

STUDY OF FAILURE OF EXITING WORM SHAFT ASSEMBLY OF OIL EXPELLER

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ABSTRACT

The paper contributes to the study of problem evaluation of a small scale industry working in the area of oil extraction. The research fruit forward the diagnosis of failure of the main shaft and worms assembly of cotton seed oil expeller unit situated at Yavatmal, midc area. This could help the industries working in these area to improve the life and functionality of the unit which would in their term lead to higher productivity. This literature tries to diagnosis the reason of uncertain failures and would suggest the suitable solution in the same regards.Thus, the study contributes to reduction of running cost of an industry by reducing the sudden breakdowns occurring because of failure of main shaft and worms assembly of cotton seed oil expeller machine.

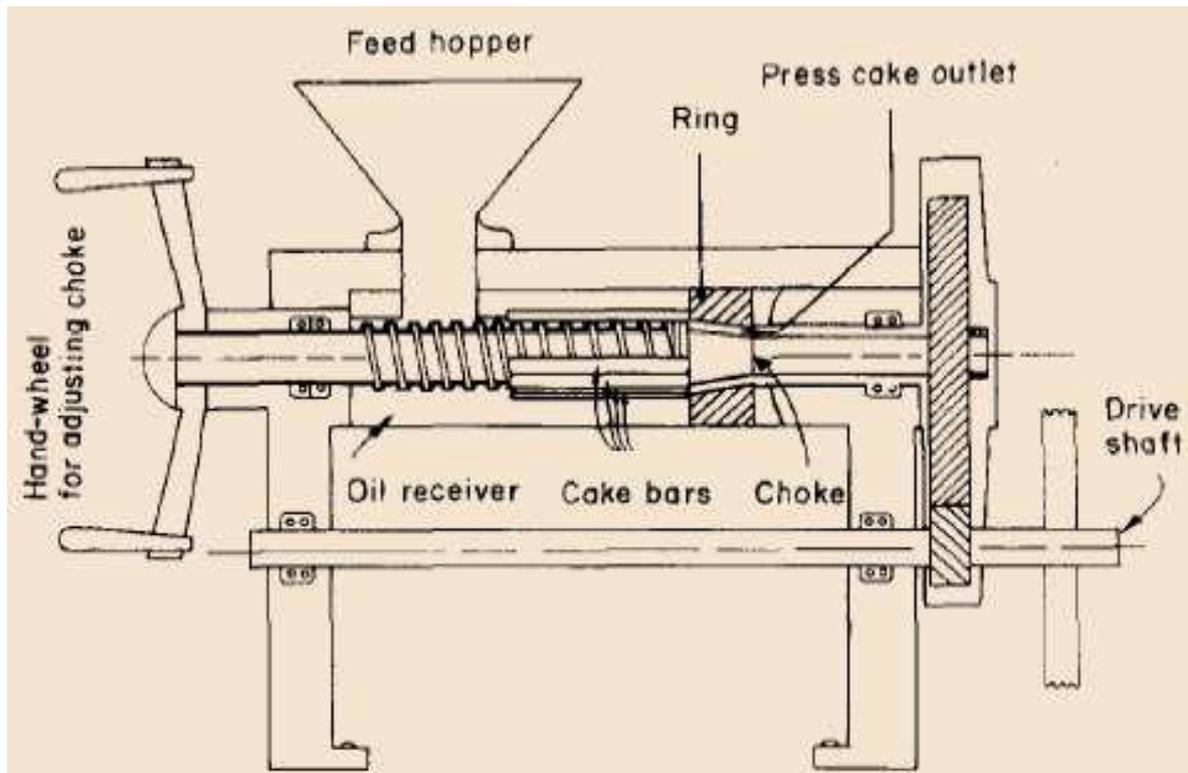
Key words: Main shaft, Worms , Oil expeller, Failure, Diagnosis, Productivity.

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INTRODUCTION

An oil expeller is a screw-type machine that presses oil seeds through a caged barrel-like cavity. Expeller pressing (also called oil pressing) is a mechanical method for extracting oil from raw materials. The raw materials are squeezed under high pressure in a single step. Raw materials enter one side of the press and waste products exit the other side. The machine uses friction and continuous pressure from the screw drives to move and compress the seed material. The oil seeps through small openings that do not allow seed fiber solids to pass through. Afterward, the pressed seeds are formed into a hardened cake, which is removed from the machine. Pressure involved in expeller pressing creates heat in the range (60 – 115 °C).Screw type oil presses are advanced oil processing machinery, characterized by their high oil output rate with good quality, simple design, easy to use and continuous operation. They can use for various raw materials, such a Cotton Seed, Peanut, beans, rape seeds, sesame, sunflower seeds, copra etc.

WORKING PRINCIPLE



In operation, the oilseed is introduced into the machine through the feeding hopper; the machine conveys, crushes, grinds and presses the oilseed inside the cylindrical barrel (casing) with the aid of the worm shaft until oil is squeezed out of the seed. The oil extracted is drained through the oil channel into the oil tray where it is collected; the residual cake is discharged at the cake outlet and collected at the cake tray.

LITERATURE REVIEW

[1]Deli S, Farah Masturah, Tajul Aris, and Wan Nadiah;The effects of physical parameters of a screw press machine on oil yield of *N. sativa* seeds were studied using a KOMET Screw Oil Expeller. Different nozzle size (6, 10, and 12 mm), extraction speed (21,54, 65 and 98 rpm) and diameter of shaft screw (8 and 11 mm) were applied in this study. Different nozzle size, diameter of shaft screw and rotational speed do effects the percentage of oil yield. By using shaft screw with diameter of 8 mm had resulted to the decrease of oil yield with the increase of nozzle size and rotational speed. While, by using the shaft screw with diameter of 11 mm had recorded the highest percentage of oil yield at 65 rpm when using nozzle with the size of 6 and 10 mm. However, when using nozzle with the size of 12 mm, the percentage of yield had recorded the same result pattern with the result of using shaft screw with diameter of 8 mm which is; the decreased of percentage of oil yield with the increase of rotational speed. The highest percentage of oil yield recorded was at the combination of shaft screw with diameter of 8 mm, rotational speed at 21 rpm and nozzle size of 6 mm. There was significantly different ($p < 0.05$) between oil yield with heat temperatures. The oil yield was higher at 50°C (22.68%) and lower at 100°C (15.21%). Most of the results obtained (percentage of oil yield of *N. sativa* seeds recorded) was significantly different ($p < 0.05$) in relation with the effect of physical parameters of machine screw press on the oil yield. The study found that optimum condition for cold press of *N. sativa* seeds oil is using 6 mm of nozzle size, 8 mm of diameter shaft screw and pressing

at speed 21 rpm. The highest amount of oil yield is 22.27% on diameter shaft screw 8 mm and 19.05% on diameter shaft screw 11 mm.

[2]V. S. Khangar and Dr. S. B. Jaju.;The various methodologies used for the failure analysis of shaft used in different application by various authors are reviewed in this paper. Roll shaft failure can be prevented primarily by introduction of better material design optimization & by using correct manufacturing processes. This paper presents the comparison of the different methodology used, their application & limitation by various authors. The objective of the present work is to study the various methodologies used for the shaft failure analysis & to choose the best methodology suitable for the failure analysis of bridle roll shaft used in continuous steel industry to prevent repetitive failure. Bridle roll failure leads to heavy loss approximately Rs 80000 per hour due to line stoppage & repairing cost associate with the breakdown.

[3]Shankar Haldar,Aniruddha Bhattacharjee,Vineet Jain, and Sudhir Singhal; This is the report submitted by the authors from InsPIRE Network for Environment New Delhi to Department of Science and Technology Government of India which consist of the detailed information about oil expellers including availability of Oilseeds, Elements of Expelling Process, Types of Expellers and their Design Features, Current Expellers, Site Visits.

[4]Adesoji M. Olaniyan, Kamaldeen A. Yusuf, Adebayo L. Wahab and Kunle O. Afolayan; A screw press expeller was designed, constructed and tested for palm kernel and soybean oil extraction. The expeller was simple enough for local fabrication, operation, repair and maintenance. Powered by a 15 hp three-phase electric motor, the expeller has average oil yield and extraction efficiency of 13.48 and 22.79 % respectively from palm kernel and 9.47 and 36.55 % respectively from soybean with a production cost of USD1200. The expeller can be used for small scale palm kernel and soybean oil extraction in the rural and urban communities. A cottage palm kernel and soybean oil processing plant based on this technology can provide employment for at least two persons at the same time providing palm kernel and soybean oil at affordable costs for rural dwellers palm kernel cake and soybean cake for livestock feed mill. An improvement in the design of the worm shaft of the expeller is expected to improve the oil yield and extraction efficiency; hence, this is highly recommended.

[5]S Sreenatha Reddy, Dr V Pandurangadu and I Srinivas A mini oil expeller is fabricated to find out the effect of variation in compression ratio of the oil chamber and speed of the screw shaft on oil recovery and energy consumption during oil extraction of Pongamia and Jatropha seeds. A mini oil expeller is fabricated by incorporating the adjustments for variation in compression and speed. During the experiment, the compression ratio is changed from 14:1 to 21.5:1, and the speed is altered from 35 rpm to 65 rpm. The interactive effect of these two parameters on oil expulsion is observed critically and compared with the conventional expeller. Compression ratio has shown significant impact on oil recovery and energy consumption.

[6]A.Ibrahim and A. P. Onwualu; Reviewed the technologies for oil extraction from oil-bearing agricultural products and different types of oil-bearing agricultural products,pre-processing conditions including the removal of hulls and shells, pre-processing conditioning such as size reduction, moisture content adjustment, heat treatment and pressure application, as well as the methods employed in the extraction, namely; traditional and modern (improved) methods dicussed in this paper. The improved method include; oil expeller, screw press, and solvent (chemical extraction). Problems (technical, socio-economic and institutional) associated with each method and the need for more research for the improvement of the methods are analysed. It has been shown that for any developing country to effectively adopt modern methods in the production of edible vegetable oils, improvement on the existing traditional methods, environmental factors,

government policies, socio-economic and cultural considerations of the users need to be studied. This can be achieved through more research in the recommended area of need.

[7]Mehul.K.Modh and J.R.Mevada;In this paper the author have carried out the thrust ball bearing analysis of oil expeller and results are compared with analytical results to solve the problem of Thrust ball bearing into pieces failure in oil expeller once in 2 to 3 months. The author had calculated the thrust force acting upon the thrust ball bearing, which is quite high which a bearing can withstand. Calculated life of existing bearing is about 5.2 months. Hence it was proposed to change the bearing which gives satisfactory life of 2.5 years by calculation Further static analysis of the Part of bearing on Pro-E wild Fire 4 and Ansys Workbench 11 was carried out. The analysis results the Principle stress, Principle strain and axial deformation found to be reduced.

[8]V. S. Khangar and Dr. S. B. Jaju. The various methodologies used for the failure analysis of shaft used in different application by various authors are reviewed in this paper. Roll shaft failure can be prevented primarily by introduction of better material design optimization & by using correct manufacturing processes. This paper presents the comparison of the different methodology used, their application & limitation by various authors. The objective of the present work is to study the various methodologies used for the shaft failure analysis & to choose the best methodology suitable for the failure analysis of bridle roll shaft used in continuous steel industry to prevent repetitive failure. Bridle roll failure leads to heavy loss approximately Rs 80000 per hour due to line stoppage & repairing cost associate with the breakdown.

PROBLEM FORMULATION

In the oil industries,situated at MIDC, Yavatmal, where 36"x6.5"screw type oil expellers are used there is a common problems of wear and uncertain failure of worm shaft which result in the breakdowns, increasing the running cost and reducing the productivity. The frequency of breakdowns due to uncertain failure main shaft assembly is nearly 1-2 times in a month and the cost incurred for the repair/replacement in high which increases the running cost of the industry.

OBJECTIVE

Analysis of Forces Acting on Main Shaft and Worm assembly of oil expeller, causes of Failure and gives probable solution, Stresses analysis is also carried out with analytical method and comparing these results with the software results that is done using the ANSYS software. As it not possible to make the dimensional changes due to limitation of space inside the crushing chamber in Current Project Work, therefore solution will be totally based on the appropriate material selection which will increase the strength and hardness enough to withstand the stresses and avoid the failure.

CAUSES OF FAILURE

- [1] Not use of process of "Cooking", which in the presence of moisture denaturats the proteins amd plasticizes the flakes, renders them less brittle and making them soft and thus reduces the extent of flake disintegration as a result of shear in the press.
- [2] Usually caused by power failure (electricity down or circuit breakers tripped) with the hard materials jammed between the Screw and crushing chamber.
- [3]Improper fitting and alignment of Shaft.
- [4]Design and material of exiting mainshaft and worms to sustain the forces and stresses generated.

METHODOLOGY

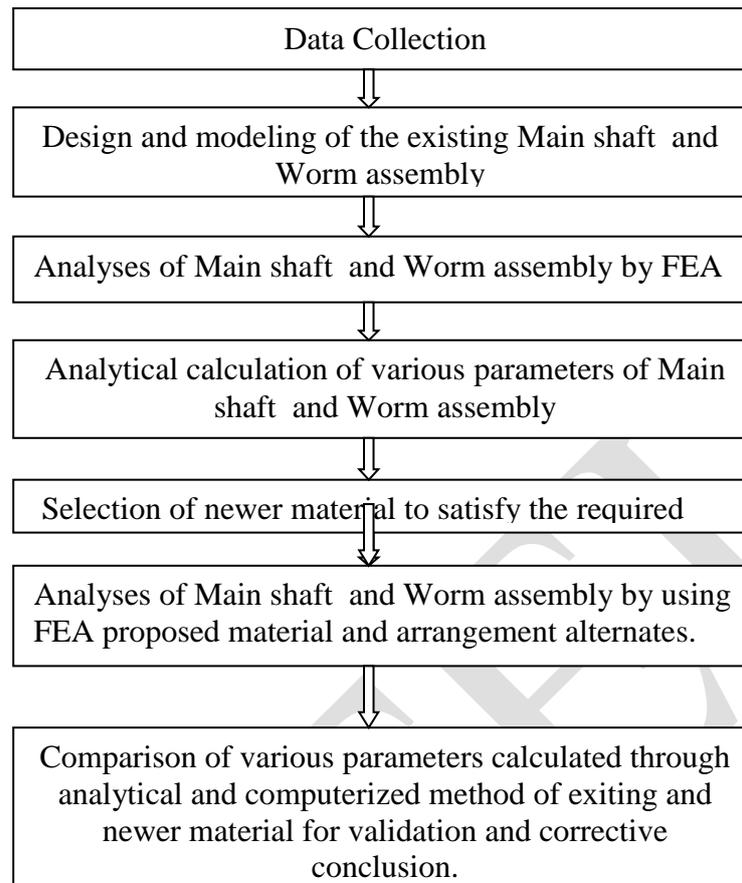


Fig 2: Methodology

CALCULATION OF VARIOUS PARAMETERS THROUGH ANALYTICAL METHOD

Technical Details

These details are taken from the machine catalogue;

1. Quantity to be crushed 12 tonne per 24 hr.
2. Motor rotation $N_1 = 960$ RPM
3. Motor Capacity = 50 HP
4. Motor Pulley Dia. $D_1 = 228.6$ mm
5. Gear Box Pulley Dia. $D_2 = 762$ mm
6. Input speed for Gear Box = N_2
7. Main Gear Teeth = 74 ; Spur Pinion Teeth = 12 ; Bevel Gear teeth = 42 ; Bevel pinion teeth = 15
8. Shaft Torque = T

Analytical Calculations. :

Calculate Gear Ratio and Verify Screw (Main Shaft + Worms) Rotation :

a) Find input speed for Gear Box :

$$\begin{aligned} \text{For belt drive} \quad D_1/D_2 &= N_2/N_1 \\ 228.6/762 &= N_2/960 \\ N_2 &= 288 \text{ Rpm} \end{aligned}$$

$$\begin{aligned} \text{For Gear Ratio} \quad G_1 &= T_3/T_2 \\ G_1 &= 74/12 \\ G_1 &= 6.166 \end{aligned}$$

$$\begin{aligned} \text{Similarly;} \quad G_2 &= T_5/T_4 = 42/15 \\ G_2 &= 2.8 \end{aligned}$$

$$\begin{aligned}\text{Gear Ratio} &= G1 \times G2 = 17.2648 \\ 7.2.2 \text{ Main Shaft Rotation (N)} \\ &= \text{i/p Speed at Gearbox (N2)} / \text{Gear ratio (G)} \\ &= 288 / 17.2648 \\ &= 16.68 \text{ Rpm} = \text{Approx. 18 Rpm.}\end{aligned}$$

Shaft Torque Calculation (T)
As 1HP = 0.754699 KW
Therefore Motor Power = 50HP = 37.73 KW
We know ; $\text{Power} = (2 \times 3.14 \times N \times T) / 60$
 $37.73 = (2 \times 3.14 \times 18 \times T) / 60$
 $T = 20016.38 \text{ N-m}$
 $T = 20016.38 \times 10^3 \text{ N-mm}$

Shaft force Calculation (F) {Due to torsion}

Considering $d=75\text{mm}$;
 $T = F \cdot r = 12867.67 \times 10^3 = F \cdot (75/2)$
 $F_1 = 343.137 \times 10^3 \text{ N}$
Considering $d=80\text{mm}$;
 $T = F \cdot r = 12867.67 \times 10^3 = F \cdot (80/2)$
 $F_2 = 321.691 \times 10^3 \text{ N}$
Considering $d=85\text{mm}$;
 $T = F \cdot r = 12867.67 \times 10^3 = F \cdot (85/2)$
 $F_3 = 302.768 \times 10^3 \text{ N}$
Considering $d=95\text{mm}$;
 $T = F \cdot r = 12867.67 \times 10^3 = F \cdot (95/2)$
 $F_4 = 270.89 \times 10^3 \text{ N}$

Torsional Shear Stress developed :

Working Stress Developed = $16T / 3.14 \times d^3$
 $= 16 \times 20016.38 \times 10^3 / 3.14 \times 75^3$
Working Stress = 241.64 N/mm^2
Now, For Mild Steel (Ductile material)
FOS = Maximum yield point stress / Working Stress
FOS = $350 / 241.64 = 1.44$
Therefore, Factor of safety for existing shaft is 1.44.

MODEL CREATION BY USING THE MODELING SOFTWARE "PRO-E"

The existing Mainshaft and Worm assembly consist of Mainshaft and Worms having dimension following;

Total Length of shaft = 2569.4 mm,
Diameter of steps on shaft = 95mm, 85mm, 80mm, 75mm
Shaft Keyway = 1600.2 mm x 20mm x 8mm
Worm Lengths = 254mm, 203.2mm, 139.7mm,
95.25mm, 76.2mm, 63.5mm
Worm Inner hub Diameter = 80mm - 85 mm
Worm Outer hub Diameter = 130mm
Worm Thread thickness = 10mm
Worm outer diameter = 165.1mm

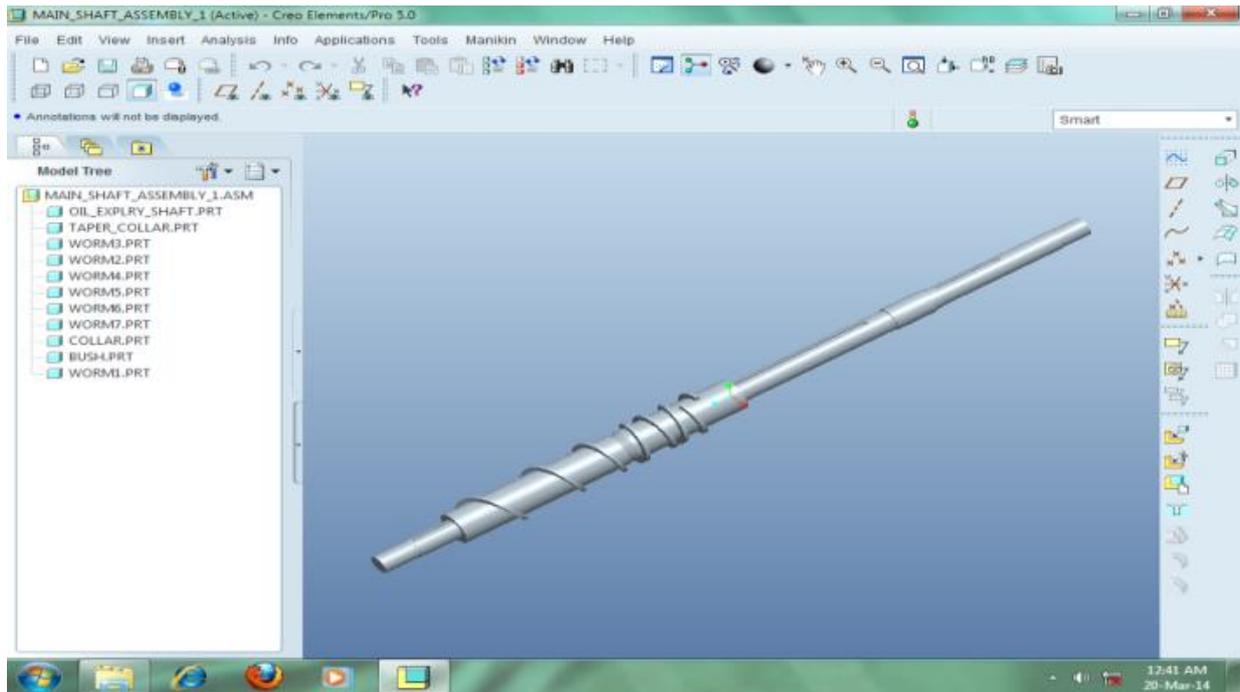


Fig 3: Mainshaft Assembly model

MATERIAL SELECTION

EN8 steel is selected as to replace Mild steel material of existing main shaft assembly ,taking into consideration following factors over existing one ;

- [1] Good tensile strength and hardness :- EN8 also know as 080M40 is a very popular grade of through-hardening.
- [2]Unalloyed medium carbon steel having good tensile strength., It can be further surface-hardened (quenched and tempered) for producing components with enhanced wear resistance and possesses good homogenous metallurgical structures, giving consistent machining properties.
- [3]Availability :- En8 mild steel is very popular grade is available easily as per requirement.
- [4]Wear Resistance :- Have Good Wear resistance.
- [5]Good Machinability :- EN8 in its heat treated forms possesses good homogenous metallurgical structures, giving consistent machining properties.
- [6]Good Weldability :- EN8 mild steel contains a less carbon 0.35-0.45% ,so have good Weldability.
- [7]Application :- EN8 steel (080M40) is EN8 is widely used for many general engineering applications. Typical applications include shafts, studs, bolts, connecting rods, screws,rollers.

Comparison of properties of En8 Steel with Mild Steel.

Materials	Mild Steel	En8 Steel
Std. Properties		
Tensile Strength	630 N/mm ²	850 N/mm ²
Yield Strength	350 N/mm ²	465 N/mm ²
Brinell hardness (HB)	255	175

CONCLUSION

After studying exiting mainshaft and worm assembly of the screw type of the oil expellers The main reason for the failure diagnosis is non use of the process of cooking, heavy choking of material between the screwshaft and crushing chamber due to presence of foreign particals, wrong assembly or fitting of mainshaft, and misalignment, apart from these the most important reason is the being old machines they use of the ordinary M.S material for main shaft assembly which is having low strength and hardness.As it is not possible to change the diameter of shaft as there is very little tapper clearance between worm threads outer diameter and crushing chamber inner diameter, so use of the material of high tensile strength and hardness to with stand the forces and stresses is desirable.The hardened and tempered EN8 material is highly use in all recent oil expeller machines having good strength and hardness,so replacing the present Mild Steel material with the En8 may reduce the chances failure of mainshaft and worm assembly,reducing the running cost and increase the productivity of Oil Expeller.

REFERENCES

- [1] Shankar Haldar,Aniruddha Bhattacharjee,Vineet Jain, and Sudhir Singhal,(2012) Report submitted on “Expellers in India and Expelling Operations”, Volume I: Main Report submitted to Department of Science and Technology Government of India June 2012.
- [2] Mehul.K.Modh,J.R.Mevada,(2011)“Design,Improvement and Thrust Bearing Analysis of Oil Expeller Machine”, Int Journal of Engg Techsci Vol 2(3) 2011,246-252.
- [3] S.N.Vijayan,M.Makeshkumar(2012),”Material Specific Product Design Analysis for Conditional Failures – A Case Study” International Journal of Engineering Science and Technology (IJEST), ISSN : 0975-5462.
- [4] Paper Publied by Singh, J. and Bargale, P.C., Indian Institute of Sugarcane Research (ICAR), Lucknow Journal of Food Engineering, Volume 43, Issue 2, February 2000 on Development Of A Small Capacity Double Stage Compression Screw Press For Oil Expression
- [5] D. K. Padhal,D. B. Meshram;(2013);Analysis and Failure Improvement of Shaft of Gear Motor in CRM Shop, International Journal Of Engineering And Science; Issn(e): 2278-4721, Issn(p):2319-6483.
- [6] Khurmi, R. S., & Gupta, J. K. (2008). A textbook of machine design. (14th ed.) New Delhi:Eurasia Publishing House (PVT) Ltd., (Chapters 7 & 14).