A SEMINAR ON

MODELING AND ANALYSIS OF GEAR BOX OF PLASTIC INJECTION MOULDING MACHINE

Guided by Mr.H.C Patel

Prepared By

ANKUR C. PATEL (090780119021)

BHAVINKUMAR K. PATEL (090780119005)

BHAVIKKUMAR D. PATEL (090784119401)

Contents

ABSTRACT

- This report present the modeling and analysis of gear box of a plastic injection moulding machine.

- At KALP CORPORATION ,MEHSANA we evaluate that the problem occur in this gear box of injection moulding machine are, wearing of gear, failure of bearing, misalignment of shaft, lack of lubrication, etc. These all problems cause the major loss to that industry.

- Among all of these problems our attention was on the major problem occur is the failure of bearing.

- This is result into reducing the life of bearing and also not economic for organization. Due to this problem the machine was braked down, and required to change the bearing and other effected parts of plastic injection moulding machine. This will increase the maintenance cost of a machine.

- Bearing failure occurs due to the excessive axial loading. In order to reduce the maintenance cost and increase the life of bearing, the proper bearing selection is required.

- After the completion of mathematical based calculation we will suggest the proper suitable bearing and analyze the bearing in AUTODESK INVENTOR, which increase the life of the bearing.

Introduction

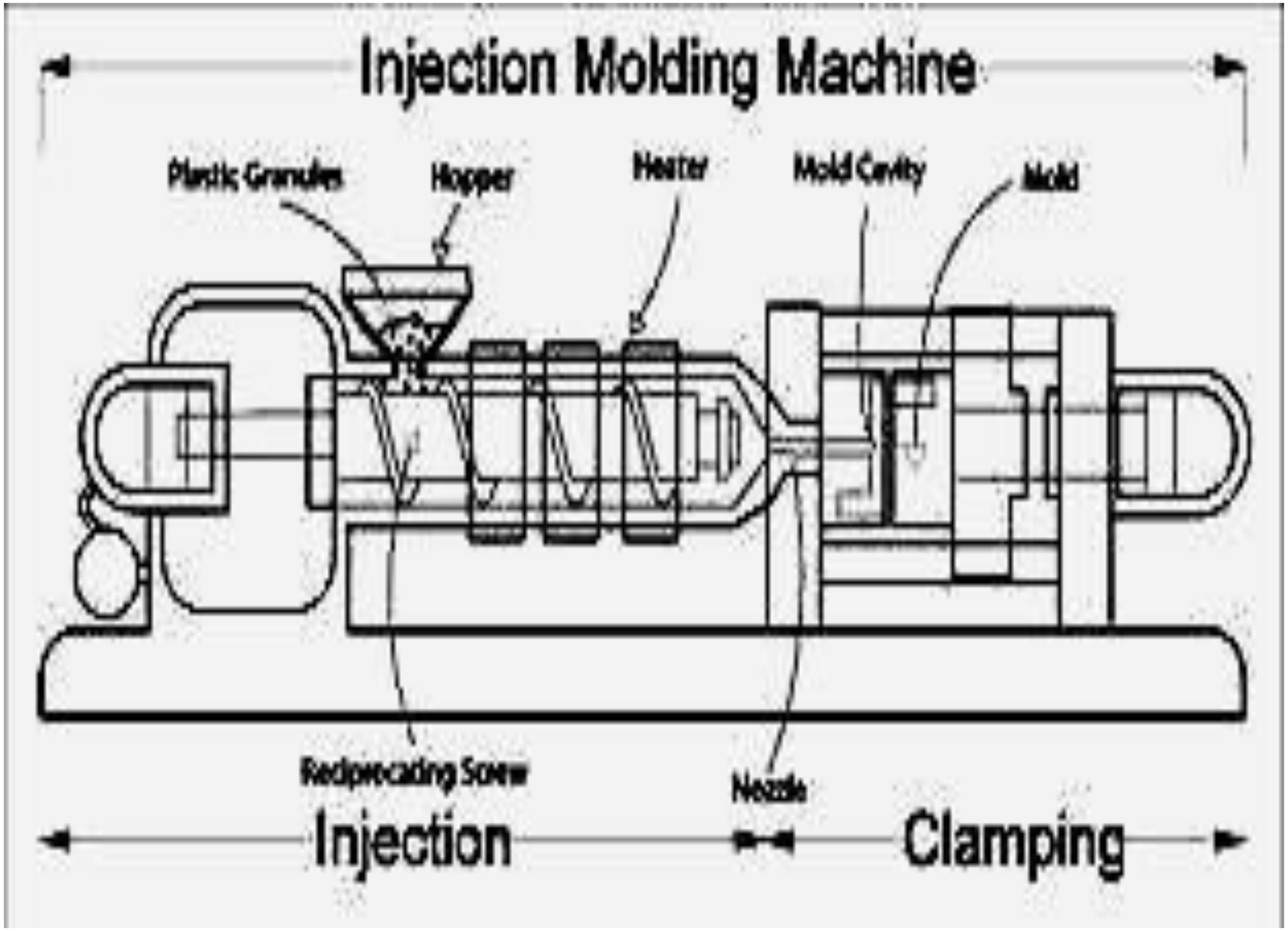
- KALP CORPORATON is held in Dediayasan GIDC, Mehsana. It produces a plastic bags using plastic granular with the help of plastic injection moulding machine. This injection moulding machine was made by LOHIA GROUP OF INDUSTRY, KANPUR. The capacity of injection moulding machine is 5 tons per day. KALP CORPORATION takes order from the market for making the bags.

Injection Moulding Machine

- Injection moulding is a manufacturing process for producing parts from both thermoplastic and thermosetting plastic or other materials including metals, glasses, and elastomers.

- Material is fed into a heated barrel, mixed, and forced into a mold cavity where it cools and hardens to the configuration of the cavity.

- After a product is designed, usually by an industrial designer or an engineer, moulds are made by a mould maker (or toolmaker) from metal, usually either steel or aluminium, and precision-machined to form the features of the desired part. Injection molding is widely used for manufacturing a variety of parts, from the smallest component to entire body panels of cars.


Injection Molding Machine
Plastic Granules
Hopper
Heater
Mold Cavity
Mold
Reciprocating Screw
Nozzle
Injection
Clamping

Gear box

❑Definition:

- ✓ An enclosed system of assembled gears that transmits mechanical energy from a prime mover to an output device.

- ✓ A gearbox can also change the speed, direction, or torque of mechanical energy.

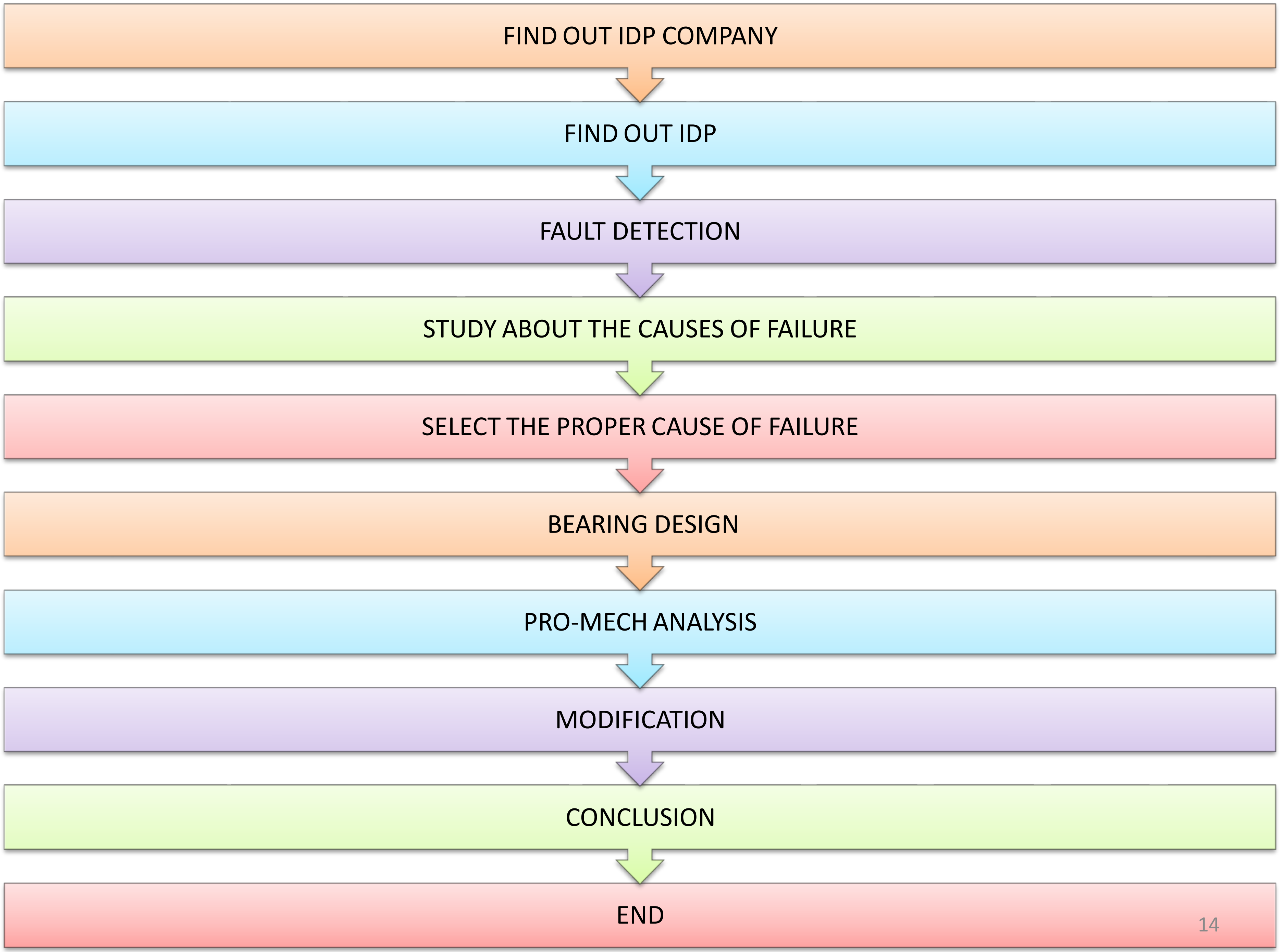
Thrust Bearing

- A **thrust bearing** is a particular type of rotary bearing.
- Like other bearings they permit rotation between parts, but they are designed to support a high axial load while doing this.
- Generally, they are composed of two washers (raceways) in which those for ball bearings may be grooved, and the rolling elements.
- Thrust bearings are designed to manage thrust (axial) loads and provide high-shock-load resistance in a variety of applications.

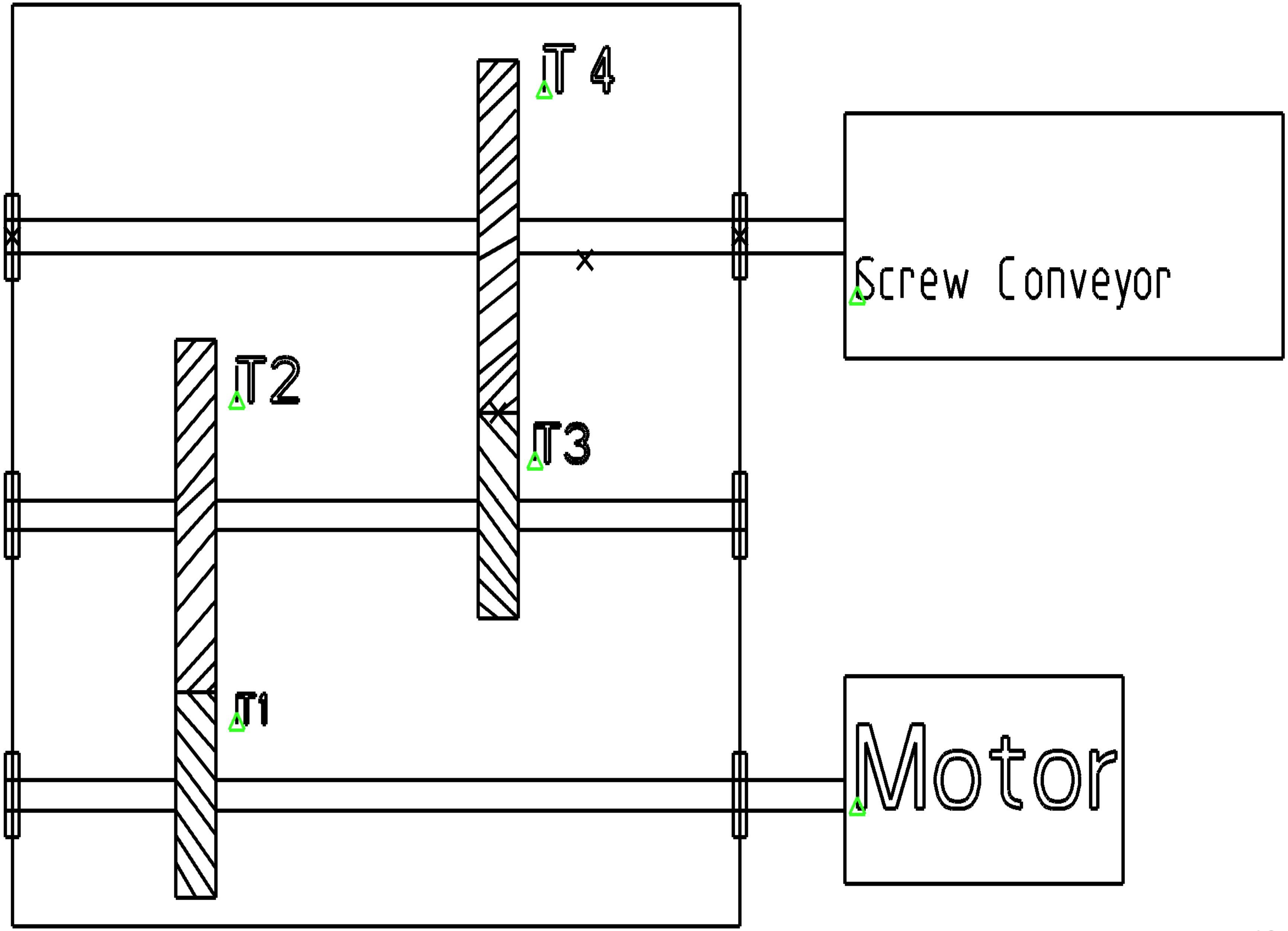
TYPES OF THRUST BEARING

- Ball Thrust Bearing
- Spherical roller thrust bearing
- Cylindrical roller thrust bearing
- Tapered thrust bearing
- Needle thrust bearing

Methodology


FIND OUT IDP COMPANY
FIND OUT IDP
FAULT DETECTION
STUDY ABOUT THE CAUSES OF FAILURE
SELECT THE PROPER CAUSE OF FAILURE
BEARING DESIGN
PRO-MECH ANALYSIS
MODIFICATION
CONCLUSION
END

Design


T 4
Screw Conveyor
T2
T3
T1
Motor

- Terms specification:

T_1= teeth of gear 1
T_2= teeth of gear 2
T_3= teeth of gear 3
T_4= teeth of gear 4
N_1= rpm of input shaft
N_4= rpm of output shaft

Now, N_1= 632 rpm and
N_4= 100 rpm
Gear ratio= N_1/N_4
=632/100
=6.32

Guide to selection of gear tooth system:

Interchangeable tooth system	Smallest no.of teeth that mesh with rack without interference	Smallest no.of teeth in equal pinion that will give conti. Driving	Comments
14½° full depth involute system	32	20 teeth with contact ratio of 1.080	Use when pinion has 40 or more teeth
20° full depth involute system	18	12 teeth with contact ratio 1.049	Recommended for general use
20° stub-tooth involute system	14	12 teeth with contact ratio 1.185	Recommended to use when the number of teeth in pinion is too small for satisfactory use of 20°full depth teeth

- From the above table, for 20   full depth involute system, minimum number of tooth to avoid interface is 18.

$$T_1 = 18 \text{ teeth}$$

Now, gear ratio is 6.32

For this we will take two stages, in the first stage we will take gear ratio of 3.16

For gear ratio 3.16

z / i	50	51	52	53	54
1.78	18:32			19:34	
2		17:34			18:36
2.24			16:36		
2.51				15:38	

z / i	74	75	76
2.82			20:56
3.16		18:57	
3.55			17:60

- For 20   full depth involute system, minimum number of tooth to avoid interface is 18.

- From the above table for single stage reduction standard gear ratio is 6.3.

- Hence $T_A=18$
  $T_B=57$
  $T_C=18$
  $T_D=36$

- Now, we will find the torque for each gear,

- Torque for gear 1

$$Pa = \frac{2\pi NT}{60}$$

T1 = 1662.06 N-mm

- Torque for gear 2

T2 = 5252.11N-mm

- Torque for gear 3

$$T3 = 5252.11 N\text{-}mm$$

- Torque for gear 4

$$T4 = 10504.22 N\text{-}mm$$

$$\frac{T_2}{T_1} = \frac{d_2}{d_1}$$

$$3.16 = \frac{d_2}{d_1}$$

d_1=110.57mm

d_2=349.42mm

Now same as above for gear ratio 2

d3=140mm

d4=280mm

$$d_2=349.42mm$$

Now same as above for gear ratio 2.

we found d_3 & d_4

$$d_3+d_4=420$$

but $d_4=2d_3$

$$3d_3=420$$

$$d_3=140mm$$

$$d_4=280mm$$

$$a = \frac{m_1 z_1 + m_2 z_2}{2}$$

$d_1 = 111mm$

$$v1 = \frac{\prod * d1 * N}{60000}$$

$v1 = 3.67m$

Now, find the tangential force

$F_{t1} = P/V$

$= 110000/3.67$

$F_{t1} = 30\ kN$

radial force

$$F_{r1} = F_{t1} * \tan \emptyset$$

$$F_{r1} = 11 \text{ k N}$$

$$a = \frac{m_2 z_2 + m_2 z_4}{2}$$

$$m_2 = 10.19$$

$$d_3 = 183.42 mm$$

$$v_3 = \frac{\prod * d1 * N}{60000} = 1.92 m/s$$

tangential force

$$F_{t3}=P/V3$$

$$F_{t3}=57.3\ kN$$

radial force

$$F_{r3}=Ft3*\tan Ø$$

$$F_{r3}= 20.86\ kN$$

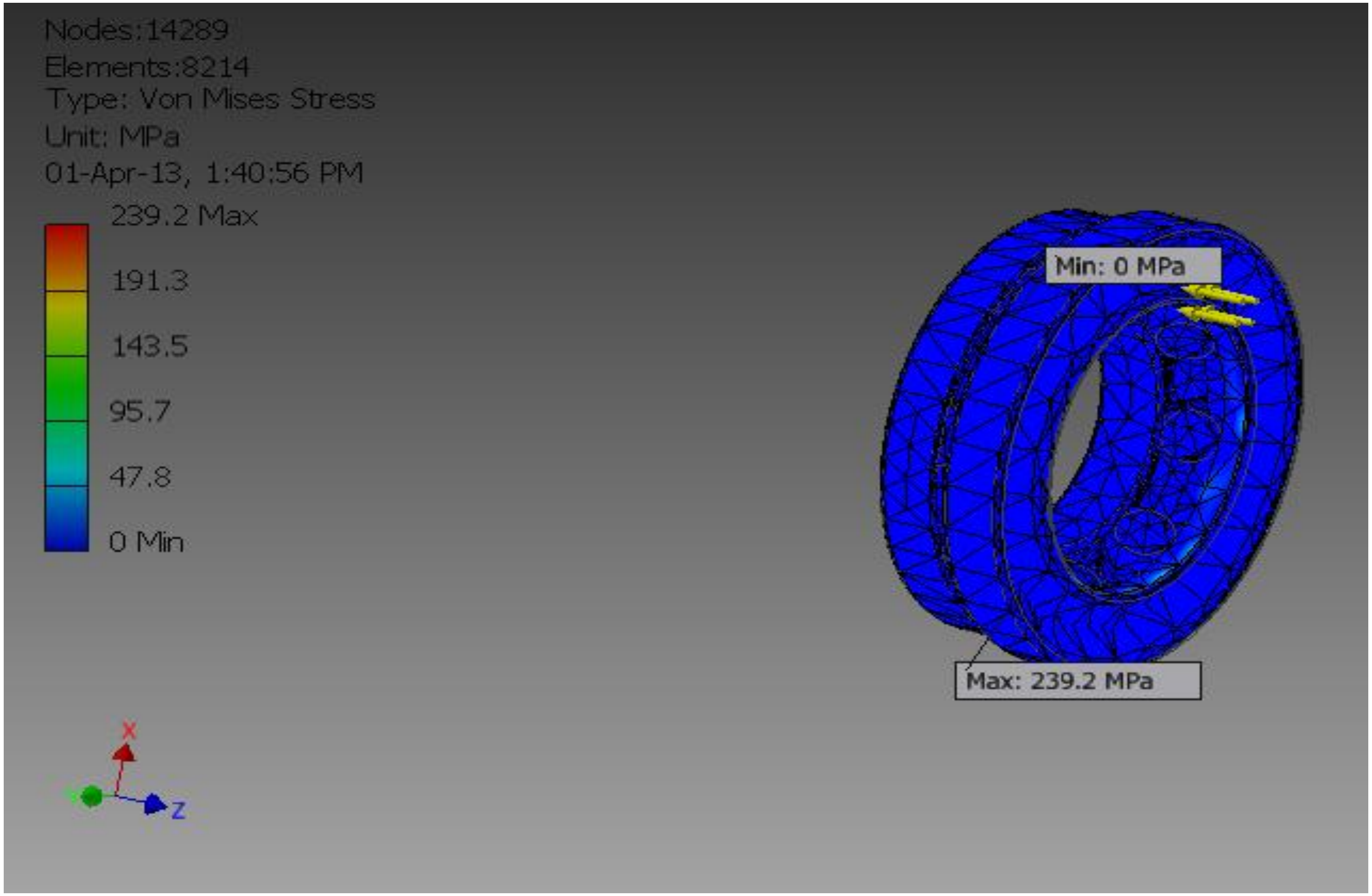
Now resultant force

$$F_1=31.95\ kN$$

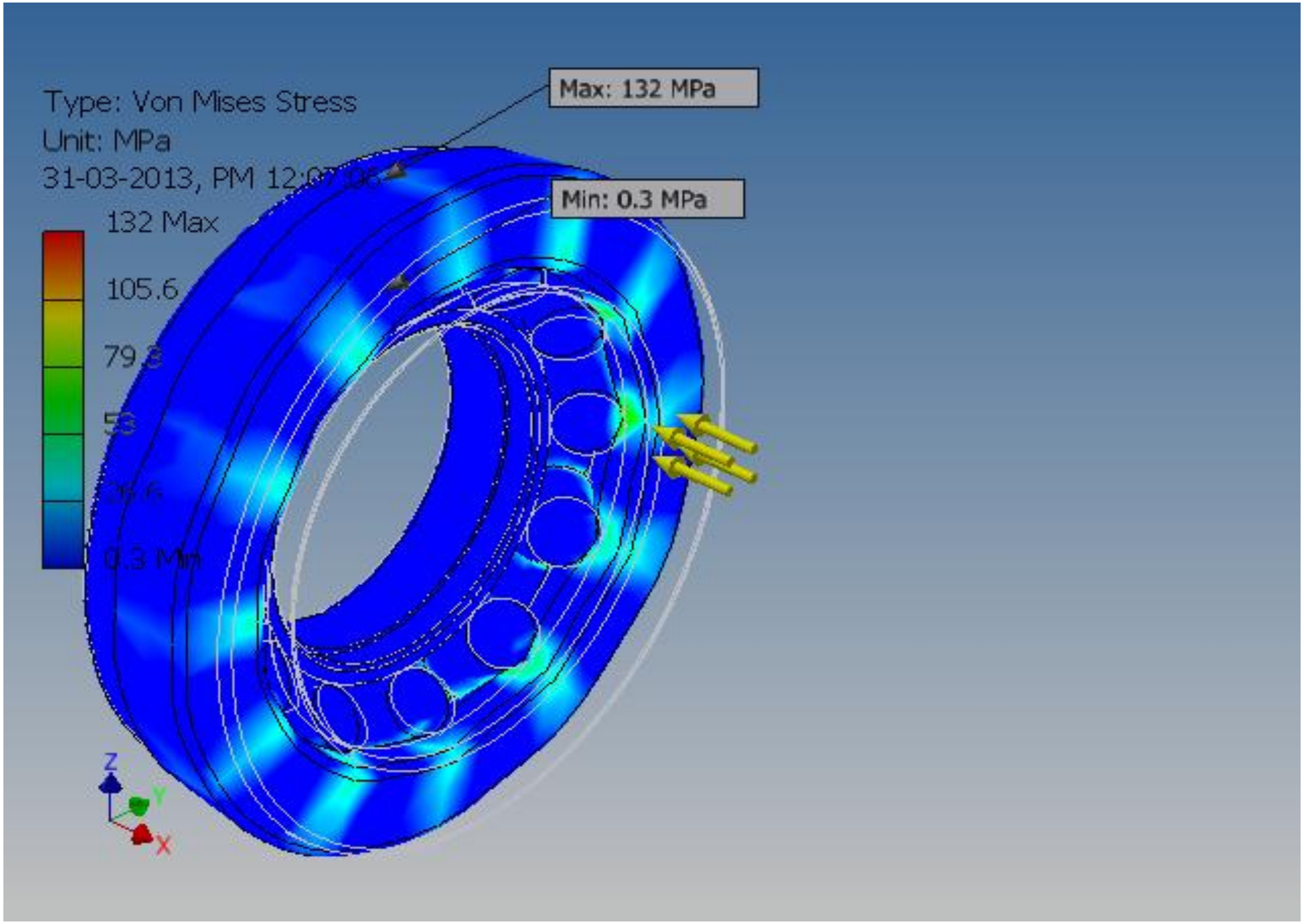
$$F_3= 61\ kN$$

Analysis

❖ For bearing, ANSI/AFBMA 24.1 TS - Thrust Spherical Roller Bearing 180TS94 :



❖ For bearing, Rolling bearing GB/T 5859-2008 29436 :



- Mathematical calculation of Bearings :

(1). For ANSI/AFBMA 24.1 TS - Thrust Spherical Roller Bearing 180TS94 :

✓ Axial thrust load,

Fa = 225 bar(as per company manual)

= 22.5 M Pa

= 1717.67 k N

Now,

P = 0.4 (Fa + 1.2 Fr)

= 0.4 (1717.67 + 1.2(20.86))

= 697 k N

Now,

P = 0.4 (Fa + 1.2 Fr)

= 0.4 (1717.67 + 1.2(20.86))

= 697 k N

Now, Bearing Life

$L_{10} = (C_1 / P)$ ^ a

where, a = 10/3 for roller bearing

$C1 = 2450$ k N

$L_{10} = 65.75$ million revolution

$L_{10} = 2.09$ years

(2). For Rolling bearing GB/T 5859-2008 29436 :

- Axial thrust load,

$$Fa = 1717.67 \text{ k N}$$

Now,

$$P = 0.4 (Fa + 1.2 Fr)$$

$$= 697 \text{ k N}$$

Now, Bearing life

$$L10 = (C2 / P) ^ a$$

where, a = 10/3 for roller bearing

$$C2 = 2600 \text{ k N}$$

L10 = 80.50 million revolution

L10 = 2.55 years

Conclusion

- The model of gear box of plastic injection moulding machine was analized.
- There are some problems occur in plastic injection moulding machine like , wearing of gears, failure of bearing, misalignment of shaft, lack of lubrication, etc.
- But the major problem occur from the above is failure of bearing. This problem is occur due to excessive axial thrust load.
- The analysis of two bearings, first ANSI/AFBMA 24.1 TS - Thrust Spherical Roller Bearing 180TS94 and second Rolling bearing GB/T 5859-2008 29436 was done in AUTODESK INVENTOR PROFESSIONAL 2012.

- It was found that the von mises stress on first bearing was higher than the second bearing.
- Also, the life of both the bearings was calculate mathematically. It was found that the life of second bearing is higher than the first bearing.
- So, the second bearing is suggested on basis of life.

Referances

1. A text book of “Machine Design” by R.S Khurmi
2. “Mechanics of Solids” by R.P Rethaliya et al.
3. Mr. M. S. Patil, Mr. Jose Mathew, Mr. P. K. RajendraKumar. “Bearing signature analysis as a medium for fault detection”, Jan 2008 vol.130.
4. Mr. H. Arslan, Mr. N. Akturk “an investigation of rolling element vibrations caused by local defects”, Oct 2008 vol.130.
5. Mr N. Tandon, Mr A. Choudhary “ a theoretical model to predict the vibration response of rolling bearing in a rotor bearing system to distributed defects under radial load". July 2000, vol.122.
6. Mr. Yazhao Qiu, Mr. Singiresu S. Rao “a fuzzy approach for the analysis of unbalanced non linear rotor system” 2005.
7. Mr. R. Serrato, Mr. M. M. Maru, Mr. L. R. “effect of lubricant viscosity grade on mechanical vibration of roller bearing” 2007.
8. K.mahadevan and k.balaveera reddy “A design data handbook” 2nd edition.

9. Douglas M. Bryce. “Plastic injection moulding: manufacturing process fundamentals. SME 1996.

10. http: // www. Custompartnet. Com/ Wu / injection molding

11. R. B. Patil and etall, “ Machine design”, techmax publication

Thank You