Study The Effects Of Speed, Viscosity, And Load On Pressure Distribution Of Journal Bearing

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ABSTRACT
We modeled the journal bearing assembly using solidworks 2022 software and assembled the different parts using the software. We studied the motion animation of the assembly using the software and made effective changes in the basic design of the journal model and made it more effective.
We created and physically assembled the designed model and tested it in our college laboratory for various speed of journal, different viscosity oil, different loading and balancing condition , and on the pressure distribution of the oil from the journal bearing .
We plotted the graphs for axial and radial pressure acting on the journal bearing and studied the behavior of pressure distribution of oil from the journal bearing .

I. CHAPTER 1

INTRODUCTION

1.1 SOLIDWORKS SOFTWARE

The SOLIDWORKS CAD software is a mechanical design automation application that lets designers quickly sketch out ideas, experiment with features and dimensions, and produce models and detailed drawings. This document discusses concepts and terminology used throughout the SOLIDWORKS application. It familiarizes you with the commonly used functions of SOLIDWORKS.

Parts are the basic building blocks in the SOLIDWORKS software. Assemblies contain parts or other assemblies, called subassemblies. A SOLIDWORKSmodelconsists of 3D geometry that defines its edges, faces, and surfaces. The SOLIDWORKS software lets you design models quickly and precisely. SOLIDWORKS models are Defined by 3D design Based on components.

SOLIDWORKS uses a 3D design approach. As you design a part, from the initial sketch to the final result, you create a 3D model. From this model, you can create 2D drawings or mate components consisting of parts or subassemblies to create 3D assemblies. You can also create 2D drawings of 3D assemblies. When designing a model using SOLIDWORKS, you can visualize it in three dimensions, the way the model exists once it is manufactured.

1.2 JOURNAL BEARING

Definition of journal bearing :-

Journal Bearing is one of the most common and the simplest types of bearings and is a type of plain bearing. Essentially, a journal bearing is a shaft that rotates in the whole.

Journal bearings operate in the boundary regime (metal-to-metal contact) only during the startup and shutdown of the equipment when the rotational speed of the shaft (journal) is insufficient to create an oil film. It is during startup and shutdown when almost all of the damage to the bearing occurs.

Hydrostatic lift, created by an external pressurized oil feed, may be employed to float large, heavy journals prior to startup (shaft rotation) to prevent this type of damage. During normal operation, the shaft rotates at sufficient speed to force oil between the conforming curved surfaces of the shaft and shell, thus creating an oil wedge and a hydrodynamic oil film.

These bearings are limited to low-load and low-surface speed applications. Semi Lubricated journal bearings consist of a shaft rotating in a porous metal sleeve of sintered bronze or aluminum in which lubricating oil is contained within the pores of the porous metal. These bearings are restricted to low loads, low-to-medium velocity and temperatures up to 100°C (210°F).

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Tilting-pad or pivoting-shoe bearings consist of a shaft rotating within a shell made up of curved pads. Each pad is able to pivot independently and align with the curvature of the shaft.

II. CHAPTER 2

LITERATURE REVIEW

1) **State of the science**

What Have Recent studies journal bearings found, how have they been conducted, by whom, and what developments have been made to the technology? A tremendous amount of research effort has been given to the subject of hydrodynamic journal bearings over the course of the second half of the 20th century and the beginning of the 21st century.

2) **Lund's groundbreaking work in the understanding of journal bearing dynamics, understanding of the function of hydrodynamics**

Journal bearings has been steadily developed with at least a couple research groups around the world producing a steady flow of research results. The advent of improved computers has given much to simulations of journal bearings however with ever improving simulation software, the need for tangible experimental results becomes essential. Unfortunately, unlike much tribological testing, test equipment for journal bearings is neither standardized nor versatile. Further antagonizing this is the complexity of thermal and dynamic effects taking place in hydrodynamic journal bearings under operation, which extend over several length scales

3) **University of Virginia One of these groups led by Ron Flack:**

University of Virginia has determined characteristics of many different bearing geometries using a test rig in which the bearing housing was shaken against a rigidly mounted shaft. Of note in this series of works is that the error between the theoretical and experimental values is generally more reasonable than the majority of research work within this field. These works provided valuable bearing data regarding a number of bearing configurations. Investigations on pad pivot friction in tilting pad bearings found that rocker pivoting pads caused the shaft loci to take a straight line path to its equilibrium location under increased loading while in the ball and socket case, the shaft took a curved path. Similarly in the case of cross-coupled dynamic coefficients, the rocker pivot bearing's coefficients were equal to zero while the ball and socket pivot bearing's coefficients were not equal to zero, and were significant.

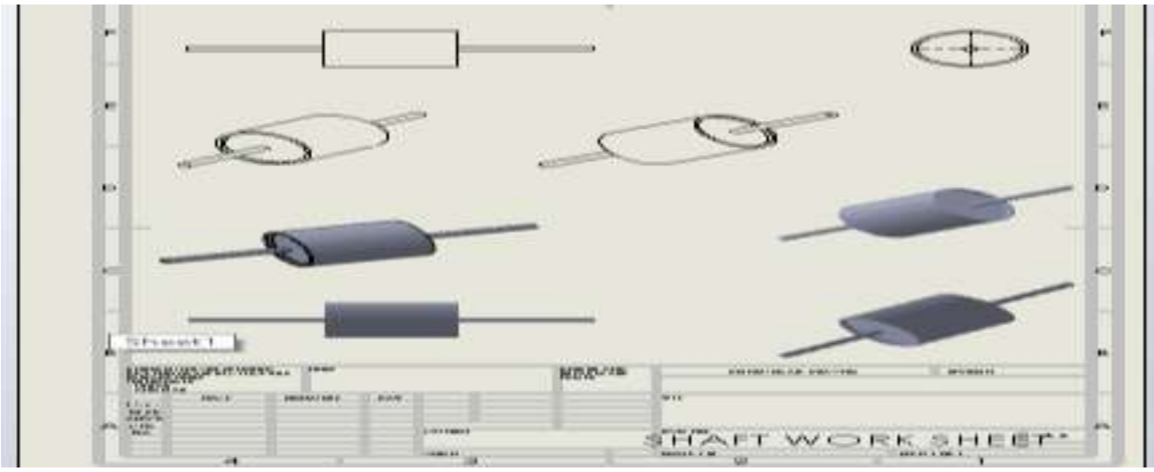
4) **Texas A&MUniversity**

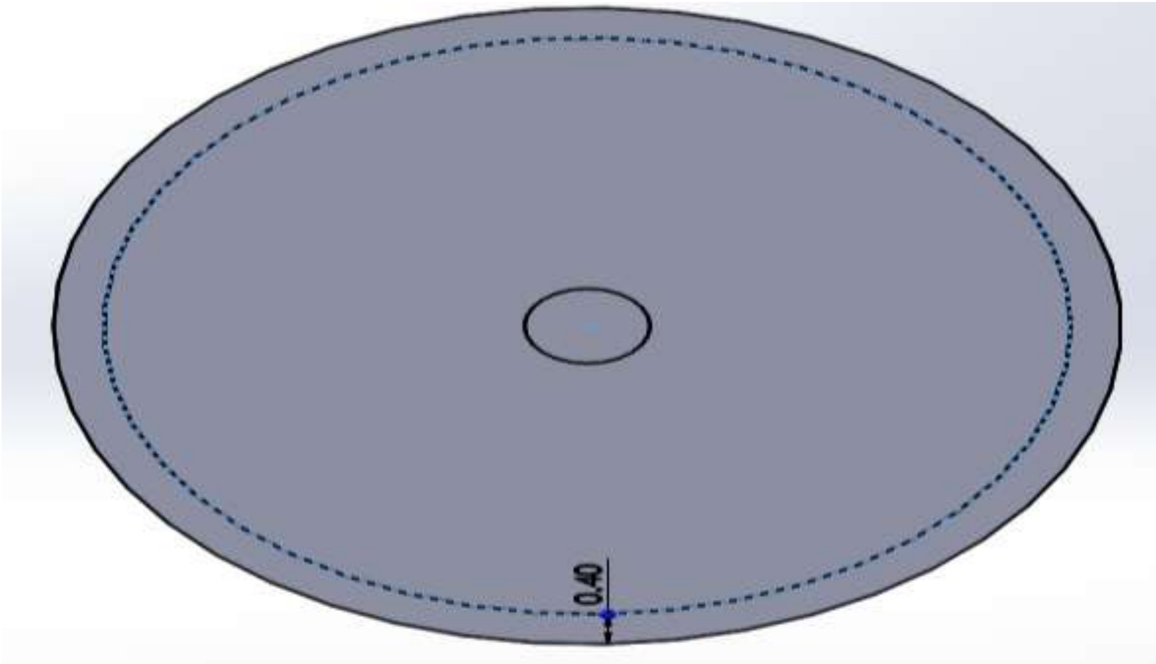
The other main group of researchers in the field of bearing dynamics during the last 15 years is led by Dara Childs and Luis San Andres at Texas A&M University. They conducted very similar work to Flack et al. using a host of similar test rigs generally with a stationary shaft and a bearing or squeeze-film damper excited by hydraulic shakers. This work has been centered on studying the characteristics of various bearing configurations. Squeeze-film dampers were

CHAPTER 3

DESIGN OF JOURNAL BEARING USING SOLIDWORKS

3.1 SHAFT OF JOURNAL BEARING

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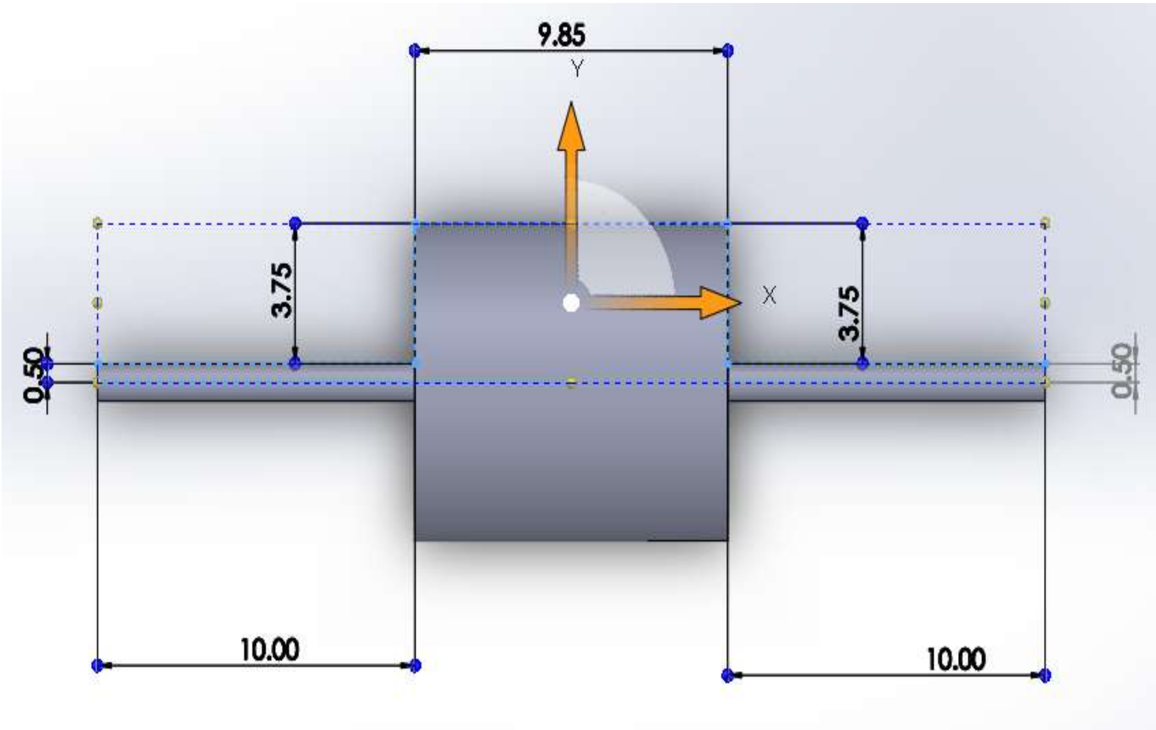
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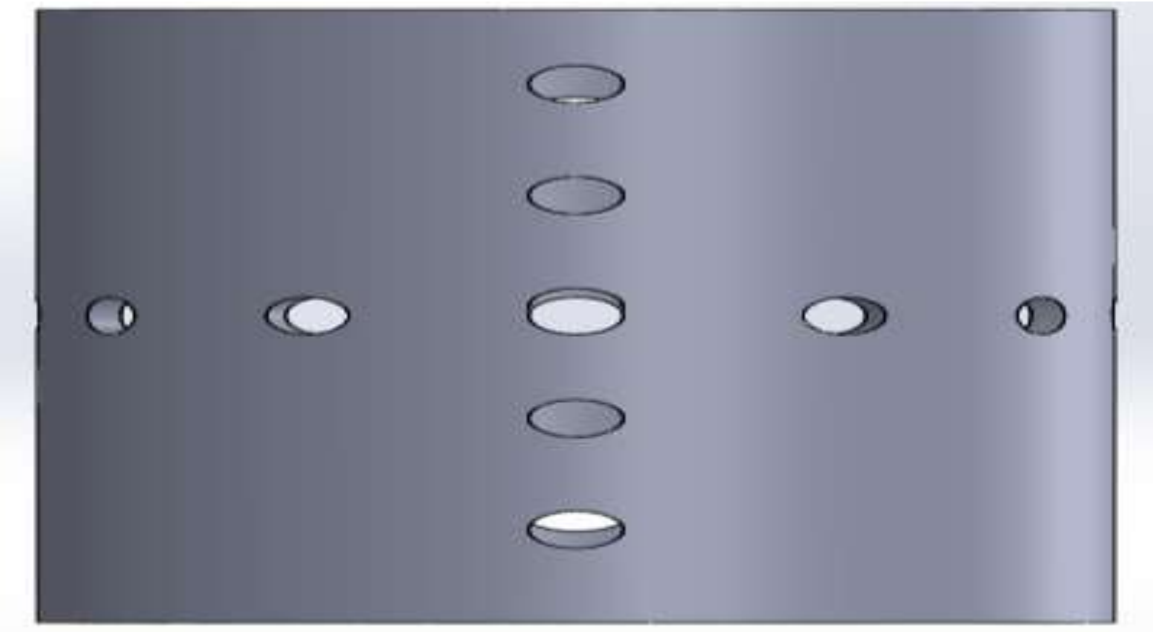
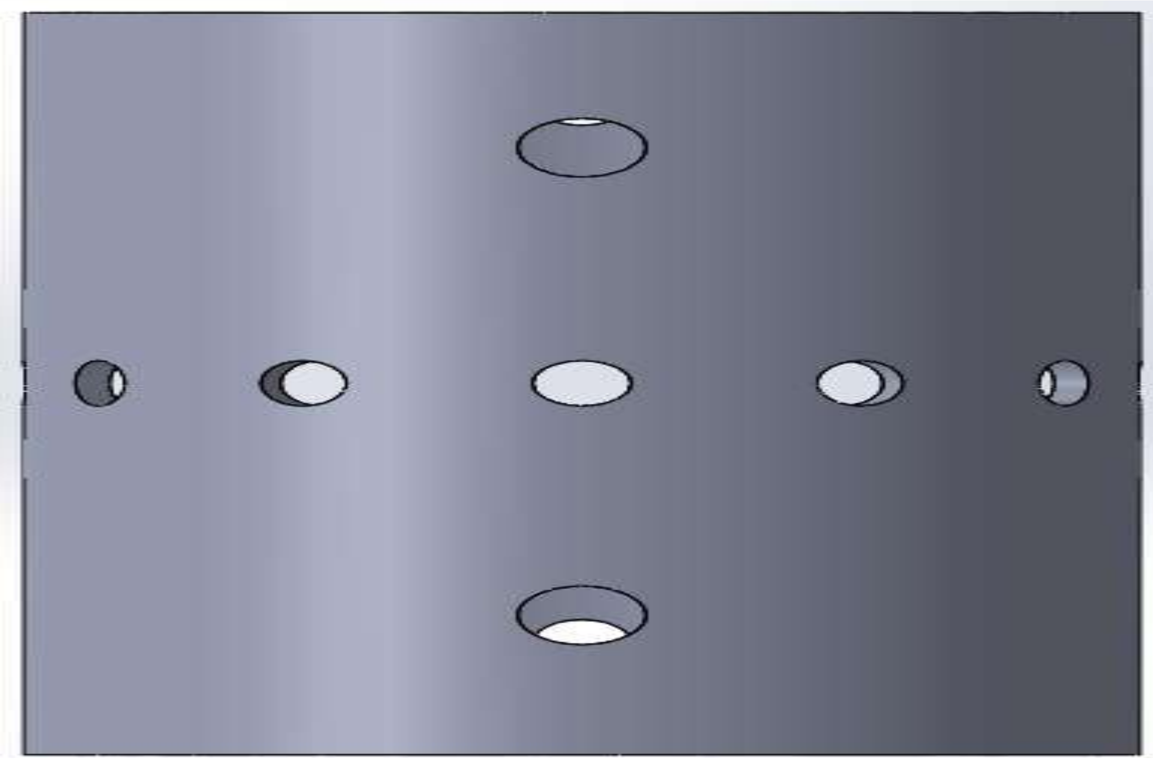
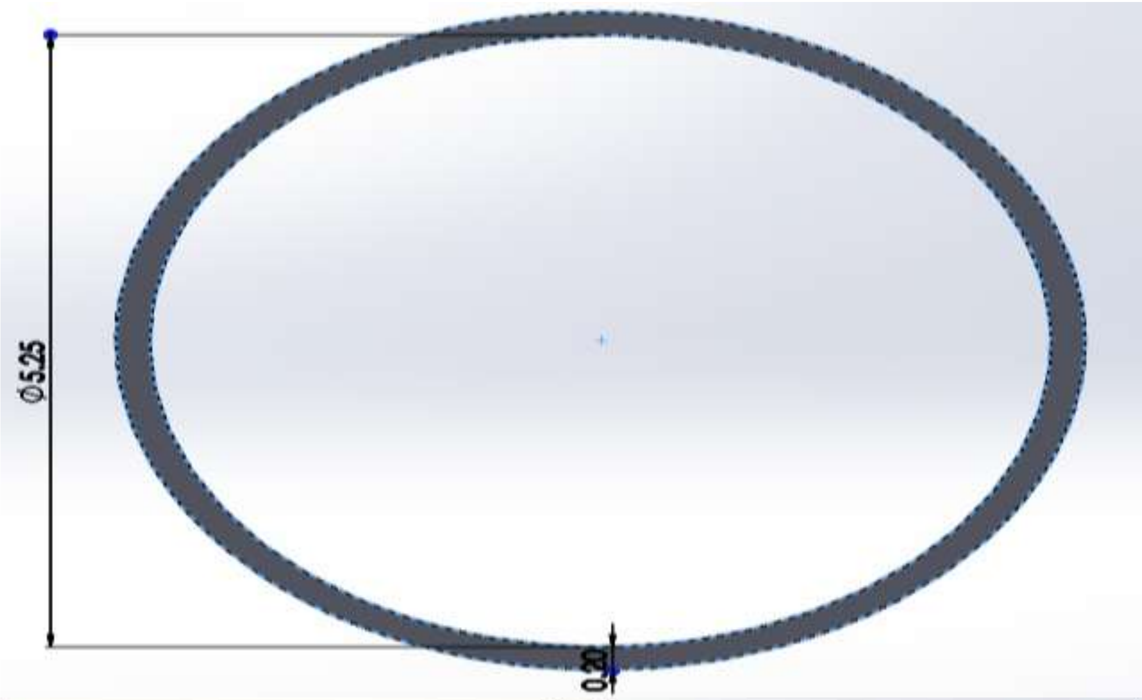
3.2 BODY OF JOURNAL BEARING



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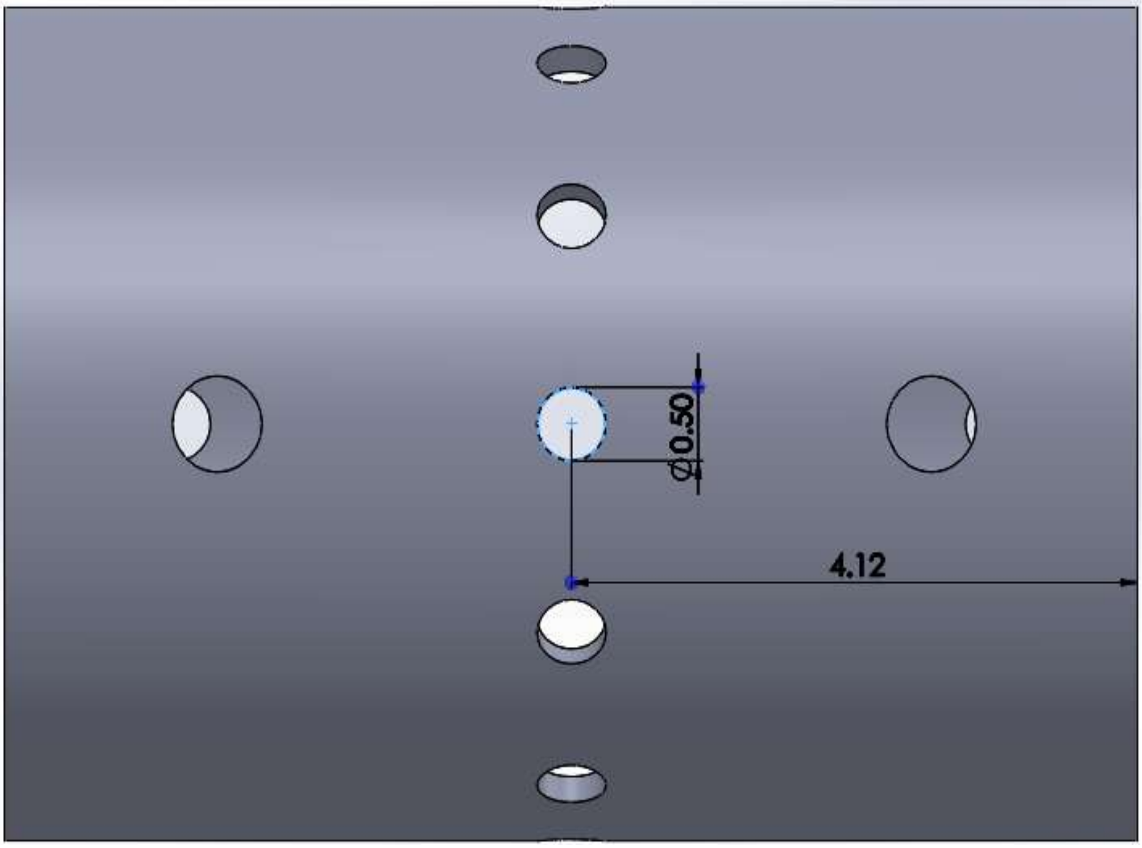
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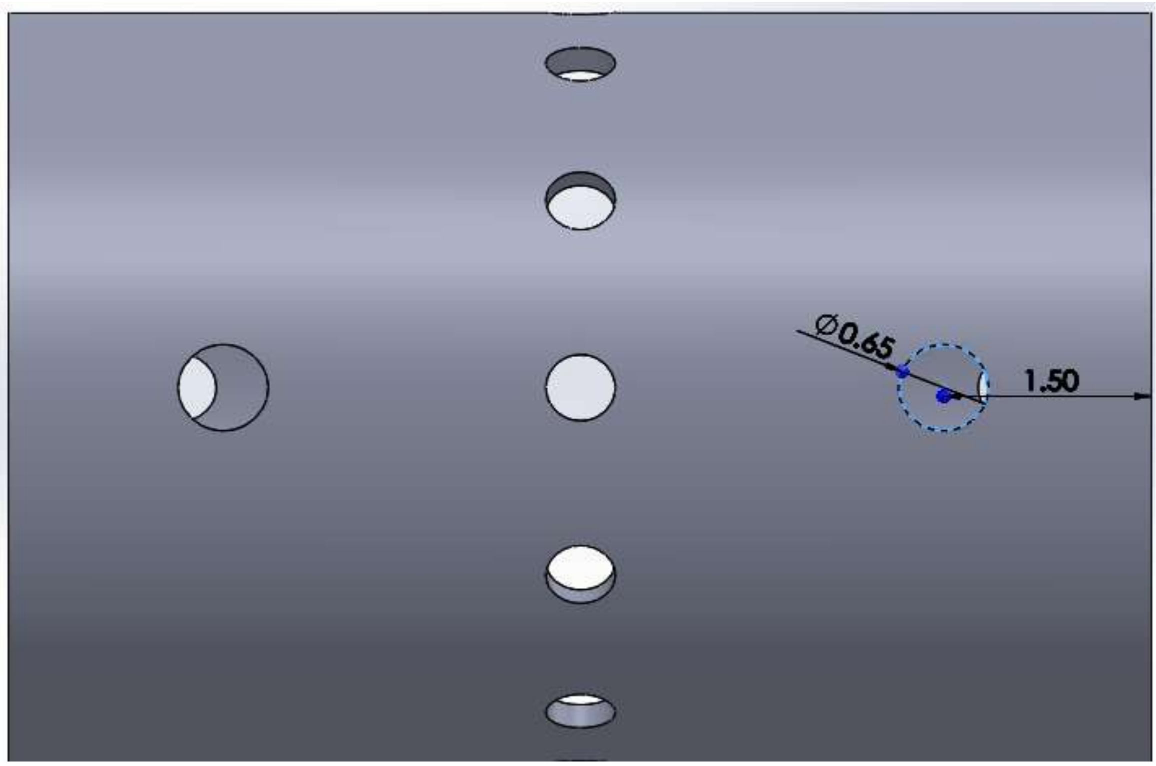

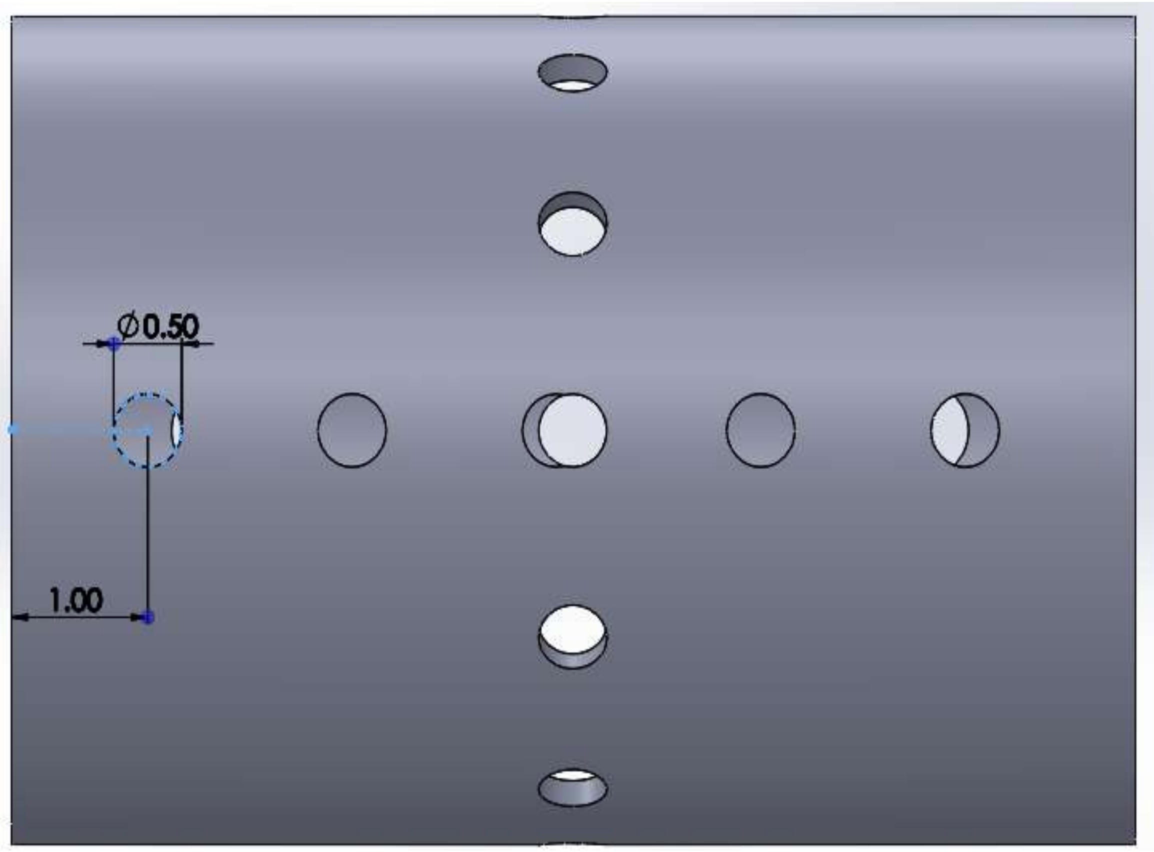

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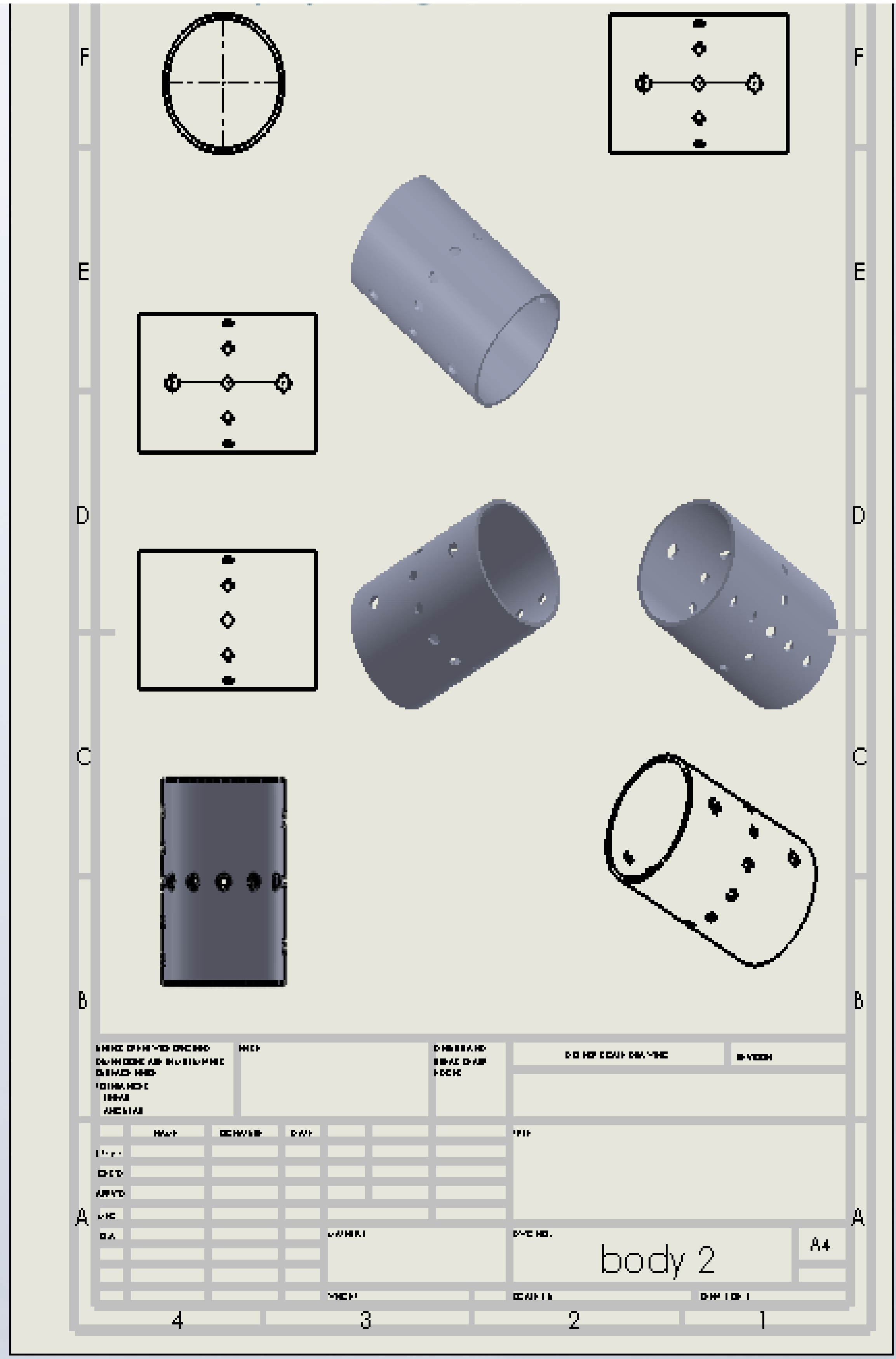
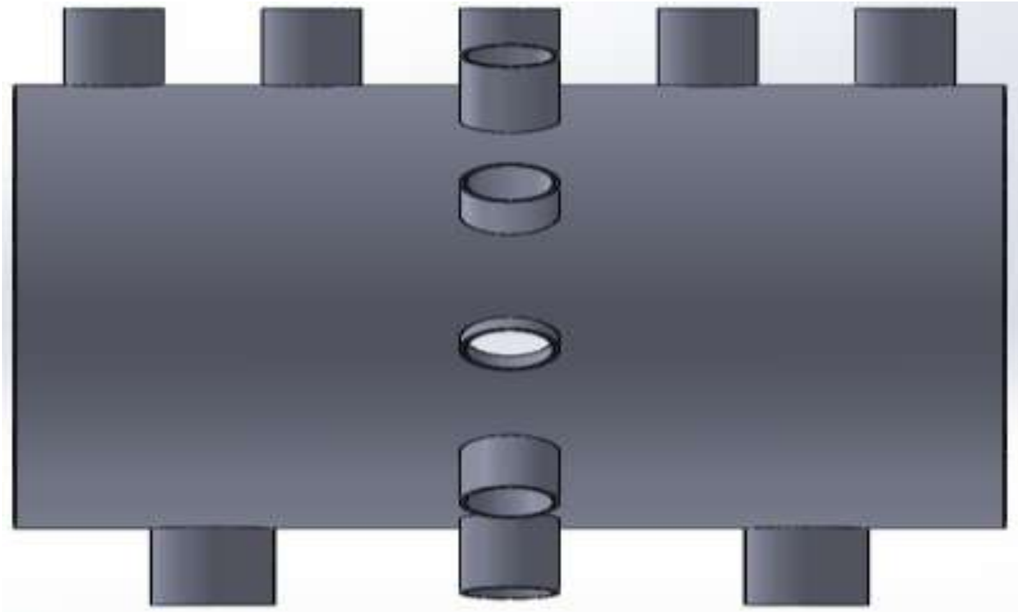
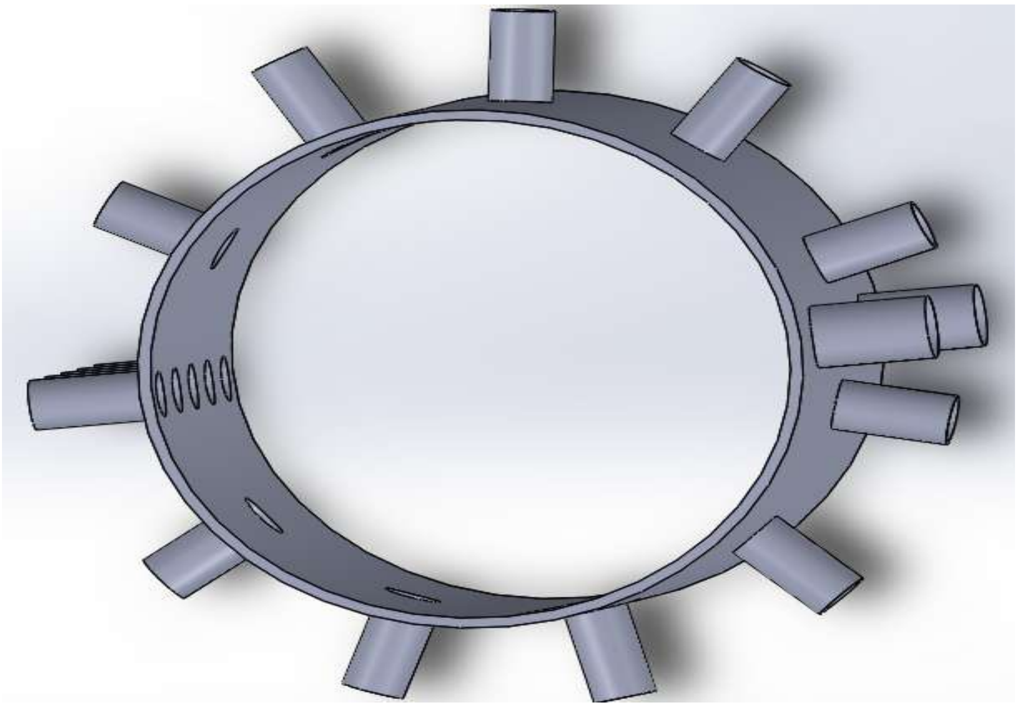


3.3 JOURNAL BEARING CASING





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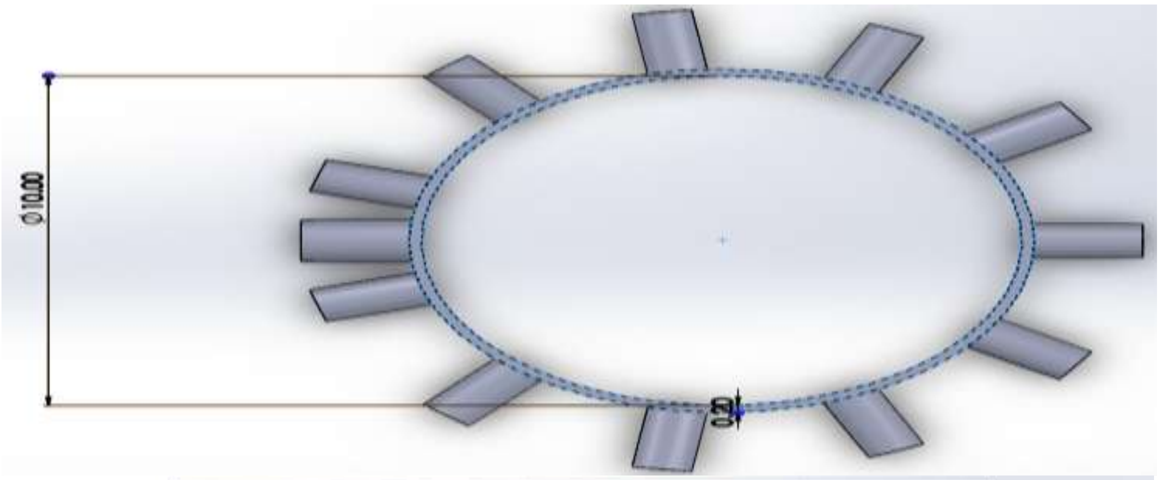

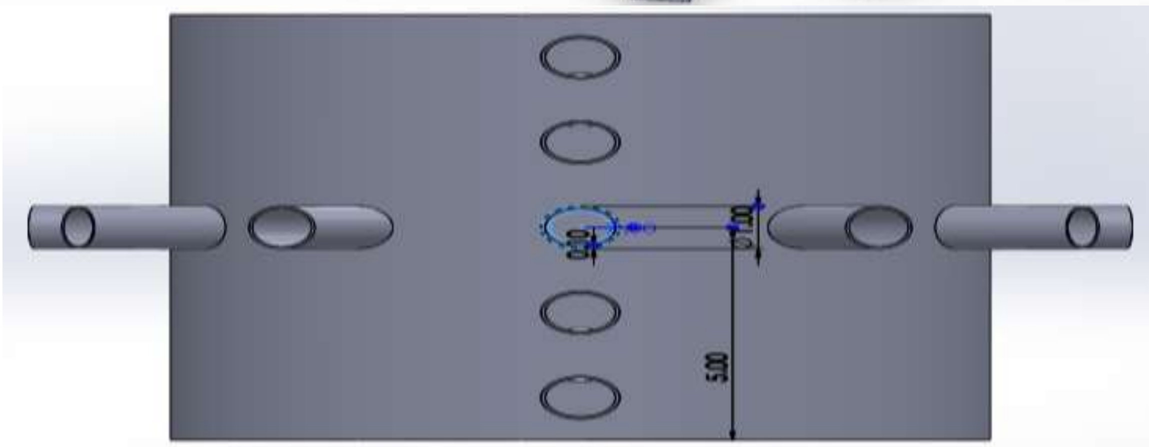

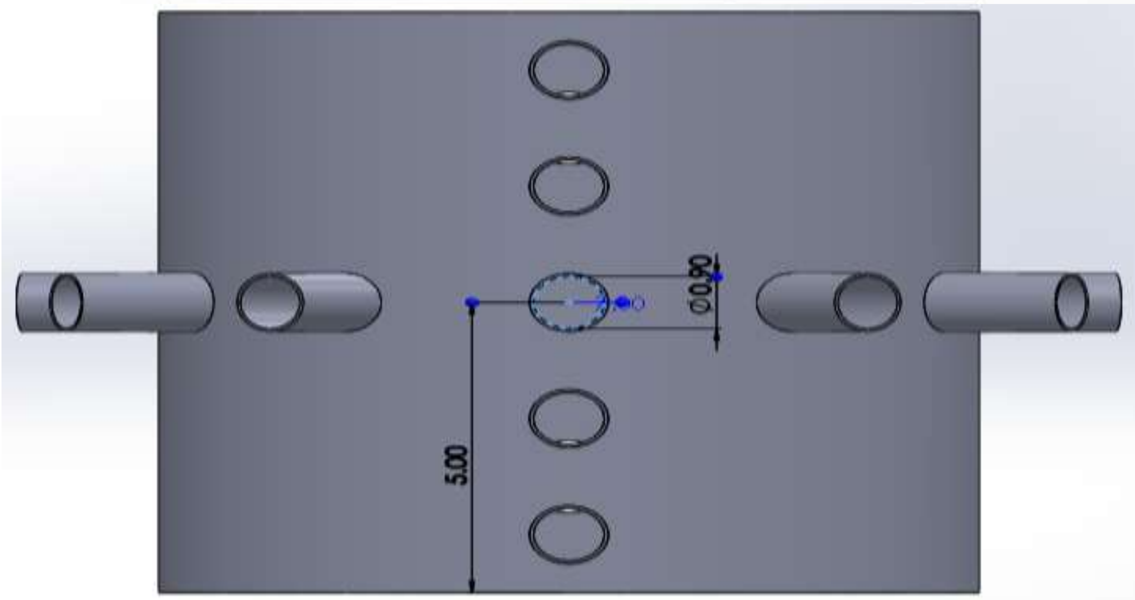

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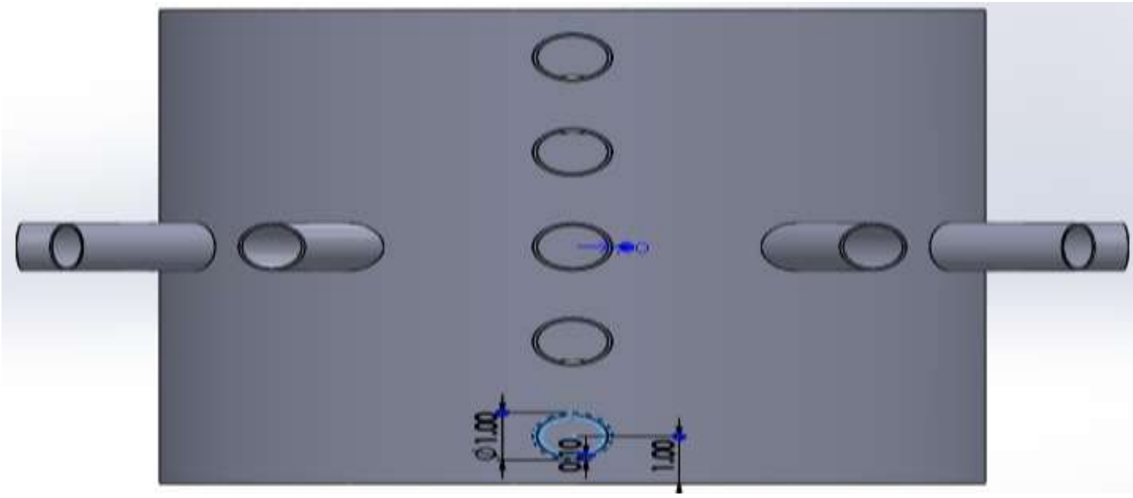

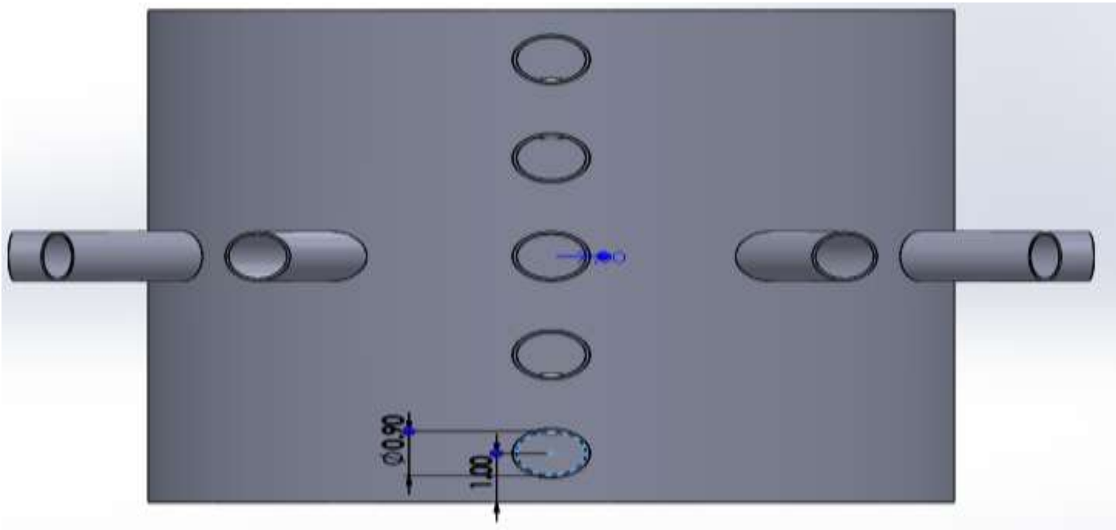

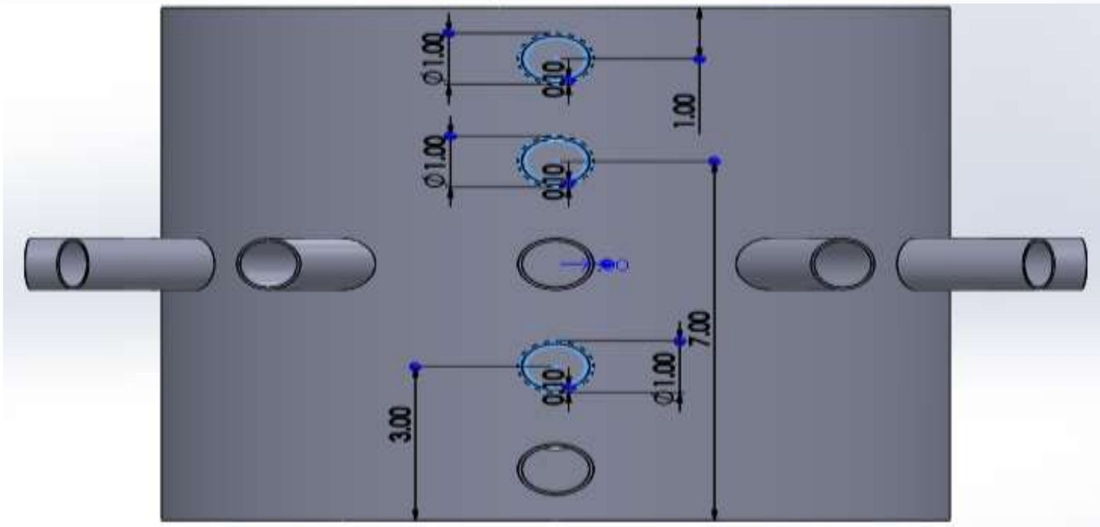

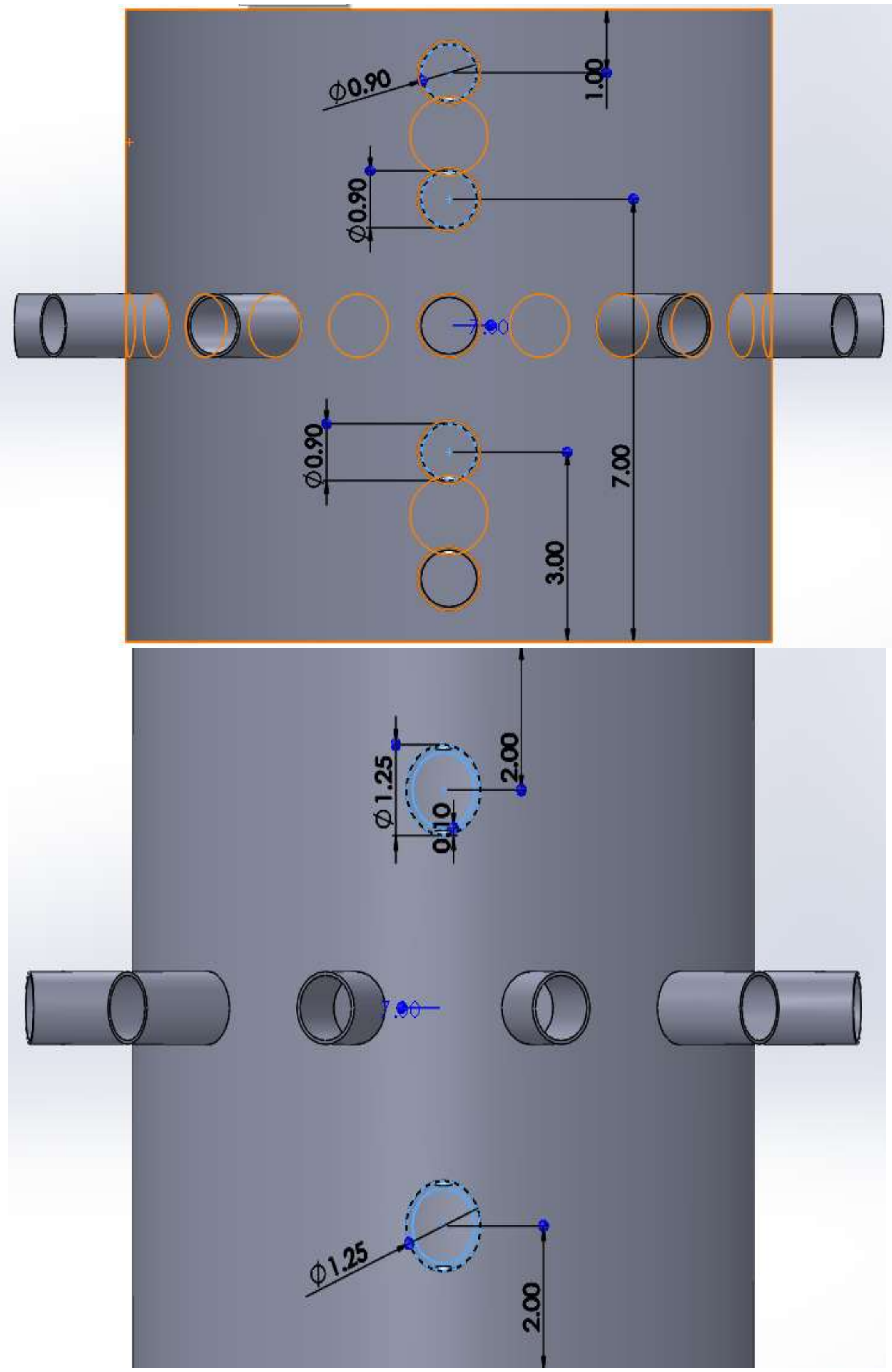
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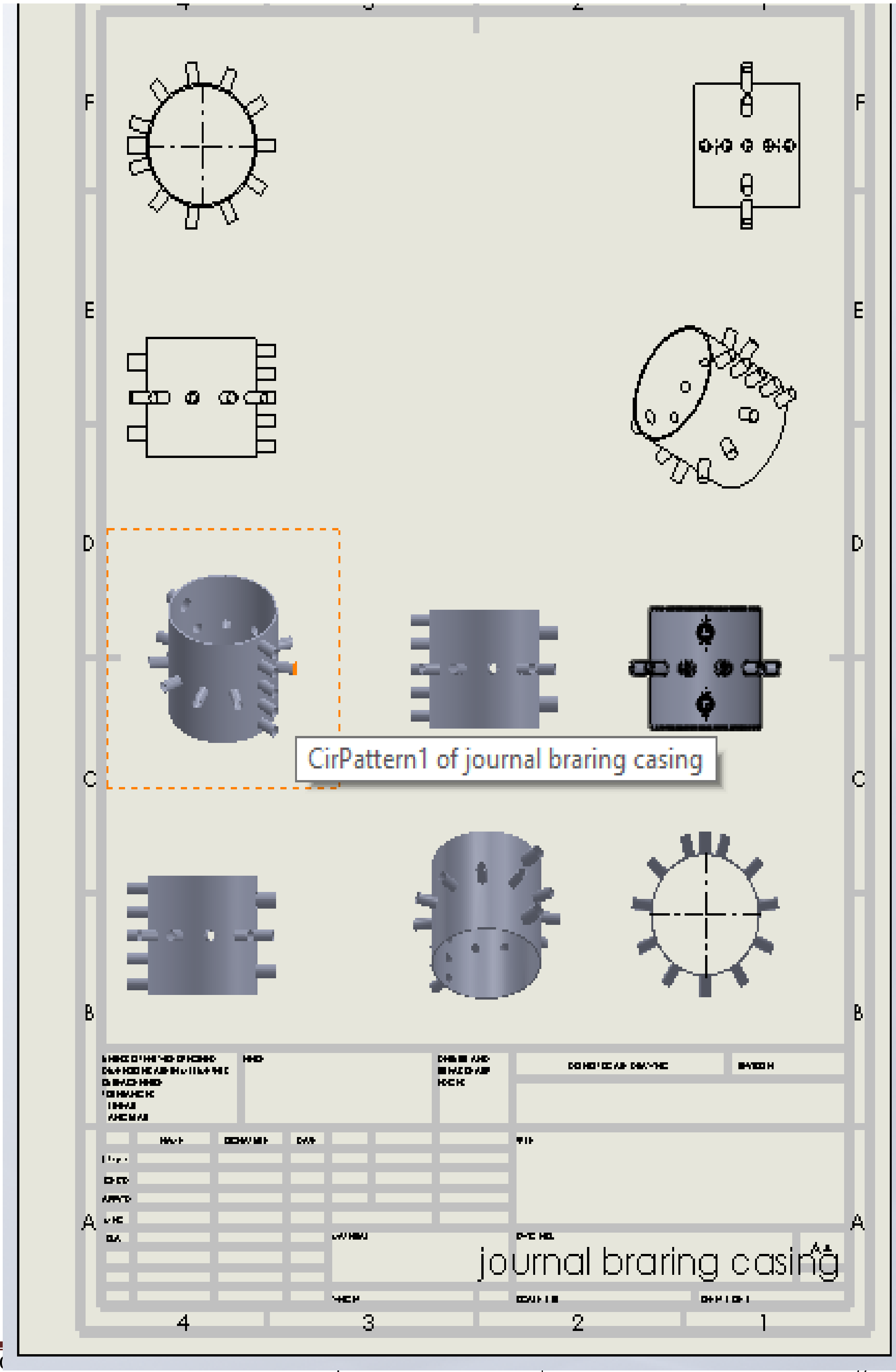
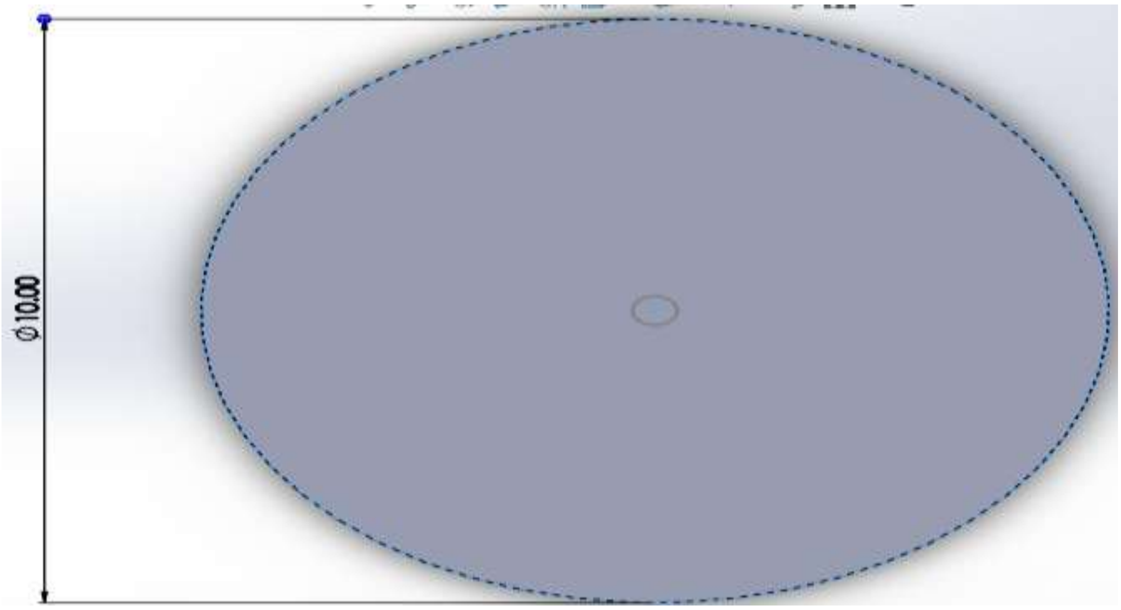
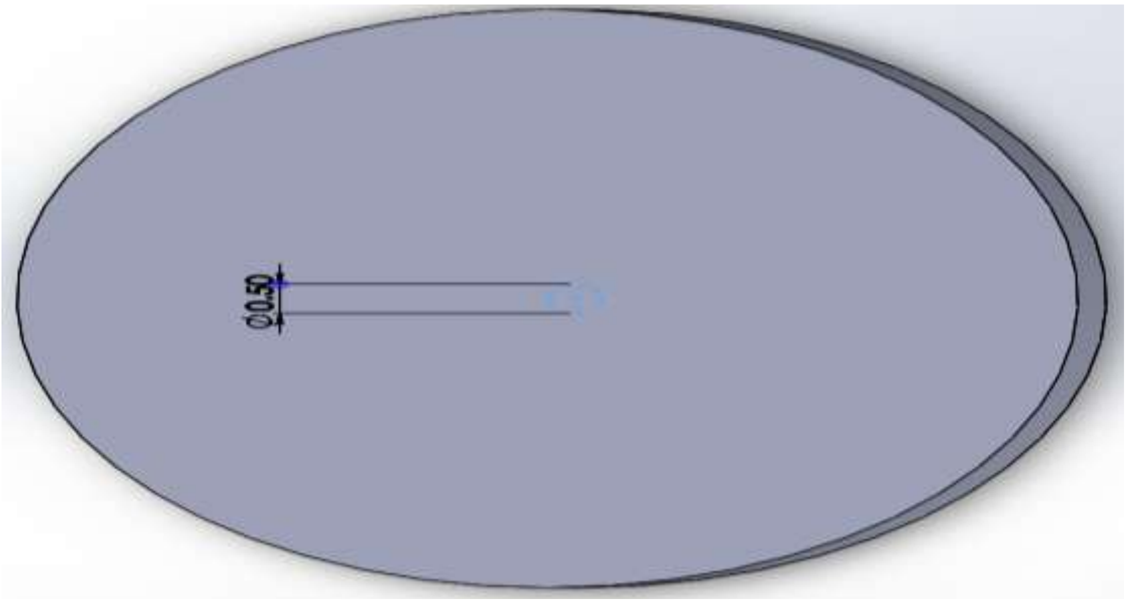
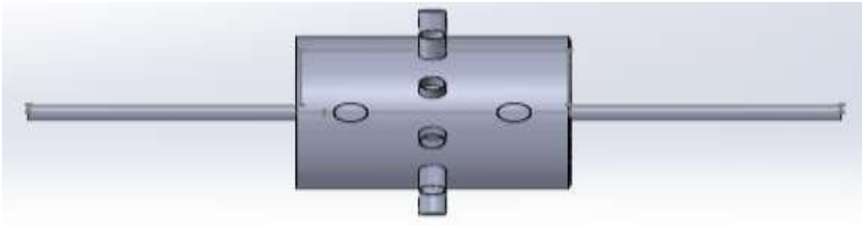

CirPattern1 of journal braring casing
journal braring casing

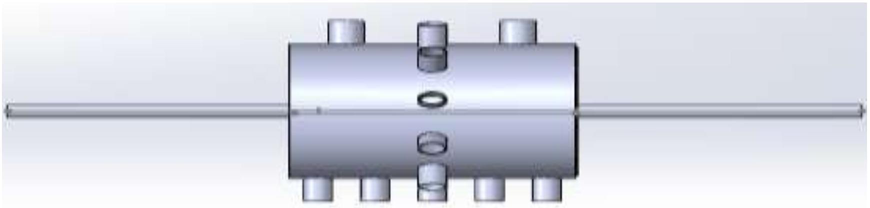
3.4 SIDE COVER FOR BEARING CASING

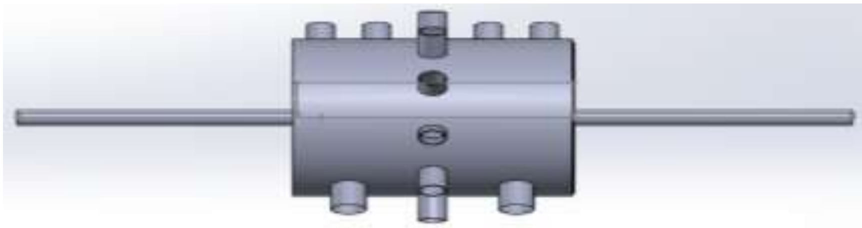




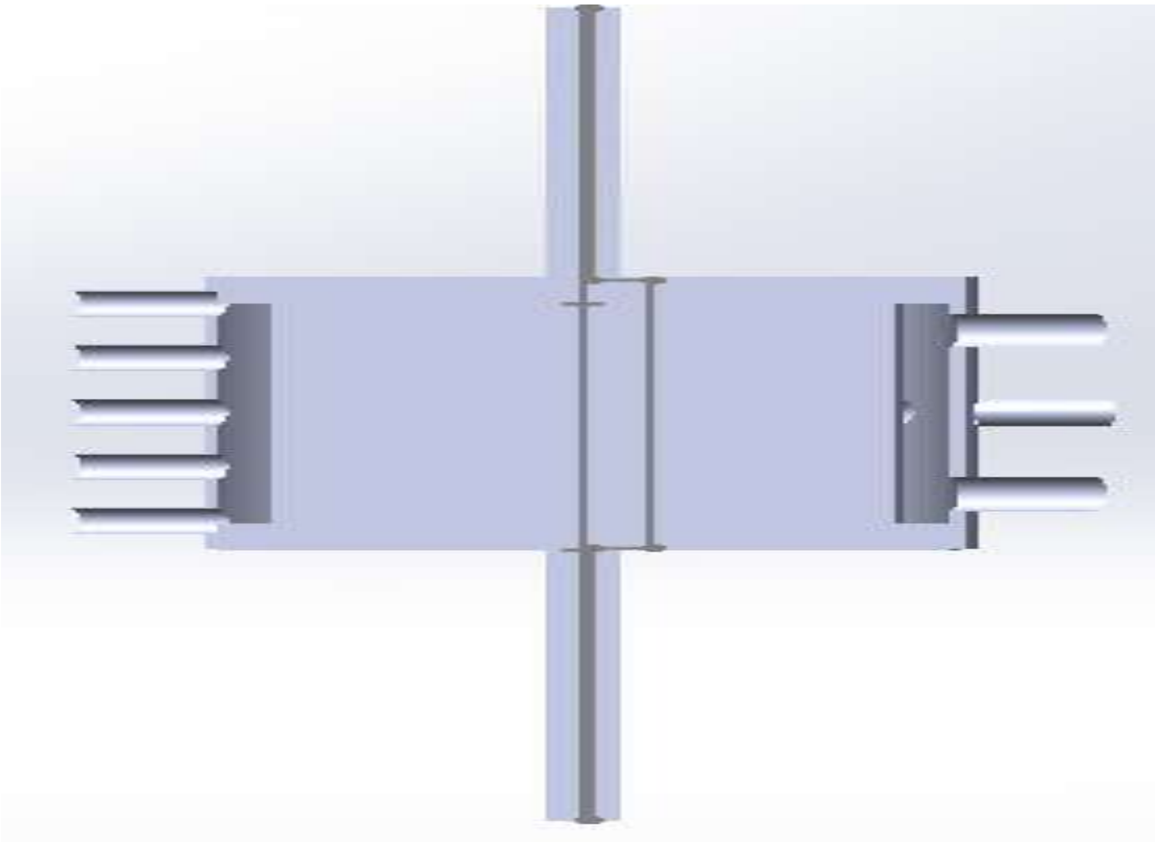
3.5 COMPLETE ASSEMBLY OF JOURNAL BEARING

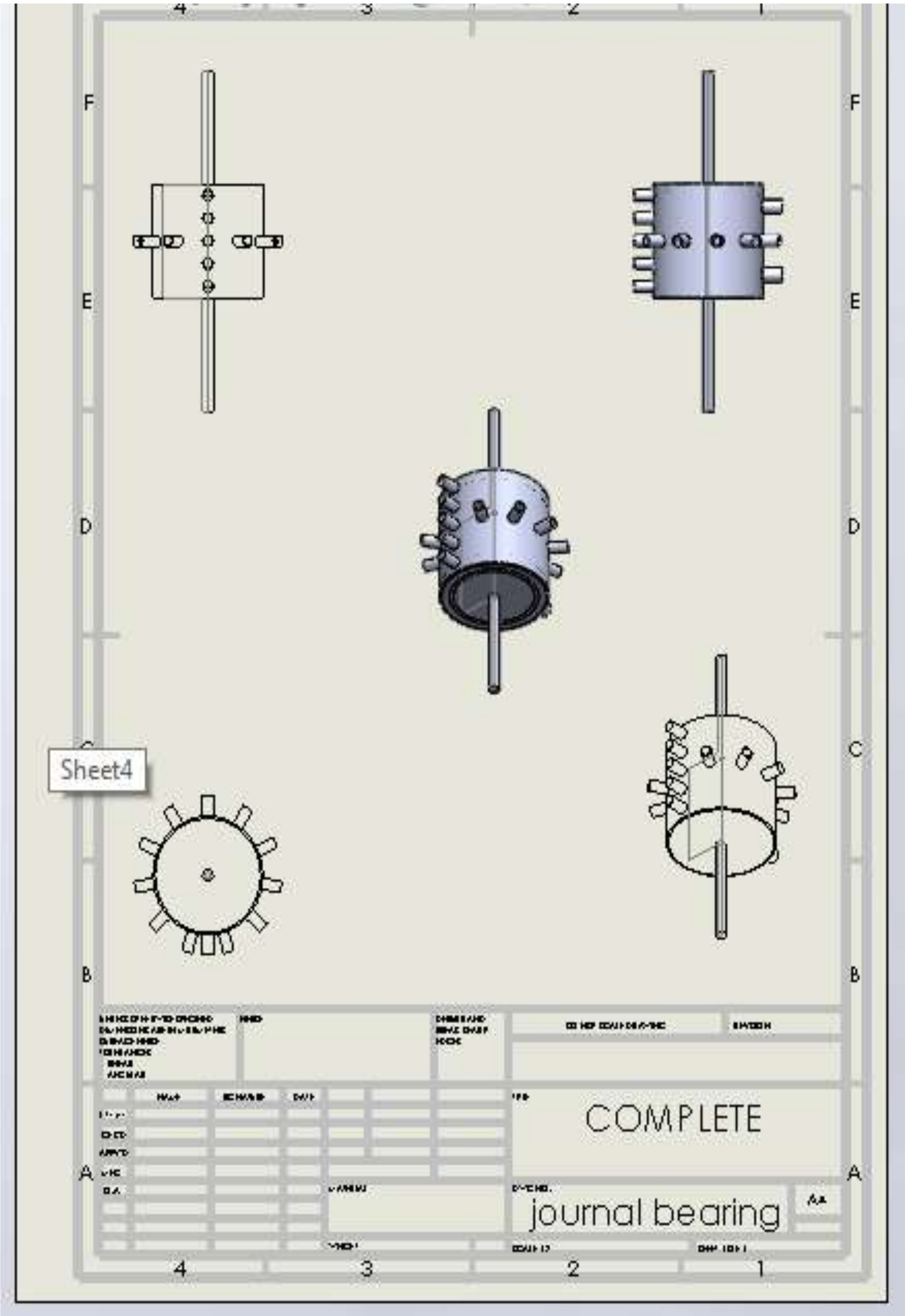






3.6 CROSS SECTION VIEW OF JOURNAL BEARING

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COMPLETE
journal bearing

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3.7 TOOLS USED DURING DESIGN

SL. NO	Tools (2D)
1	Plane
2	Line
3	Circle
4	Offset
5	Smart dimension
6	Trim
7	Extend
8	Linear pattern
9	Circular pattern

Sl no	Tools (3D) and Assembly tools
1	Extrude boss
2	Revolve boss
3	Extrude cut
4	Circular and linear pattern
5	Import
6	Rotate of assembly
7	Mates 1) Concentric 2) Parallel 3) Distance 4) Perpendicular 5) Connective
8	Motion view and cross-section view

III. CHAPTER 4

JOURNAL BEARING EXPERIMENTAL PROCEDURE AND GRAPHICAL REPRESENTATION OF DATA

AIM :-

To determine the hydrodynamic pressure distribution in full journal bearing using graphs .

APPARATUS :-

1) JOURNAL BEARING
2) ELECTRIC MOTOR
3) VOLTAGE REGULATOR
4) PIPE
5) OIL
6) MEASURING TAPE

THEORY OF JOURNAL BEARING WORKING :-

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1) Friction The force of resistance in the relative motion between the two subjects surface in contact point
2) to reduce the friction surface required application lubrication is fluid and there is enough space between the surface to separate them completely by a fluid film
3) the oil fill between the surface is theme such that there is no metal metal interaction

PROCEDURE FOR CONDUCTING OF EXPERIMENT

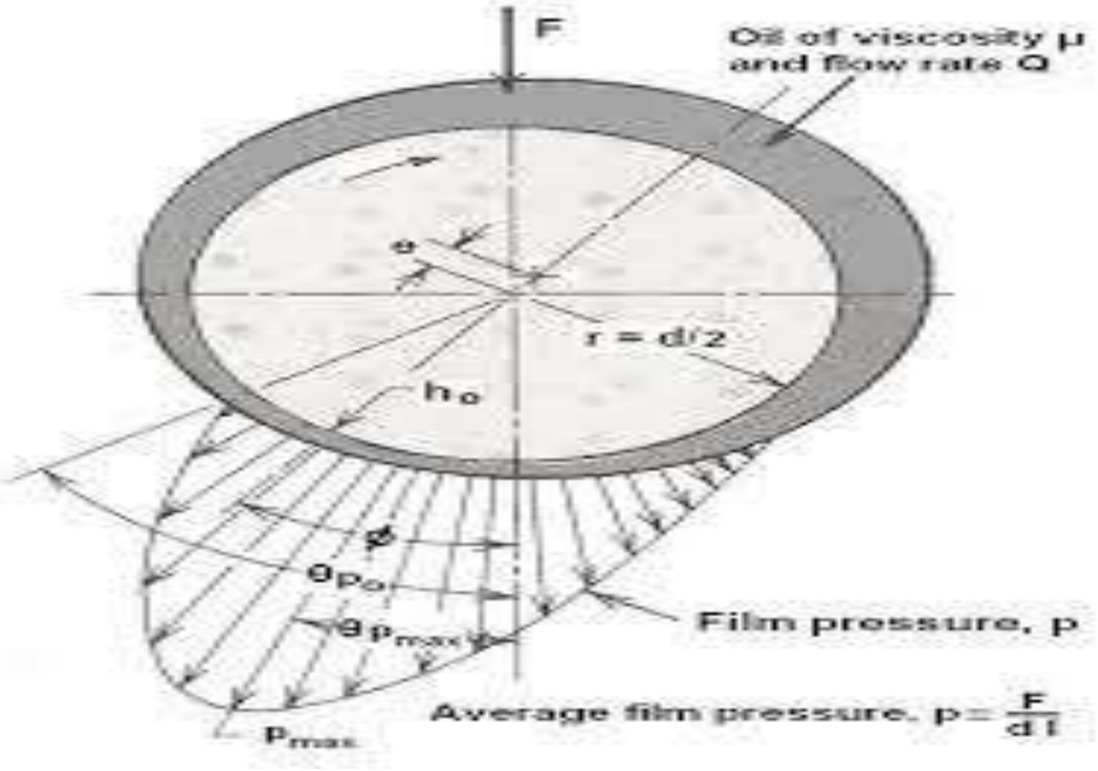
1) Fill the oil tank completely with oil
2) Note down the initial reading P 0
3) Make sure that oil in every bite is at the same level in the beginning
4) make sure that there are no air Bubbles in the pipe
5) turn on the motor
6) set it to the lowest voltage possible and let it Run for 10 to 15 minutes
7) slowly increase the speed by increasing the voltage
8) note down the oil readings
9) measure the speed of the journal bearing
10) tabulate the values and draw the graph

FORMULA :-

P=ϱgh

1) P= pressure
2) ϱ= density of oil
3) g= gravitational constant (9.8)
4) h= height to which the oil rise in the tube (h=p-p0)

DIAGRAM :-



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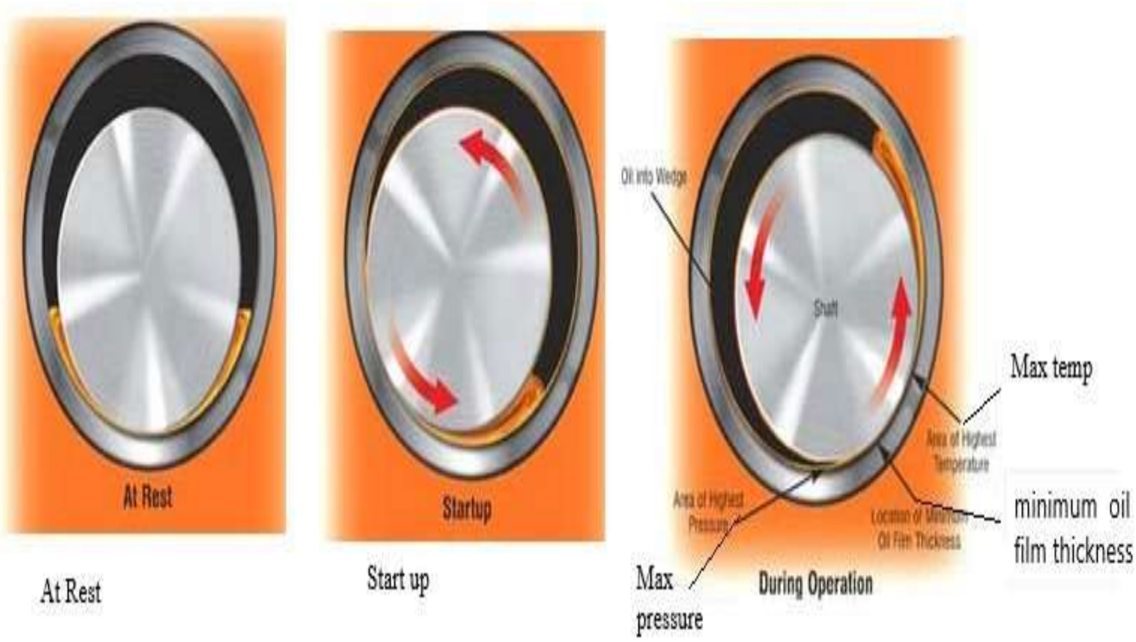
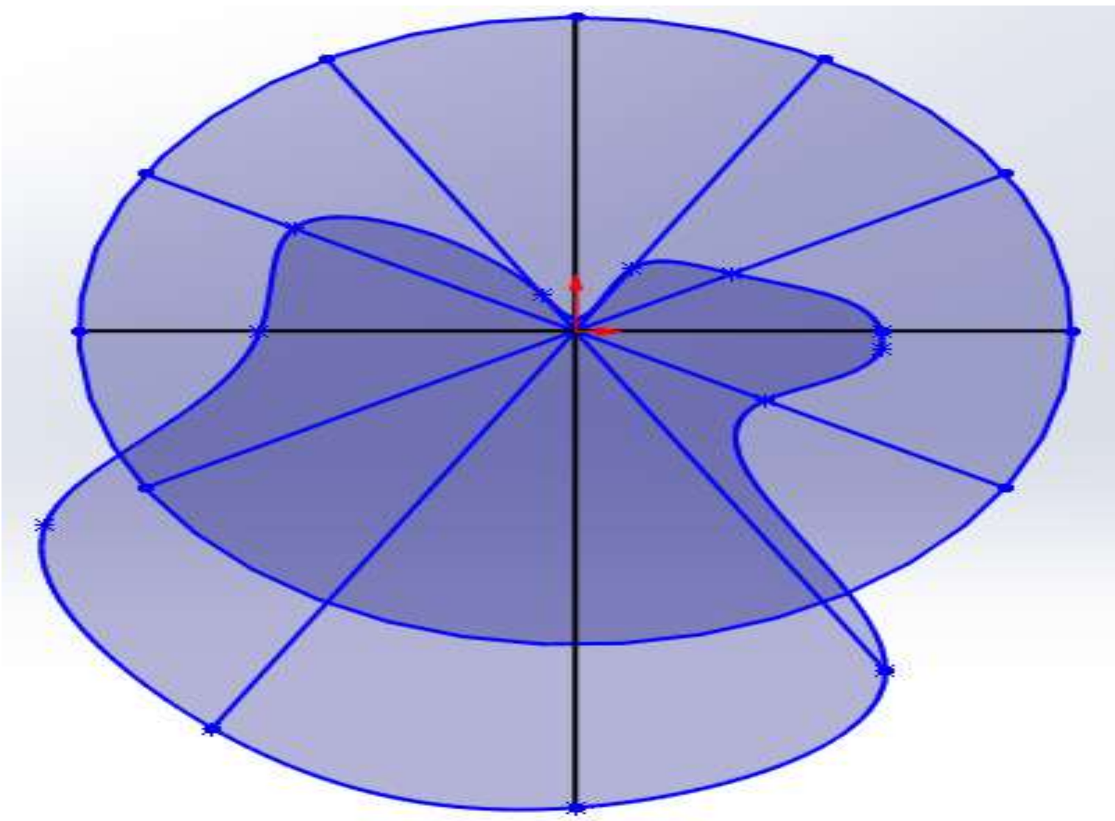


GRAPH :-



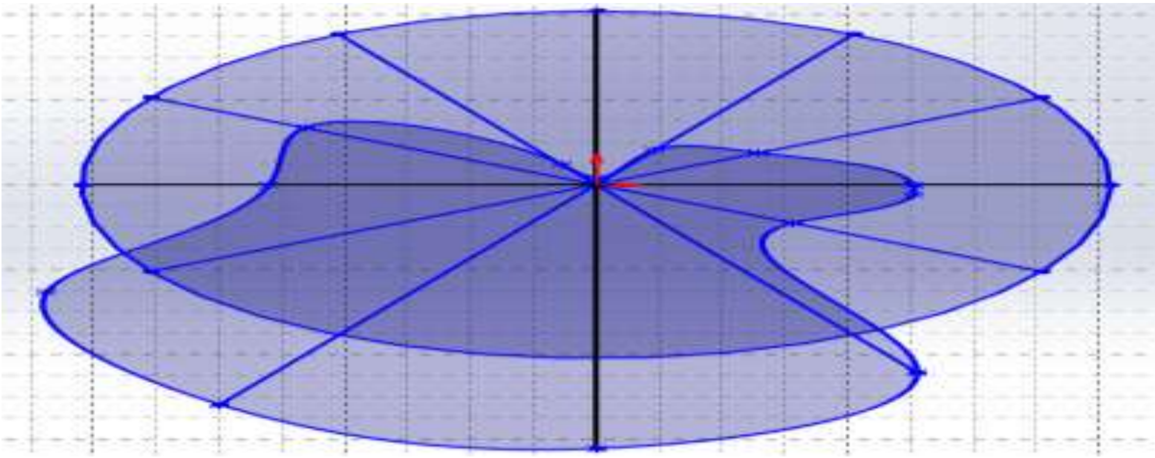
SET -1
OBSERVATION :-
1) Speed:- 650rpm
2) Voltage:- 40V
3) Density :- 950kg/m^3

4) Initial pressure(p0) :- 52cm

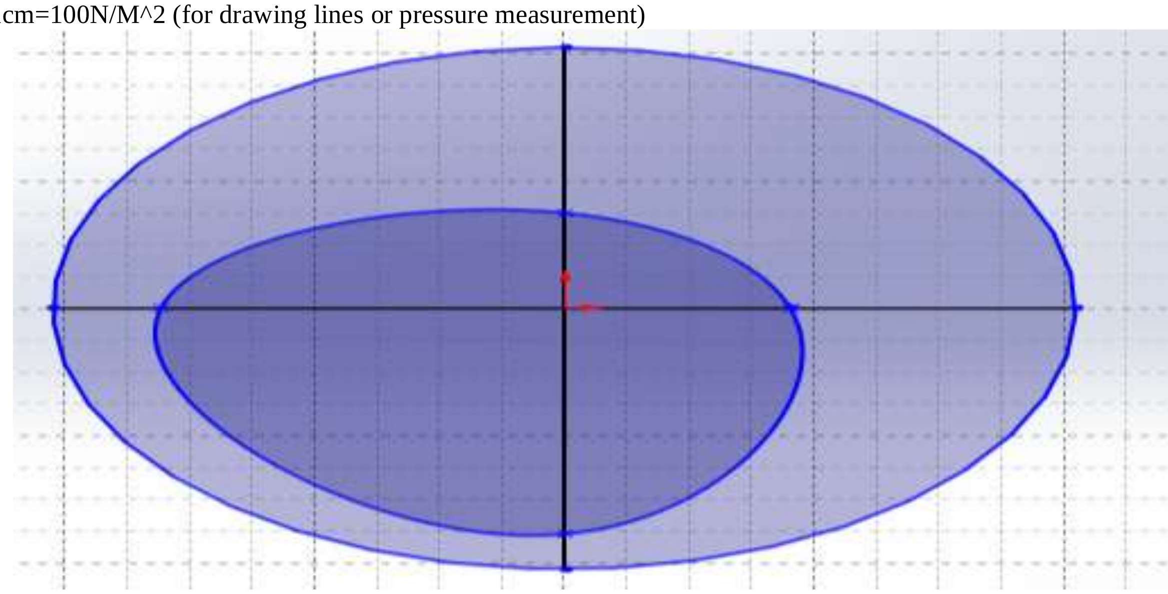
Tabular column :-

SL.NO	P0in cm	P in cm	$\lvert p - p0 \rvert = h$ in cm	P=ϱgh in n/m^2
1	52	48.5	3.5	32 5.85
2	52	49.9	2.1	195.51
3	52	50.7	11.3	121.03
4	52	52.2	0.2	18.6
5	52	52.8	20.8	74.4 8
6	52	55.7	3.7	344.47
7	52	48.5	3.5	325.85
8	52	58.9	6.9	642.39
9	52	60.2	8.2	763.42
10	52	60.5	8.5	79 1.35
11	52	59	7	651.7
12	52	55	3	279.3
A	52	54.5	2.5	232.75
B	52	54	2	186.2
C	52	56.4	4.4	409.64
D	52	56.8	4.8	44 6.88

RADIAL PRESSURE GRAPH:-
SCALE :-
1cm=10cm (for drawing circle)
1cm=100N/M^2 (for drawing lines or pressure measurement)



AXIAL PRESSURE GRAPH:-
SCALE :-
1cm=10cm (for drawing circle)
1cm=100N/M^2 (for drawing lines or pressure measurement)



SET -2
OBSERVATION :-
5) Speed:- 1130rpm
6) Voltage:- 60V
7) Density :- 950kg/m^3
8) Initial pressure(p0) :- 52cm

Tabular column :-

SL.NO	P0in cm	P in cm	$\lvert p - p0 \rvert = h$ in cm	P=ϱgh in n/m^2
1	52	44.3	7.7	716.87
2	52	47.6	4.4	409.64
3	52	48.8	3.2	297.92
4	52	50.9	1.1	102.41
5	52	52.6	0.6	55.86
6	52	48	4	372.4
7	52	47.25	4.75	442.225
8	52	62.25	10.25	954.275
9	52	62.5	10.5	977.55
10	52	60	8	744.8
11	52	54.6	2.6	242.06
12	52	54.2	2.2	204.82
A	52	53	1	93.1
B	52	56.4	4.4	409.64
C	52	57.4	5.4	502.74
D	52	58	6	558.6

RADIAL PRESSURE GRAPH:-
SCALE :-
1cm=10cm (for drawing circle)
1cm=100N/M^2 (for drawing lines or pressure measurement)

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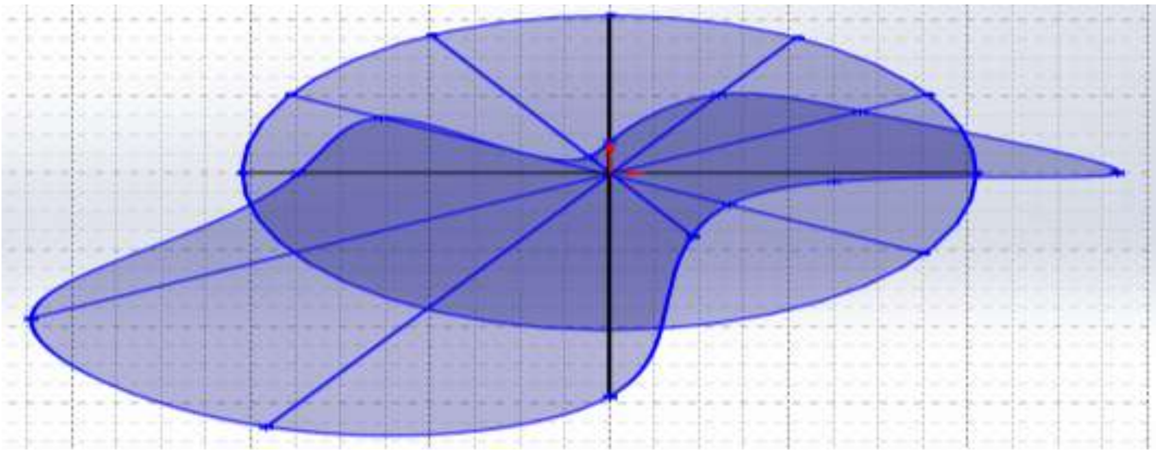
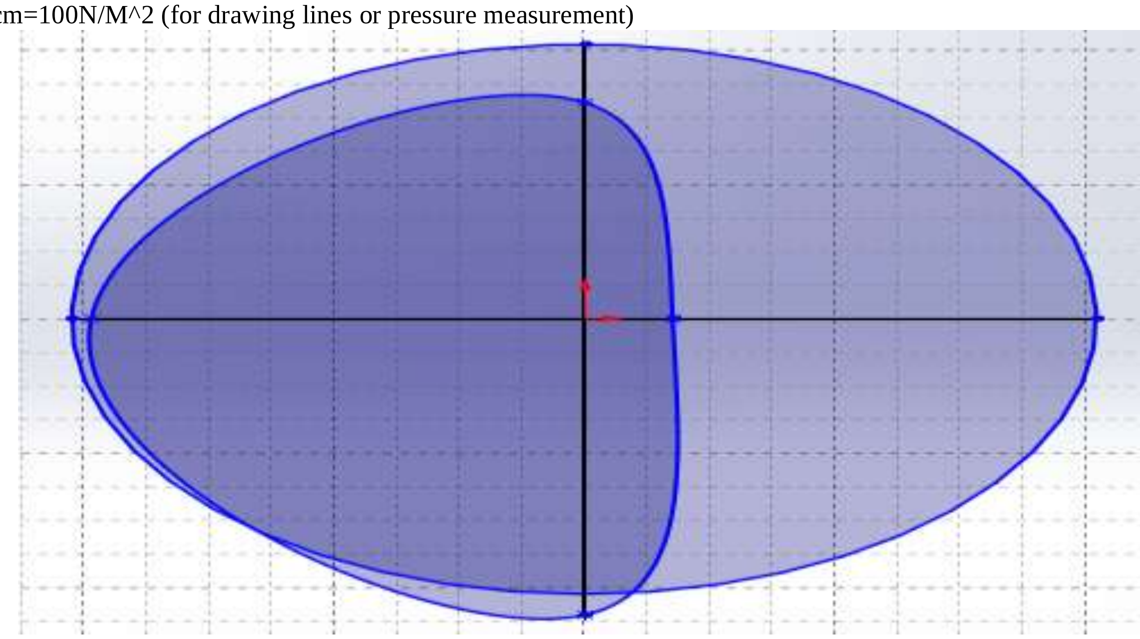


AXIAL PRESSURE GRAPH:-
SCALE :-
1cm=10cm (for drawing circle)
1cm=100N/M^2 (for drawing lines or pressure measurement)

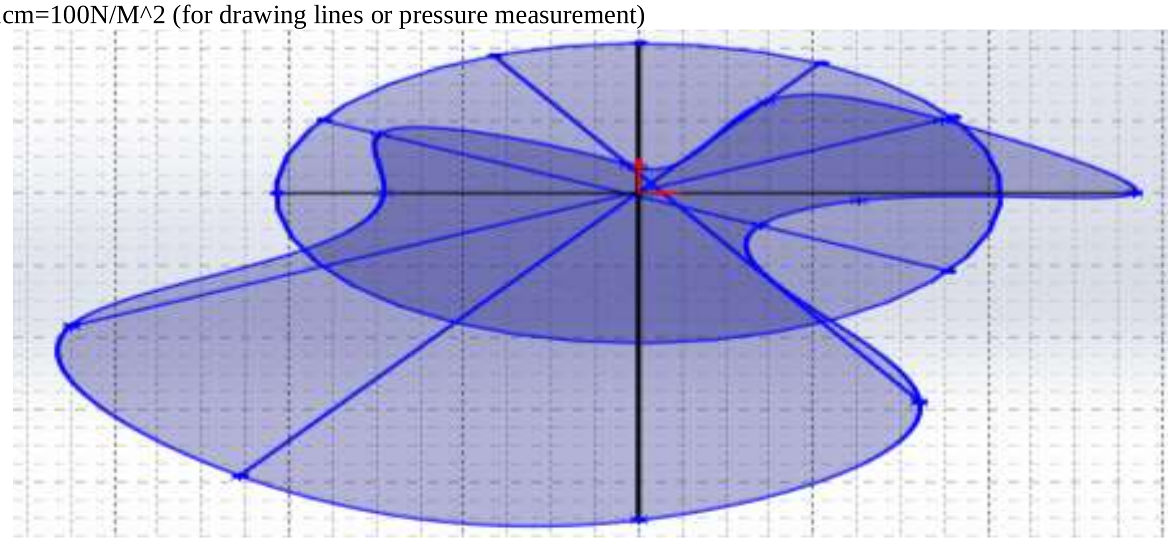


SET -3
OBSERVATION :-
9) Speed:- 1780rpm
10) Voltage:- 80V
11) Density :- 950kg/m^3
12) Initial pressure(p0) :- 52cm
Tabular column :-

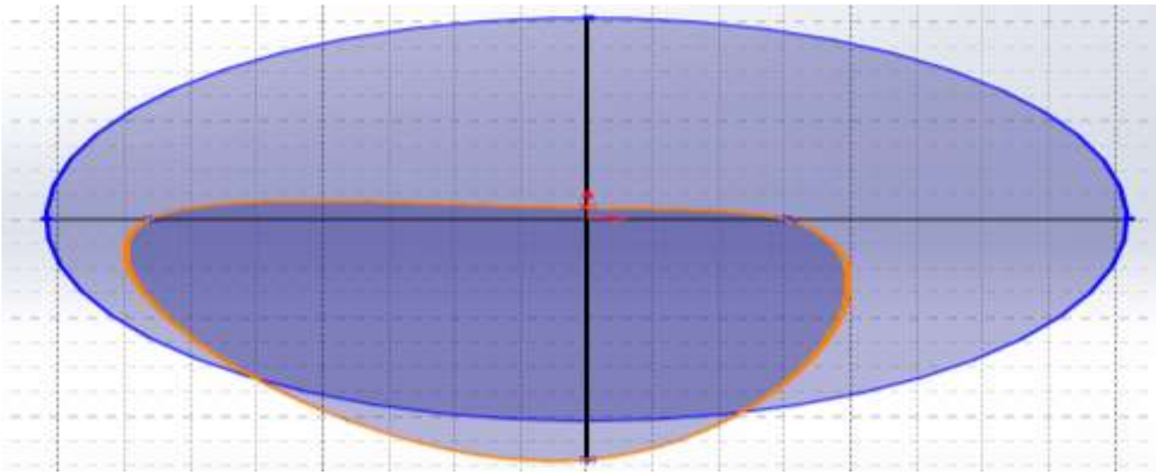
SL.NO	P0in cm	P in cm	$|p - p0| = h$ in cm	P=ϱgh in n/m^2
1	52	46.5	7.75	721.525
2	52	44.5	5.5	512.05
3	52	48	4	372.4

4	52	51	1	93.1
5	52	53.2	1.2	111.72
6	52	56.6	4.6	428.26
7	52	48	4	372.4
8	52	62.25	10.25	954.275
9	52	64.35	12.35	1149.785
10	52	64.35	12.35	1149.785
11	52	61	9	837.9
12	52	54.25	2.25	209.47
A	52	54	2	186.2
B	52	52.3	.3	27.93
C	52	56.5	4.5	418.95
D	52	58.6	6.6	614.64

RADIAL PRESSURE GRAPH:-
SCALE :-
1cm=10cm (for drawing circle)
1cm=100N/M^2 (for drawing lines or pressure measurement)



AXIAL PRESSURE GRAPH:-
SCALE :-
1cm=10cm (for drawing circle)
1cm=100N/M^2 (for drawing lines or pressure measurement)



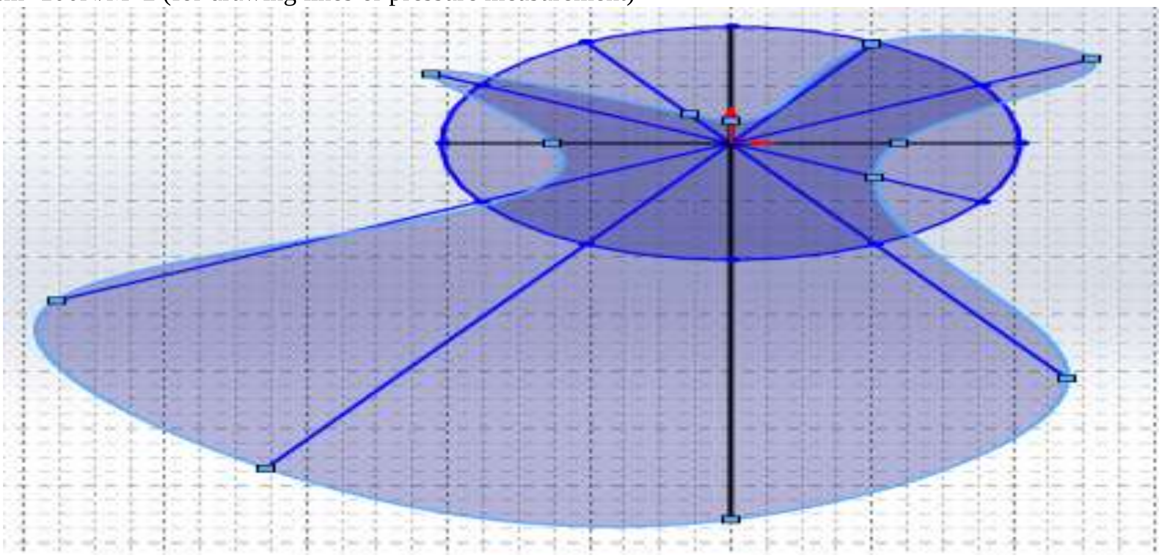
SET -4
OBSERVATION :-
13) Speed:- 2250rpm
14) Voltage:- 100V
15) Density :- 950kg/m^3
16) Initial pressure(p0) :- 52cm

Tabular column :-

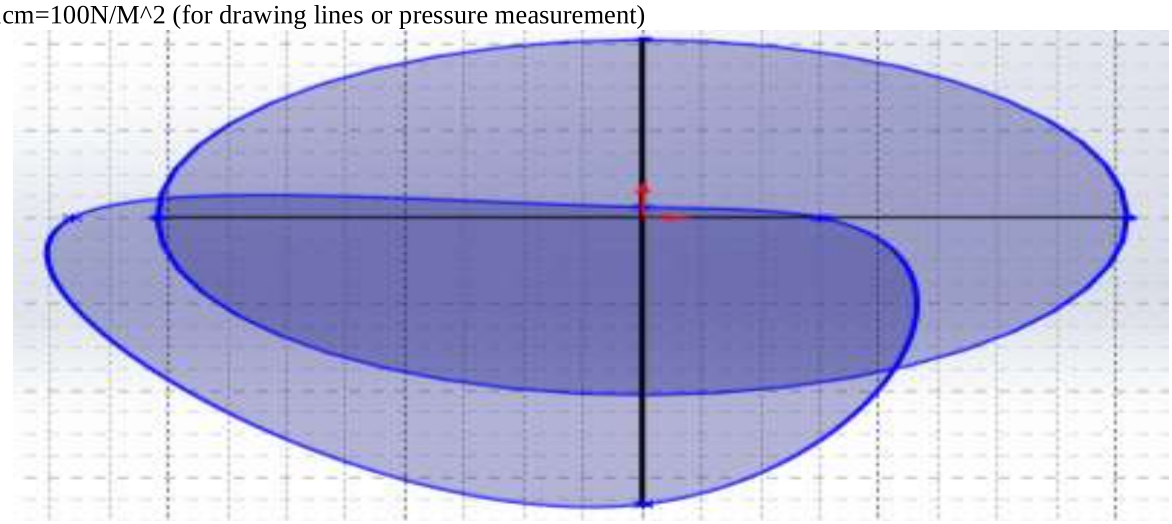
SL.NO	P0in cm	P in cm	$\lvert p - p0 \rvert = h$ in cm	P=ρgh in n/m^2
1	52	48.8	3.2	297.92
2	52	43.9	8.1	754.11
3	52	46.5	5.5	512.05
4	52	50.9	1.1	102.41
5	52	53.6	1.6	148.96
6	52	58.7	6.7	623.77
7	52	48.6	3.2	316.54
8	52	67	1	1396.5
9	52	70	18	1675.8
10	52	70	18	1675.8
11	52	65	13	1210.3
12	52	55.2	3.2	297.92
A	52	54	2	186.2
B	52	52.3	.3	27.93

C	52	58.5	6.5	605.15
D	52	61	9	837.9

RADIAL PRESSURE GRAPH:-
SCALE :-
1cm=10cm (for drawing circle)
1cm=100N/M^2 (for drawing lines or pressure measurement)



AXIAL PRESSURE GRAPH:-
SCALE :-
1cm=10cm (for drawing circle)
1cm=100N/M^2 (for drawing lines or pressure measurement)



SET -5
OBSERVATION :-
17) Speed:- 2760rpm
18) Voltage:- 120V
19) Density :- 950kg/m^3
20) Initial pressure(p0) :- 52cm
Tabular column :-

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SL.NO	P0in cm	P in cm	|p − p0| = h in cm	P=ᑭgh i1862n n/m^2
1	52	48.5	3.5	325.85
2	52	41.5	10.5	977.55
3	52	45.5	6.5	605.15
4	52	51.6	0.4	37.24
5	52	54.3	2.3	214.13
6	52	60	8	744.8
7	52	48.8	3.2	297.92
8	52	70.8	18.8	1750.98
9	52	72	20	1862
10	52	70	18	1675.8
11	52	62.5	10.5	977.55
12	52	51.6	0.4	37.2
A	52	52.3	0.3	27.93
B	52	47.5	4.5	418.97
C	52	55.8	3.8	353.78
D	52	61.3	9.3	865.83

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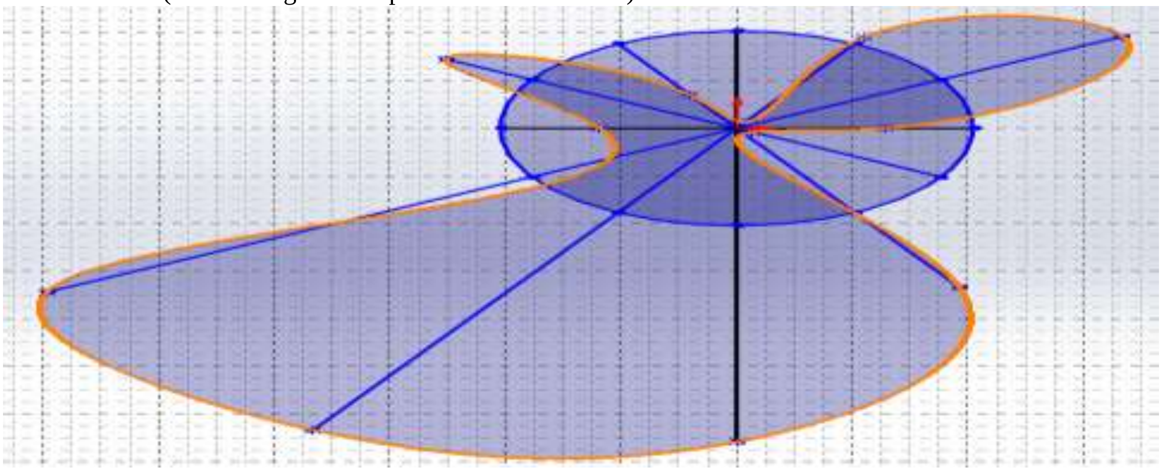
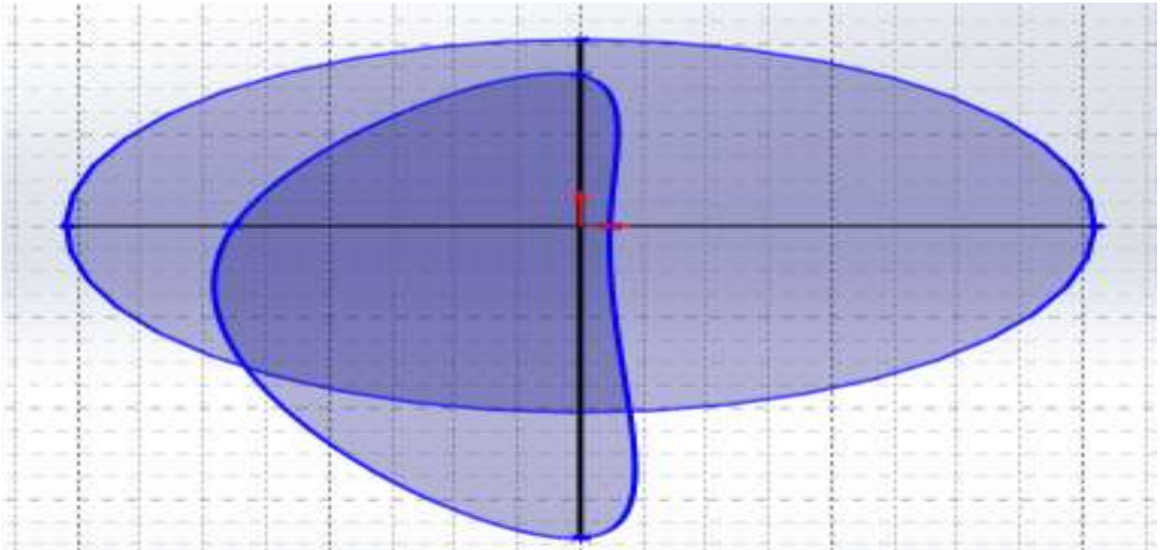
RADIAL PRESSURE GRAPH:-
SCALE :-
1cm=10cm (for drawing circle)
1cm=100N/M^2 (for drawing lines or pressure measurement)



AXIAL PRESSURE GRAPH:-
SCALE :-
1cm=10cm (for drawing circle)
1cm=100N/M^2 (for drawing lines or pressure measurement)

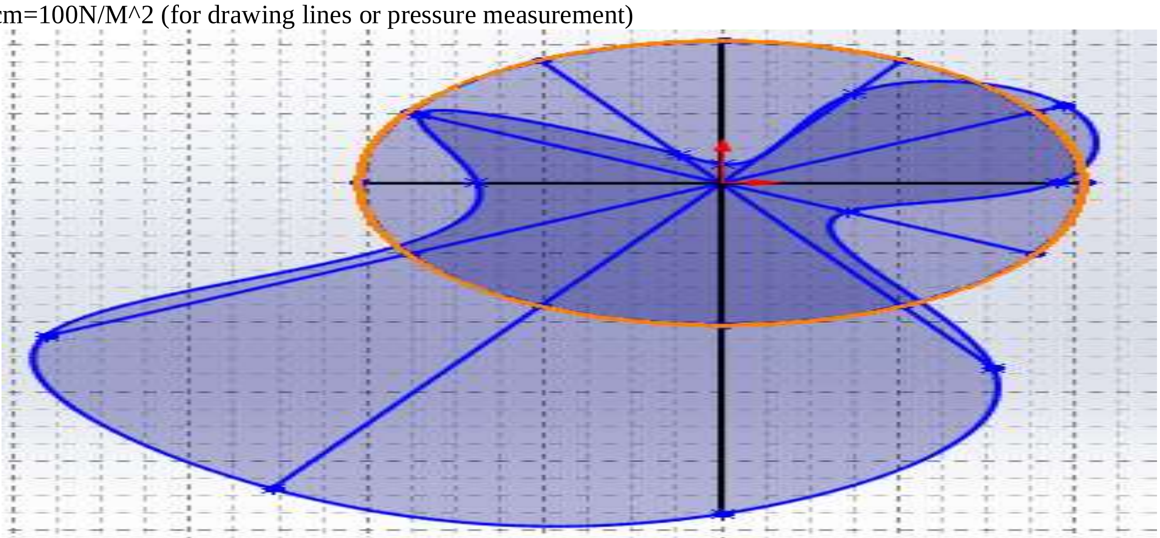


AVERAGE PRESSURE OF ALL 5 SETS IN N/M^2

SL NO.	SET-1	SET-2	SET-3	SET-4	SET-5	AVERAGE
1	325.85	716.87	721.25	297.92	325.85	477.603
2	195.51	409.64	512.05	754.11	977.55	569.772
3	121.03	297.92	372.4	512.05	605.15	381.17
4	18.62	102.41	93.1	102.45	37.24	70.756

5	74.48	55.86	111.72	148.96	214.13	121.03
6	344.47	372.4	428.26	623.77	744.8	502.74
7	325.85	442.225	372.4	316.54	297.92	350.987
8	642.39	954.275	954.275	1396.8	1750.28	1139.544
9	763.42	977.55	11439.785	1675.8	1862	128.71
10	791.35	744.8	1149.785	1675.3	1675.8	1207.407
11	651.7	242.06	837.9	1210.3	977.55	783.902
12	279.3	204.82	209.475	297.92	37.2	205.743
A	232.75	93.1	186.2	186.2	27.93	145.236
B	186.2	409.64	27.93	27.93	418.97	258.822
C	4096.4	502.74	418.95	605.15	353.78	458.052
D	446.88	558.6	614.64	837.9	865.83	664.734

RADIAL PRESSURE GRAPH:-
SCALE :-
1cm=10cm (for drawing circle)
1cm=100N/M^2 (for drawing lines or pressure measurement)



AXIAL PRESSURE GRAPH:-
SCALE :-
1cm=10cm (for drawing circle)
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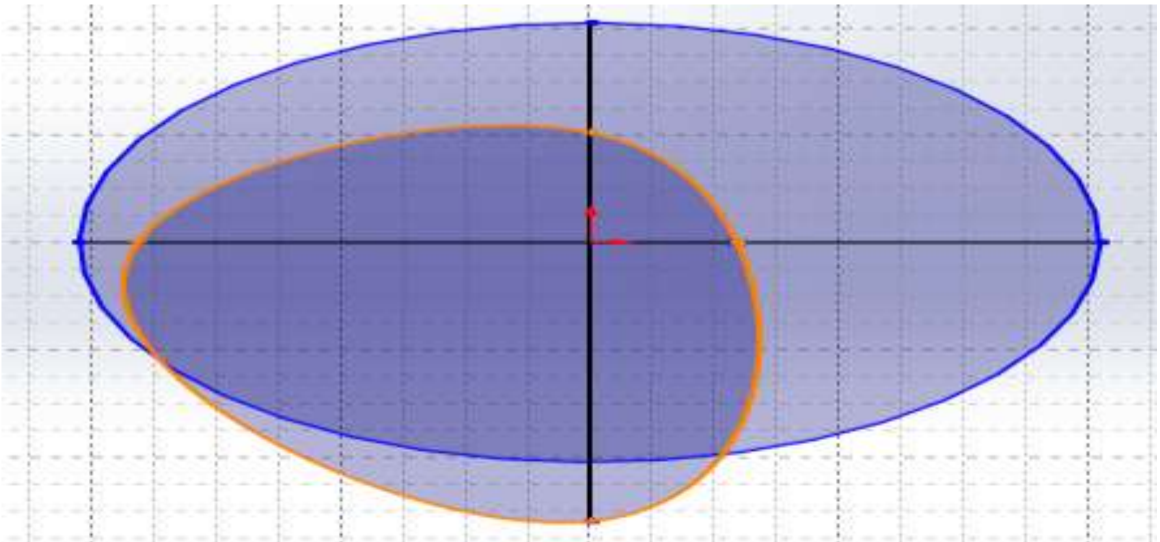

POINTS TO BE NOTED WHILE CONDUCTING THE EXPERIMENT

1) The maximum voltage that can be given is equal to 120 V
2) Let the journal bearing Run for 15 to 20 minutes before conducting the experiment
3) Note down the initial reading
4) Note down the initial speed
5) Always keep the oil tank full

POINTS TO BE NOTED WHILE DRAWING THE GRAPH

1) Take the scale as 1 cm is equal to 10 cm for drawing the circle (radi=value of P 0)
2) Divide the circle into intervals of 30°(for radial pressure graph)
3) Divide the circle into intervals of 90°(for axial pressure graph)
4) Note just the final graph nature
5) AXIAL AND RADIAL PRESSURE GRAPH:-
6) SCALE :-
7) 1cm=10cm (for drawing circle)
8) 1cm=100N/M^2 (for drawing lines or pressure measurement)

NOTE FOR CALIBRATION OF JOURNAL BEARING

1)Keep the elephant at the highest level
2)If there is are gaps present in the oil pipe remove the nut from the lower end of the Apparatus and run the journal bearing at medium speed
3)Remove the nut on at a time

IV. CHAPTER 5

OUTCOME OF THE PROJECT

1) We were able to efficiently use design software
2) We were able to explorer deeper in to many aspects of design
3) We abel to draw an assembly and get to know the motion view of the model and other design aspect of the model
4) We were able to modify the previous model effectively
5) We assembled the model
6) We conducted experiment on the model
7) We were able to understand difficulties during the project
8) We were able to overcome them effectively
9) We calculated the pressure distribution
10) We were able to understand the nature of graph
11) By understanding the nature of grah we were abel to conclude the pressure distribution pattern of model
12) We learned teamwork

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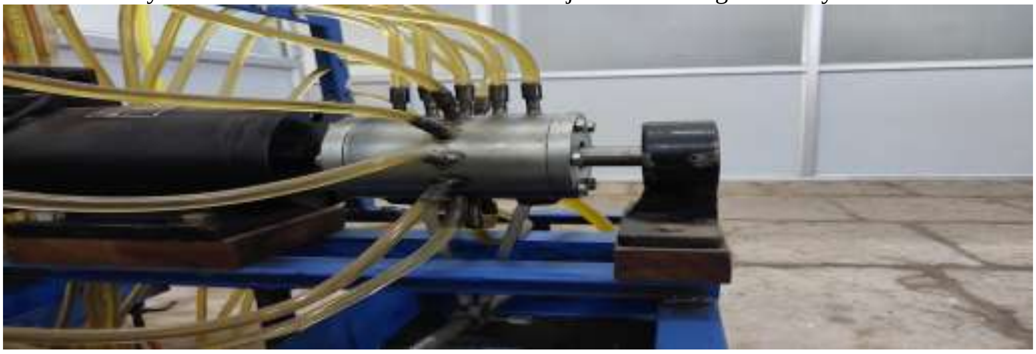
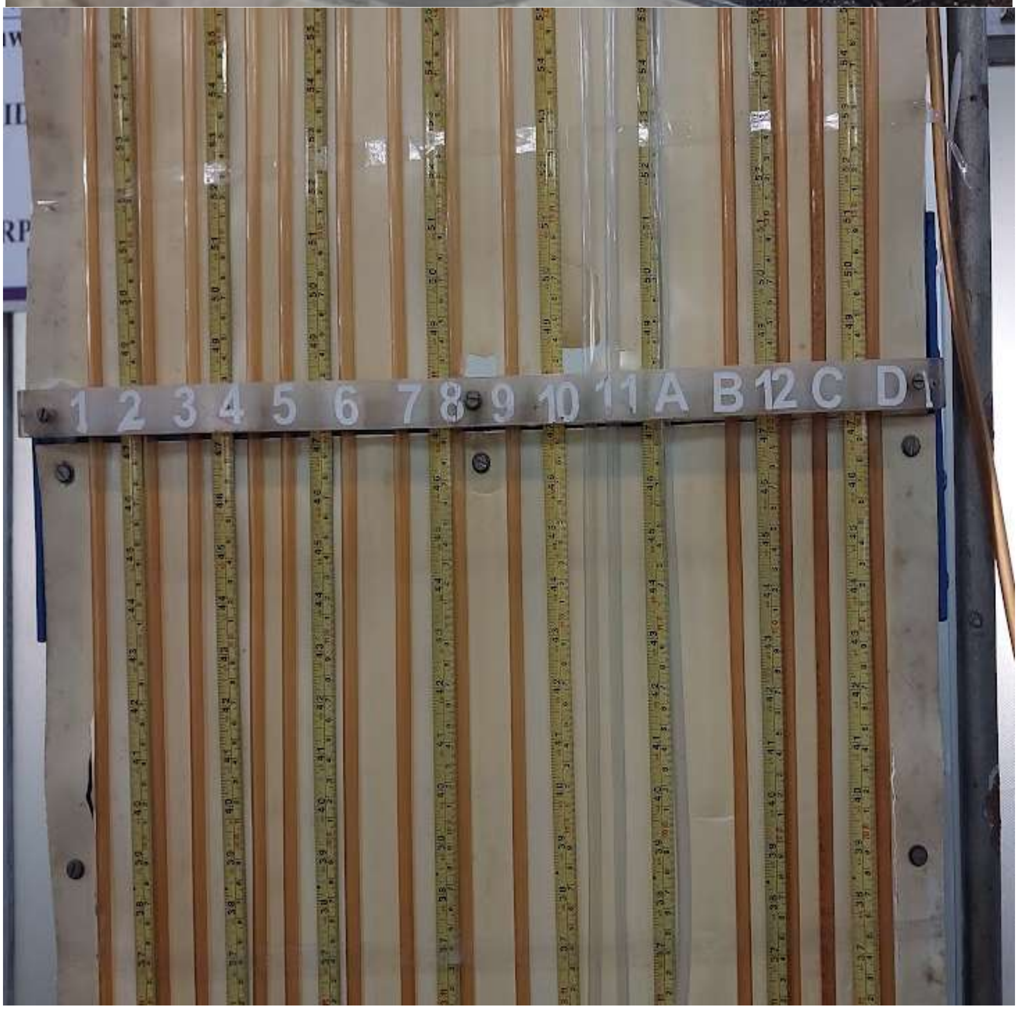
Picture of assembly and modification of the journal bearing assembly




1 2 3 4 5 6 7 8 9 10 11 A B 12 C D

V. CHAPTER 6

FUTURE APPLICATION OF THE PROJECT

1) The knowledge acquired from using the solidworks software for design will help us to do more complex design in the future
2) We researched on the project which will help increase our knowledge
3) Help to study the effect of variation in dimension of the model using different software
4) To study the various effects pressure distribution of the model for different oil
5) To study the effects of speed on pressure
6) It can in used in heavy automobile for generation of initial pressure in oil
7) Can be used in places with high requirement of lubrication for motion with less loss speed
8) In future research on pressure distribution in multiple point of a system

REFERENCE

1) Journal bearings optimization and analysis design tool for engineering
Publisher :- VMC Written by :-Miles Zengeya
2) Thermo-Hydrodynamic analysis of journal bearing
Publisher :-LAMBERT academy Written by :-kevin smith mathives
3) Journal -Bearing data book
Publisher :- saptagiri-vertrag berlin Written by :- TsuneoSomeya
4) Heat transfer through journal bearingA case study
Research by :-Peeyush Vast , B.C.Sharma, Sumit Sharma

ESTIMATED COST

Motor :- 2000rs
Pipes :- 1000rs
Apparatus framework :- 4000rs
Bearing & Housing :- 3000rs
Total approximate cost :- 10000rs