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Design and Fabrication of Oil Separator

Akshay Sonawane, Sanket Shinde, Satyam Buchude, Rohan Mali
Sir Visvesvaraya Institute of Technology, Chincholi,Nashik, BE (Mechanical)

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I. INTRODUCTION

In today's manufacturing industry the demand is growing for low cost, high productivity and good product quality. High productivity that is inherently associated with high cutting speed, feed rate and depth of cut significantly lead to a large amount of heat generation and raises the temperature in cutting zone. Consequently, the dimensional accuracy, tool life, and surface integrity of the product are deteriorated. Today, cutting fluid is considered as an accessory in a machining operation in order to increase the productivity. In terms of performances, it effectively increases the tool life producing a better dimensional control and good surface quality. A good surface finish is not only desired for the aesthetic appearanceof a product but also to improve the tribological properties, fatigue strength, and corrosion resistance. Thus, surface quality is extremely important in evaluating the productivity of machine tools and mechanical parts.

Cutting fluids represent a significant part of manufacturing costs. Just two decades ago, cutting fluids accounted for less than 3% of the cost of most machining processes. These fluids were so cheap that only few machine shops gave them much thought. Times have changed and today cutting fluids account for up to 15% of a shop production cost.

So it is necessary to remove oil from the burr produced. Centrifugal type oil-burr separators are often a good solution because they remove the oil using only centrifugal force. Absorbents or other consumable items (such as filter cartridges) are not required, and the oil that is separated is often recyclable. No pumping or other utility costs are usually required. They can be designed to function under a great range of operating conditions. Separator set up is located beside the CNC, lathe Machine or operating machine where the burr is produced which contains the cutting oil. Centrifugal motion is preferred for better removal of cutting oil.

1.1Problem Statement

Cleanliness of the oil is a vital problem and it should to be free from contaminants such as sludge, carbon, water, burr etc. in order to control problems such as foaming, bacterial growth, fungi, corrosion of metal parts, etc. Hence it should be filtered before next operating cycle.

The metal removed during the process is collected in the tank along with cutting oil. The 60% of oil is recovered by filtration like gravity method. The remaining 40% of oil retain in chips due to curliness of chips and viscosity of oil. It is necessary to separate the oil from the burr. As the loss of the oil to this much extend is undesirable. This will affect economy and the overall efficiency.

1.2 Objective

1. The design and operation of the centrifugal oil cleaning systems are based on the basic laws of physics and general chemical engineering principles for specific operating pressure.
2. The layout of components should provide ease for servicing especially for those components which require frequent servicing should be easily dismantled.
3.By using this set up the recovered cutting oil can be recycled and it can be used for further process.

1.3 Methodology

The method used to achieve the objective of the project that will provide perfect results.This final year project use three major steps to implement project starting from planning, designing and implementing. All the methods used for finding and analyzing data regarding the project are related below:

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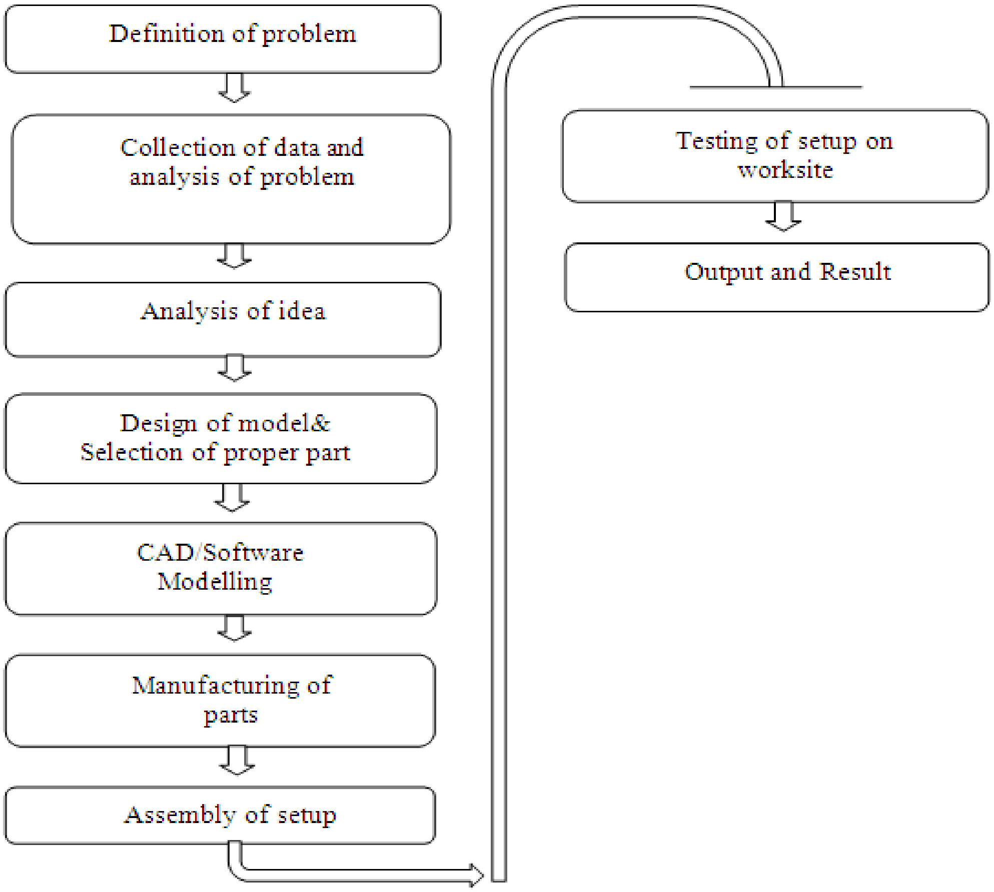

1. **Definitionof problem**: Burr removed from various metal working processes contains large amount of oil within it. These manufacturing chips, mixed with cutting fluid, are difficult to recycle. As widely recognized, recycling these metal chip wastes could enhance the economic profit and reduce the environmental impact of manufacturing.

2. **Collection of data and analysis of problem:**The metal removed during the processes in the form of burr is collected in the tank along with cutting oil. 60%oil is recovered by filtration and 40% of oil retain in chips due to curly nature of chips and viscosity. Loss of the oil to this much extend is undesirable. This will affect economy and the overall efficiency.

3. **Analysis of idea:** Inspired from different real life examples like washing machine to removes water from clothes, in food industry to remove oil content from fried products, etc. the principle of centrifugal action is selected for the removal of oil from the burr.

4. **Design of model & selection of proper part**: In this stage different components of the system was defined and the system was designed as per requirement

5. **CAD/Software modelling:** Depending on the design data the CAD model of the system is developed using solidworks.

6. **Manufacturing of components**: Different parts of the machine are manufactured in this stage. Most of the components are readily available in the market, which are selected as per the requirement of the system. Apart from them, the machine parts-frame, shaft, net drum, base plate, etc. are manufactured.

7. **Assembly of setup:** This stage involves complete assembly of the machine.
8. **Testing of setup on worksite:**This stage involves testing of machine for oil removal rate (per 5 kg), efficiency of machine, power required, cost, time etc.

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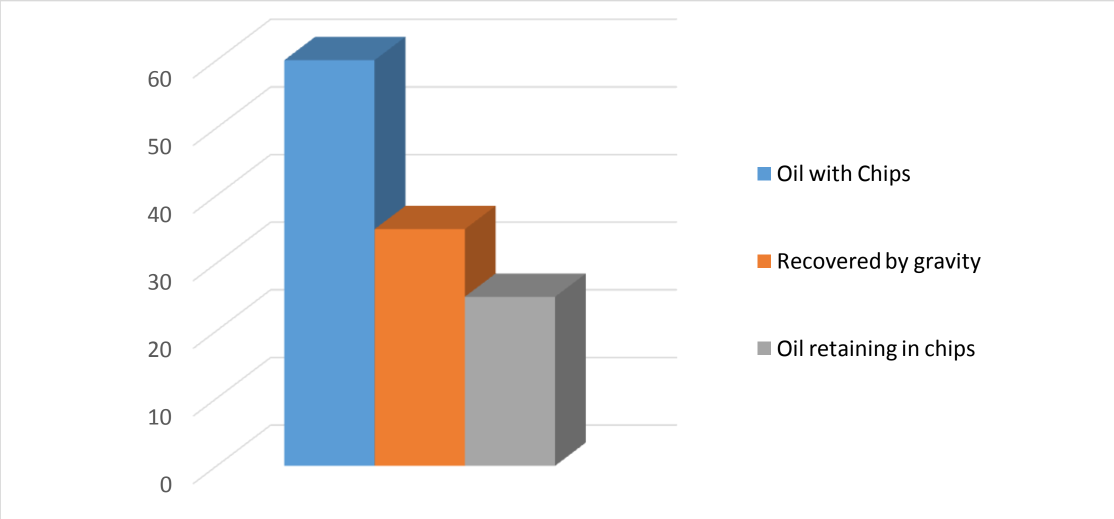
1.4 Problem Details

In industry, machining processes like hobbing, broaching etc. are adopted.The amount of oil required for the operation as well as the rate of burr removal is high. Huge amount of burr is generated which contains significant amount of cutting oil. The burr which contains cutting oil is further processed without recovering the oil.As this much loss of fluid is not economical,the oil should be separated from the burr.

1.4.1 Current Status of Oil Consumption in Industry:

Oil from chips are collectedin sump tank

1. Chips containing oil are collected in perforated trays from chip conveyors.
2. 60% of oil from chips is collected using gravity method in the sump tank.
3. 40% of oil retainswith chips due to curly nature of chip and the viscosity of oil.
4. Even after processing the 24% oil of total oil consumption goes to scrap yard along with chips.



Graph No. 1.4.1.1 Percentages of Oil Consumptions

1.4.2 Cutting Fluid used for Metal Working:

Cutting oils are primarily used when good lubricating properties are required, such as in deep-hole drilling, threading and reaming. Cutting oils have different viscosities. Base oils and additives are selected depending on the processes and which metals are being machined. Mineral oils, synthetic oils, white oils and esters are used as base oils. "Fatty oils" are also often added (such as vegetable oils, animal oils or esters) to protect against wear. EP additives are also sometimes used (e.g. sulphur, phosphorus or chlorine).

Input Setup

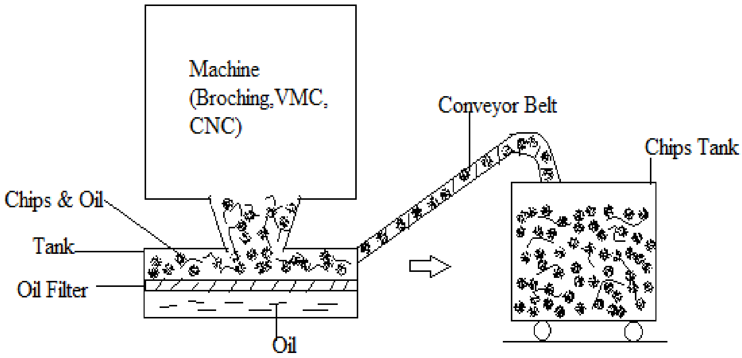


Figure No.1.4.2.1 Input Setup

Separator System Setup

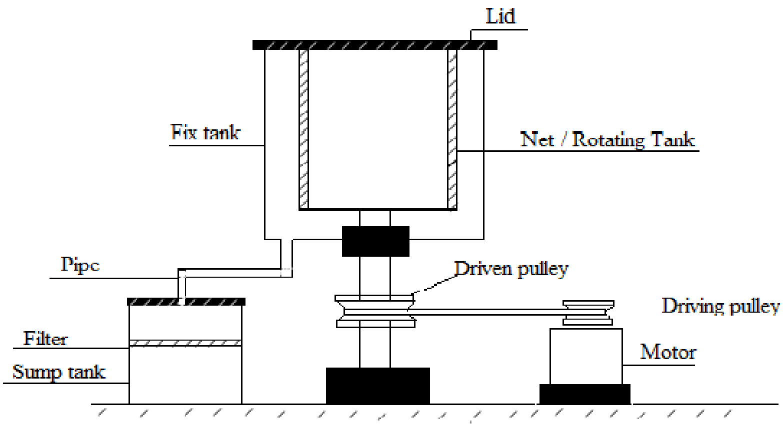


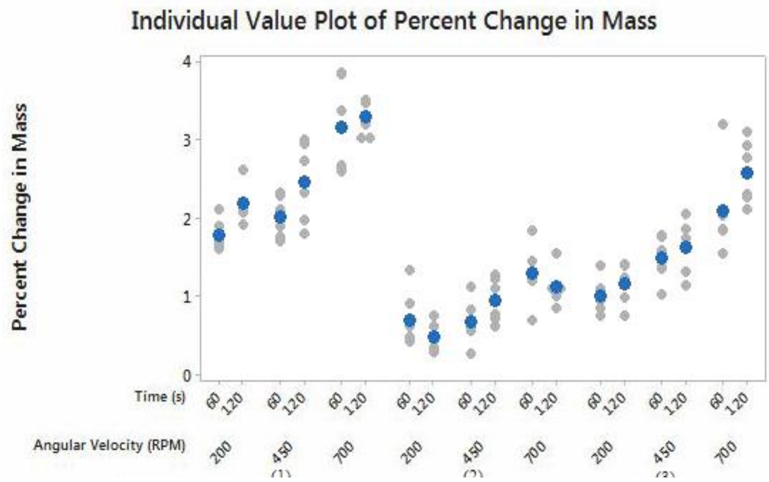
Figure No. 1.4.2.2 Separator System Setup

II. LITERATURE REVIEW

i. Mr. S. D. Chavan, Prof. A. V. Karande-worked on "Design and Development of Centrifugal Oil Cleaner and Finite Element Analysis using ANSYS". In this research paper they stated as the engine oil after prolonged use needs to be filtered. They studied the characteristics of the oil change during engine operation.Even if centrifuge oil cleaner though an effective solution where in the high rate of discharge can be maintained proves to be a costly option today as the cartridge used in the centrifugal oil cleaner needs to be replaced after use which increases the maintenance cost treme-ndously.This paper discuss the design and FEA analysis of the modified oil cleaner and evaluate the performance of cleaning of the oil cleaner.[1]

ii.Pramod Kumar&Mohd Anees Siddiqui- concerned about the hazards related to cutting fluids and their remedies. The paper involves analysis of different types of cutting fluid on the basis of environmental and operator health related hazards.as cutting fluids remove the contaminants in work area providing friction reduction ,retaining material properties , act as coolant, etc. The fluid with impurities cannot be disposed directly due to hazardous metal carry off. Health hazards related with the exposure to the cutting fluids are about 80% of all occupational hazards. Thus the metal contents of oil needs to be separated for eco-friendly disposal of cutting fluid. [2]

iii.Yufay Chow-Yee– studied the determination of the amount oil removed from the fried food without affecting the structure of the food, using simply designed centrifuge system. Results were obtained at different speed by varying the processing time. It was observed that oil removal rate is effective/efficient at higher speed. Oil can be efficiently removed from fried chicken at speed of 1500 rpm without affecting its structure. They have also studied the amount of oil removed from French fries from different speed i.e.200,450,700 rpm .the period of operation was kept constant the result were compared. It was concluded that angular velocity affects the amount of oil removed. Almost 25.7% of total oil content in fries can be removed at 700 rpm in 120 seconds. The study concluded that centrifugation is a cost effective &efficient method free removal of oil. [3]

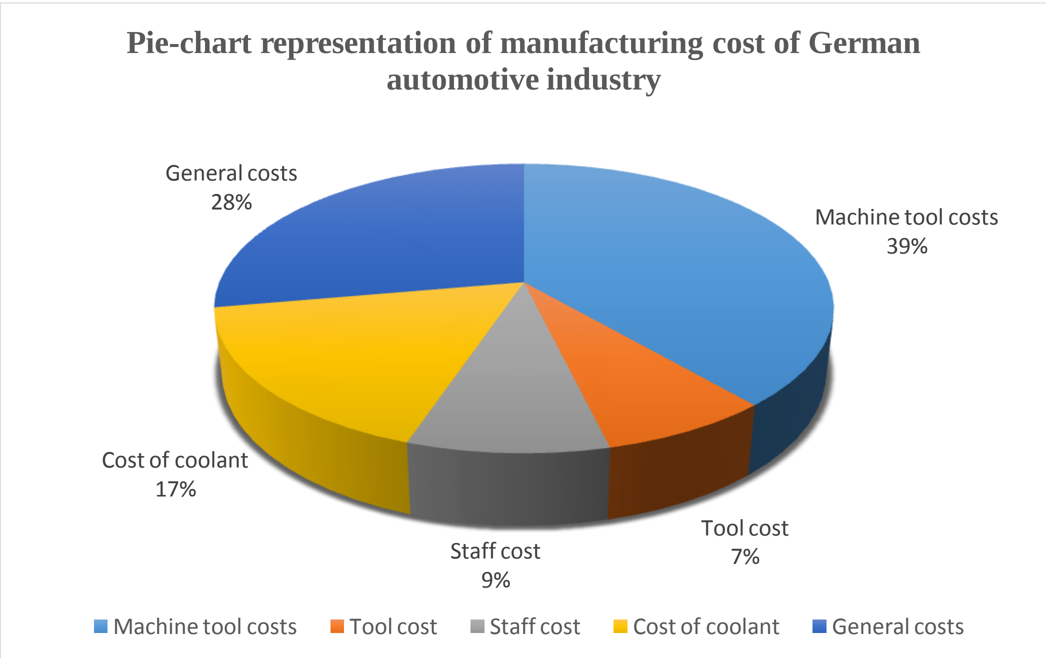


Graph No.2.1 Percentage Change in Mass vs. Angular Velocity

iv.Karen L - Discussed cutting fluid management and waste reduction techniques along with cost reduction and performance improvement. The study involves information about different oil recovery systems which incorporates different technologies. It was concluded that there is almost 7.52% reduction in annual operating cost for machine after oil recovery. [4]

v.Meet D. Bakotia1 Pritesh Prajapati- Focused on the design and analysis of decanter centrifuge. The decanter centrifuge is a device that separates solid materials from liquid slurry and thus plays an important role in wastewater treatment. It was obtained that the separation process relies on few process characteristics such as centrifugal force, dimension of centrifuge and speed of rotor. It was observed that centrifuge separators are more efficient than mechanical screen separators. [5]

vi.ViktorP.Astakhov-pointed out that the cutting fluids also represent a significant part of manufacturing costs. Pie-chart represents manufacturing cost at the German automotive industry. The conspicuous high share of the costs for cooling lubrication technology reaches 16.9% of the total manufacturing costs. [6]



Pie-chart No.2.2. Representation of Manufacturing Cost of a German Automotive Industry

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III. DESIGN OF ELEMENTS

3.1 Working Principle

Oil Recovery Centrifuge works on the principle of centrifugal separation. Rotor bucket made of perforated mild steel is driven by motor. Burr from which oil is to be recovered are loaded in the rotor bucket. Centrifugal force created in the rotor separates oil from surface of burr. Collected oil is depleted out by opening valve located at the base of unit.

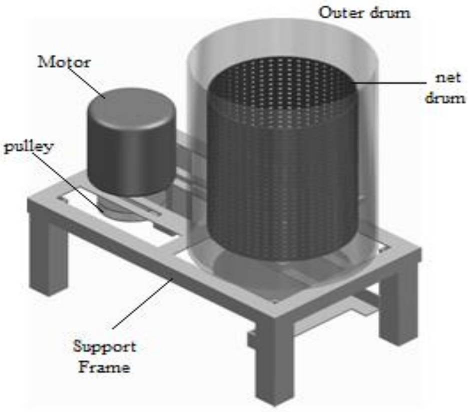

Figure No. 3.1.1 Setup of Oil Separator

Centrifuge is used in conjunction with positive filters to remove small fines from metal working cutting oil. The fluid mix feeds into a centrifugal open type net drum which rotates at a high rpm. Centrifugal force pushes the swarf in the outward direction from center of the bucket. The cutting oil from the net splits into outer drum/bucket. Then oil is collected at the bottom of container the tank. It is again filtered using some filter media in order meet the standards of the oil.

In mechanical design the components are listed down and stored on the basis of their procurement in two categories:

- Designed parts
- Parts to be purchased

For design parts a detailed designing is done & designation thus obtained are compared to the next highest dimension which is readily available in market. Selection of material is made according to the condition of loading shapes of products environment conditions & desirable properties of material.

3.2 List of Components

1. Motor
2. Belt
3. Pulley
4. Shaft
5. Drum
6. Net cylinder
7. Base plate
8. Bearings
9. Frame

3.3 Motor Selection

As review of various application of centrifugal force for theseparation such as, in food industry to remove oil content from fried foods e.g. fried chicken (at 1500 RPM for 7 Kg), to separate blood cells in pharmaceutical industry, to remove water from clothes, etc. In this machine we are using centrifugal force to remove the oil from burr. To produce centrifugal force on burr we required to rotate drum at speed ranging between 1400-2000 RPM.

Motor Specification

AC Motor, Flange Mounting
Speed = 2880 rpm
Frequency = 50 Hz
Phase = Single
HP = 0.5 = 0.372 kW
Voltage = 440 volt
Current = 3 amp

Torque Analysis:

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

Where, T= Torque (Nm)
P = power (kW)
N = Speed (rpm)

$$T = \frac{P\ 60}{2\ \pi\ N} = \frac{0.372 \times 10^3 \times 60}{2\pi \times 2880}$$

= 1.23 N.m

Considering 100% Overload,
$T_{design} = 2T$
= 2.4669N.m
=2466.9016 N.mm

3.4 Belt Selection

Input: P=0.372kW
N= 1440 rpm (reduced)
C = 0.310 mm(assumed)
Groove angle, 2β=40°Coefficient of friction,
$\mu = 0.25$

Max. Belt speed (linear)=2πr $\times rps$
= 15.0796 m/s

1) Application for medium duty (heavy start)
Daily Working = 8-10hr

Service factor=1.21 (Page No.16 – SKF catalogue) [8]

2) Design Power

$P_d = 1.2 \times Pa$

$=1.2 \times 0.372$

=0.4464 kW

3) Speed Ratio

I= Speed of motor / Required Speed (Speed of Drum)

$I = \frac{2880}{1440}$

I = 2

If both pulleys have the same diameter, they will rotate at the same speed. However, if one pulley is larger than the other it has mechanical advantage.A system of pulleys is used to lift heavy loads by the mechanical advantage of increasing the length of travel of the pull and decreasing the load. Hence, to obtain desired speed ratio bigger pulley should be double in diameter of small pulley.

Driver = 100 mm

Driven = 200mm

(PageNo.21, SKF Catalogue) [8]

4) Centre distance preliminary (C_p)

C_p min = 0.7(D+d) =210 mm

C_p max = 2(D+d)= 600 mm

5) Belt datum length (L_D)

$L_D = 2C_p + 1.57(D+d) + [(D-d)^2/4Cp]$

=902.904 mm

6) Centre Distance

a =2Ld-π (D-d)

=1491.6487mm

$C = \frac{a+\sqrt{(a2-8(D-d)2}}{8}$

=309.46mm ≈ 310 mm

7) Power Rating

P_b =3.98 kW

(Table 9b, Page No. 42, SKF catalogue) [8]

8) Correlation factor

Belt length C1= 0.89mm

(Table 8, Page No.40, SKF catalogue) [8]

From table 7, Page No. 40 basis of[(D-d)/x]

Arc of contact=163°

Correlation factor C3=0.96

9) Belt Power Rating

$P_r = P_b \times C1 \times C3$

$=3.98 \times 0.89 \times 0.96$

=3.400kW < 0.4464kW

Hence, selected belt is safe.

A) Angle of lap (α)

Sinα = (D2-D1)/2a

$Sin\alpha = \frac{(200-100)}{2\times 10}$

α = 9.28

θ=180°-2α

θ=161.44=2.81 rad

Max belt speed (linear)

$M = 2\pi r \times rps$ =15.0796m/s

Mass of belt /m=M_m= 0.115kg/m

Centrifugal tension = $T_c = MV^2$

=26.15N

A=12.7×7.874= 99.998

Max tension $T_b = 2\times A$

$=199.996 N/mm^2$

$T1 = T_b - Tc = 173.84$ N

$\frac{T1}{T2} = e^{\theta\mu}$ =77.9057

T2= 86.1138N

T1-T2=87

$P = \frac{(T1-T2)V}{1000}$

= 1.322 kW >0.4464 kW

Hence, the Selected Belt is safe

Type	Speed Ratio	Driver	Driven	Belt Length	C.D	Power rating	Arc of contact
A	2	100 mm	200 mm	900 mm	310 mm	3.98 kW	161.5^0

SPA 13 mm (Belt width) wrapped type

3.5 Design of Drum and Base plate

a) Inner Net Cylinder

Inner net cylinder used to rotate burr, in order to produce centrifugal force on burr so that the oil will be removed and burr will trapped at net. So we have to design cylinder such that burr should rotate freely, height of cylinder should be greater than diameter of cylinder. Because, as we have to remove oil, more area of net should be in contact with burr, So diameter of net cylinder we select same as big pulley (200)

Material of Burr Fe, Al, steel etc. as our design consideration is to manufacture machine for maximum capacity of load we'll use maximum density from this material is of steel which $8050 kg/m^3$for design.

Mass of burr =6kg

$Density = \frac{mass}{volume}$

Burr Volume=7.4534×10^ (-4) m^3

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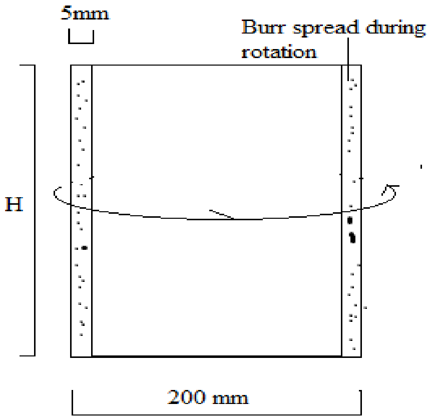

Now,Volume for Cylinder,

$V=\pi\times(R^2- r^2)H$

$H=\frac{7.4534\times10^{(-4)}}{\pi\times(0.1^2-0.095^2)}$

H=0.2433m

H = 24.33cm

Result

H=24+4=28 cm (4 cm is space kept for free rotation of burr)

D=20+2= 22cm(2cm for mounting).

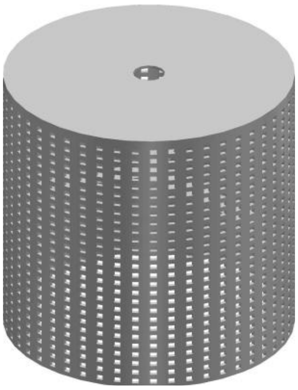

Figure No.3.5.1 Net Cylinder

b) Outer Drum to collect oil

It is stationary drum to collect oil from net cylinder, so it'll identical in shape but greater in dimension.

Diameter = 28 cm

Height=38cm

(10 cm greater than net cylinder dimension)

Figure No. 3.5.2 Outer Drum

c) Base plate

Burr container or cylinder which is a rotating part, for this there is need of supporting structure which canwithstand high load and should not corrode by burr content, and different oil contaminants. The material for plate selected is steel which has good strength, corrosion resistance. As net cylinder is mounted on the plate is should have an equal diameter that of the cylinder i.e. 22 cm, and thickness is 0.7 cm.

3.6 Design of Frame

Frame is the support structure for machine. It is designed according to machine dimensions, shape and then checked for deflections and slope at load of machine components. For frame material should be ductile & malleable so it can stand with high tensile force, it should be lighter in weight, should have good strength, impactness. Angle of mild steel are used because it poses all required properties and mounting of component by nut and bolt are easy on angle shape. Angle are available in market in standard sizes, According to all dimensions available & considered we designed following frame.

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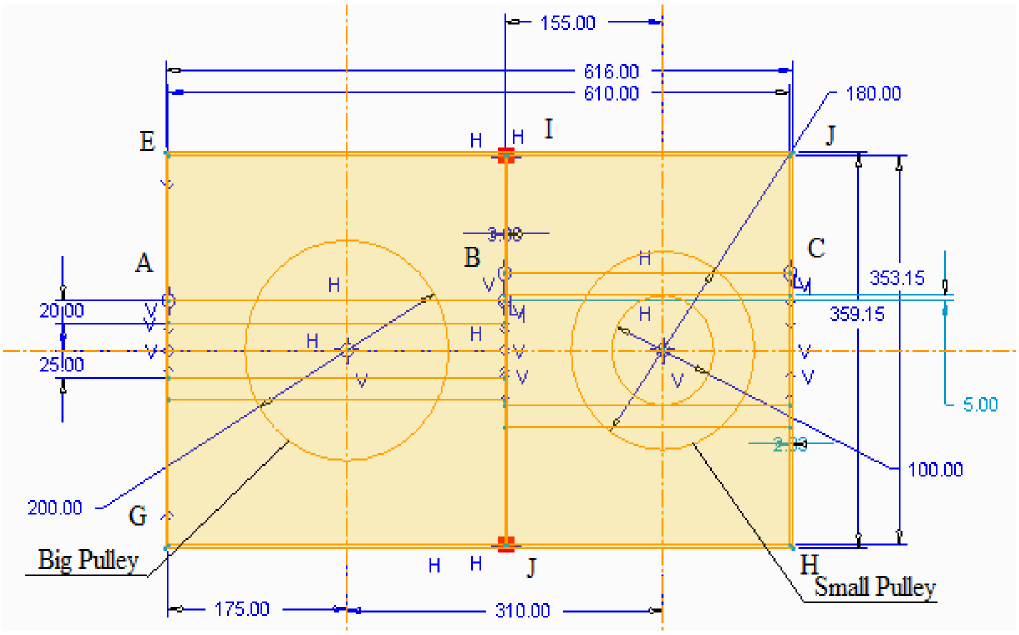

Figure No. 3.6.1 Detailed Dimensions of Frame

A) Load Calculation

1) Angle weight = volume ×density (MS)
= (2×3-0.3)×3×35×7.85
=4.698 kg

2) Strip(BC) = 4×1×30.5×7.85
=957.7 gram = 0.958kg

3) Strip (AB)= 2×1×30.5×7.85
= 478.85 gram
=0.478 kg

4) Metalplate (steel) $=\pi r^2 h\times 8.05(\rho/cm^3)$ (steel)
$=\pi\times 11^2\times 0.7\times 8.05$
= 2142.0490gram
=2.2 kg

5) Burr= 6 kg

6) Drum= 3 kg … (assumed)

7) Net Cylinder=Perimeter×height×density
$=\pi D\times H\times thickness\times\rho$
$=\pi\times 22\times 28\times 0.2\times 8.05$
=3.1157kg

8) Shaft $=\pi r^2 h\times 8.05$(steel)
$=\pi\times 1.25^2\times 20.5\times 8.05$
=810.064 gram
=0.810064 kg

9) Weight of big pulley= 192.62 ×9.81
= 2.020 kg
Weight of small pulley= 191.62×9.81
= 1 kg

10) Motor = 8 kg

11) Bearing = Flange bearing = 1.5 kg
Pedestal bearing = 1.5 kg

12) Angle =4.698 kg
= 46.0873 KN

B) Total Load

1) EI section total load=2.02 kg – big pulley
+2×0.478 - strip
+1.5 kg – flange bearing
+0.8100 kg – shaft
+03.1157 kg – net
+2.2 kg – plate
+3 kg – drum
+6 kg – burr
19.6017 kg or 192.29 N

2) IF section total load = 1 kg – small pulley
+8 kg – motor
+2×0.957 kg - strip
10.914 kg or 107.0663 N

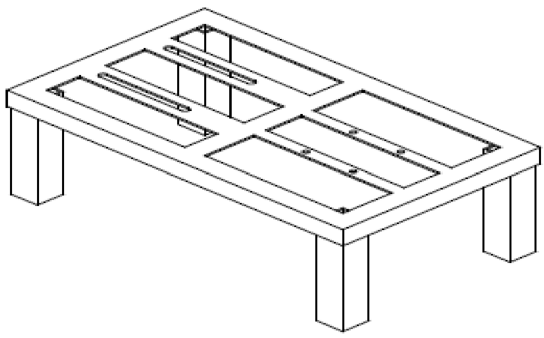

Figure No. 3.6.2 Frame

C) SFD & BMD Calculation

a) EF Section

As we considered, shear force distribution from one side of frame, so we have to take value of force/load

at E (A) & at point F (B) & total center load half of its original value.
Therefore take A = 96.145/2 = 48.07 N
B = 53.53/2 = 26.76 N (Calculated from support reactions)
Total load at center = 74.8375 N

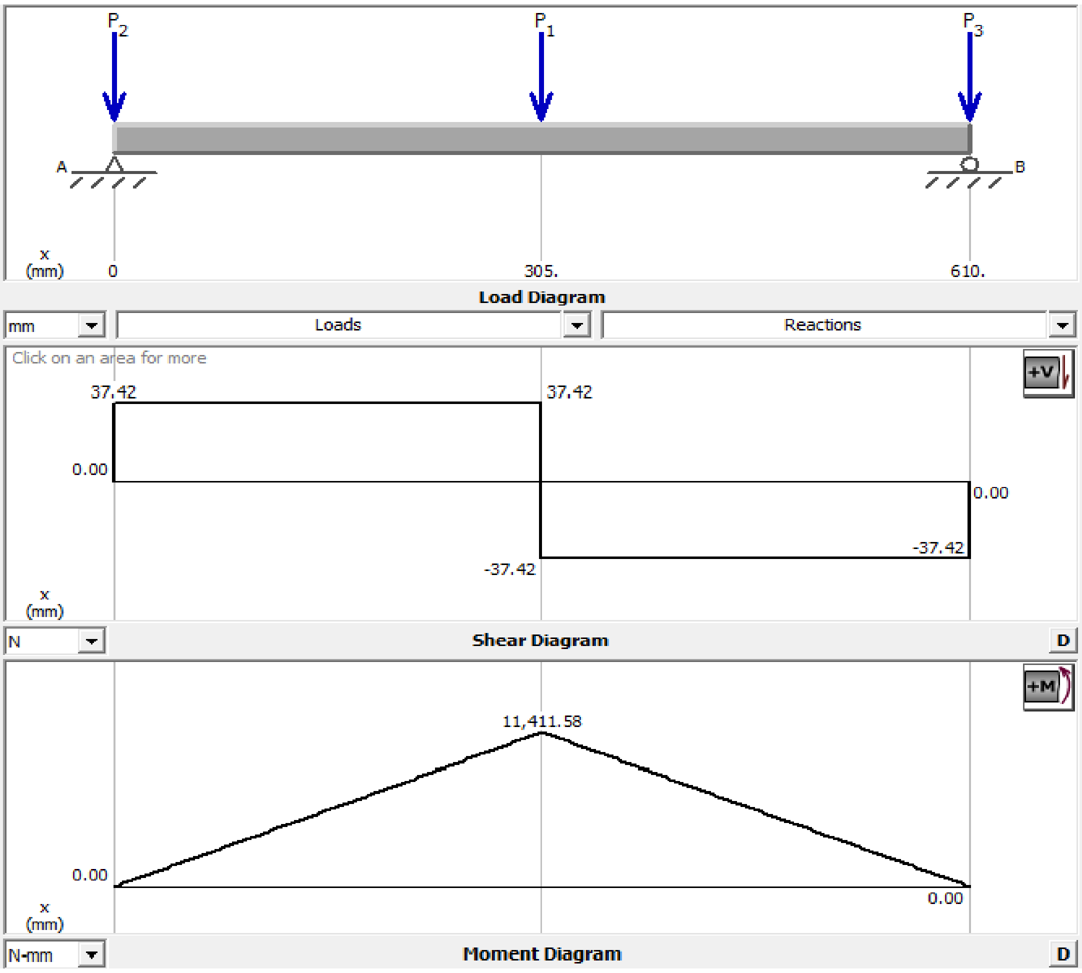

Figure No. 3.6.3 SFD & BMD of Section EF

Maximum slope = - 0.6064 rad
Maximum deflection = - 4.854 mm
b) IJ Section
Reaction at I is Ra & reaction at J is Rb
Load at P1 & P2 is 26.76 N
Load at P3 & P4 is 48.07 N

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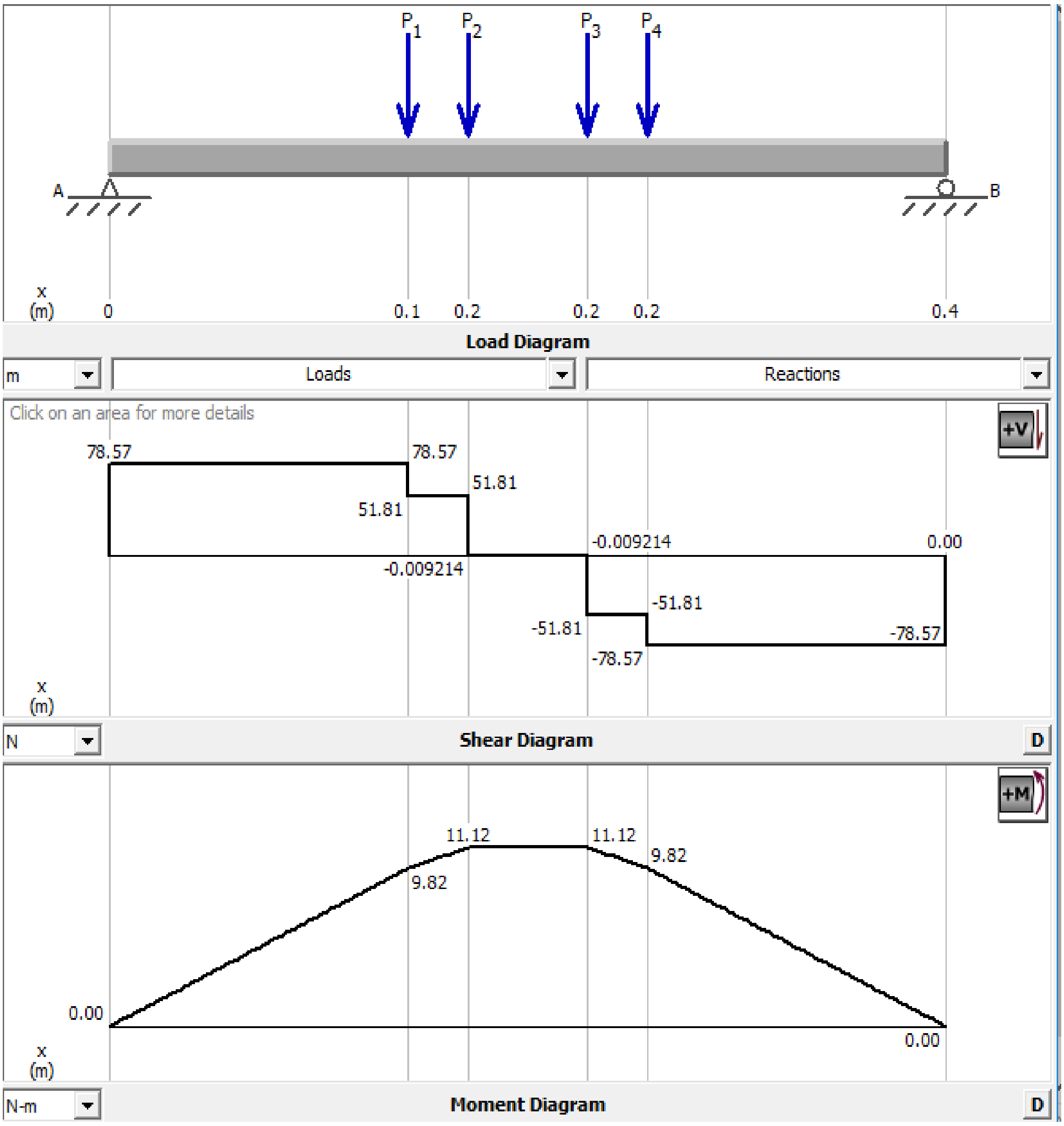

Figure No. 3.6.4 SFD & BMD of Section IJ

Maximum slope = - 0.3775 rad
Maximum deflection = - 1.696 mm
c) EG Section
Reactions at E is Ra & reaction at G is Rb
Load at P1 is 48.07 N
Load at P2 is 48.07 N

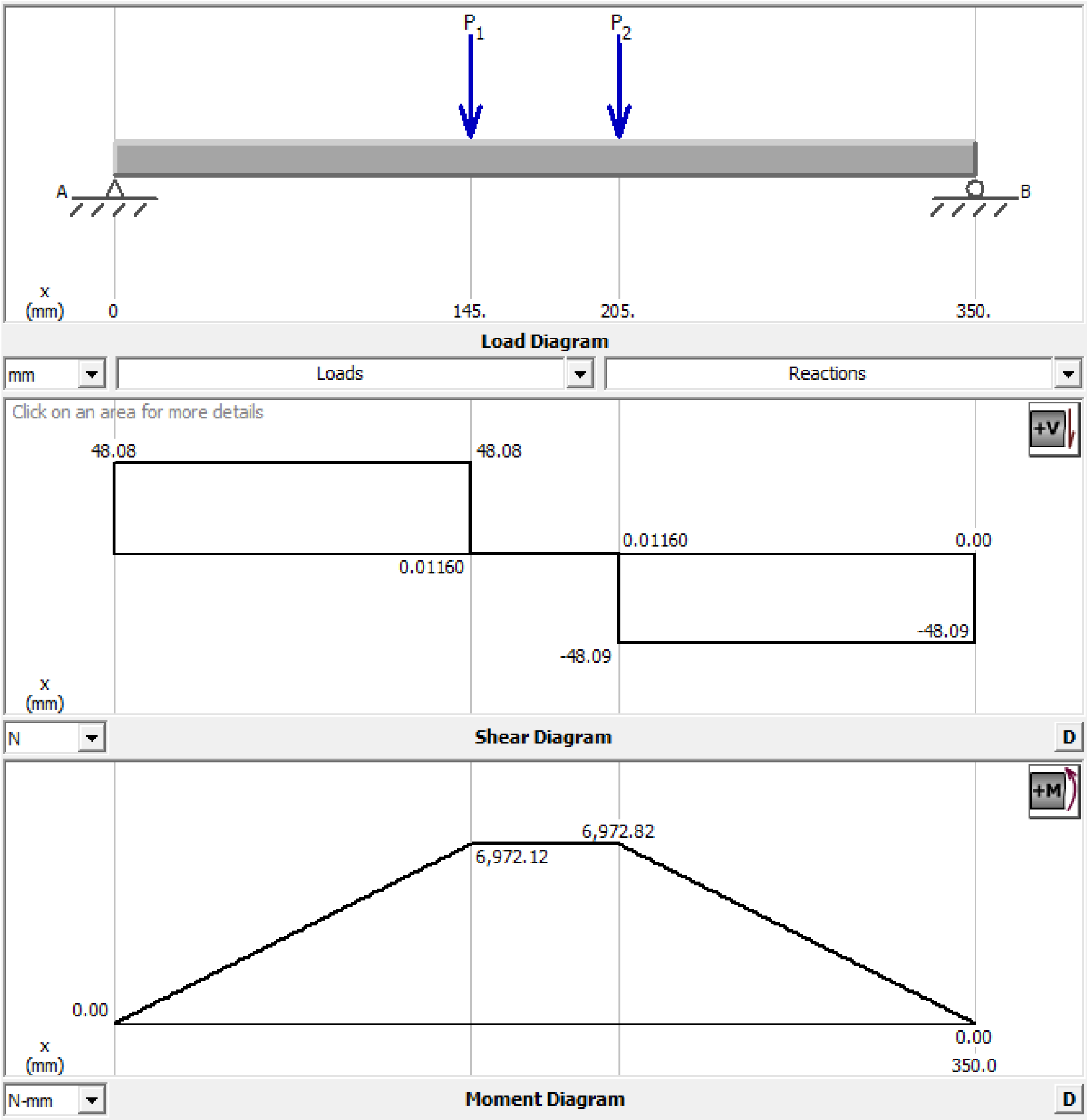

Figure No. 3.6.5 SFD & BMD of Section EG

Maximum slope = - 0.2464 rad
Maximum deflection = - 1.056 mm

d) FH Section
Reaction at F is Ra & reaction at H is Rb
Load at P1 is 26.76 N
Load at P2 is 26.76 N

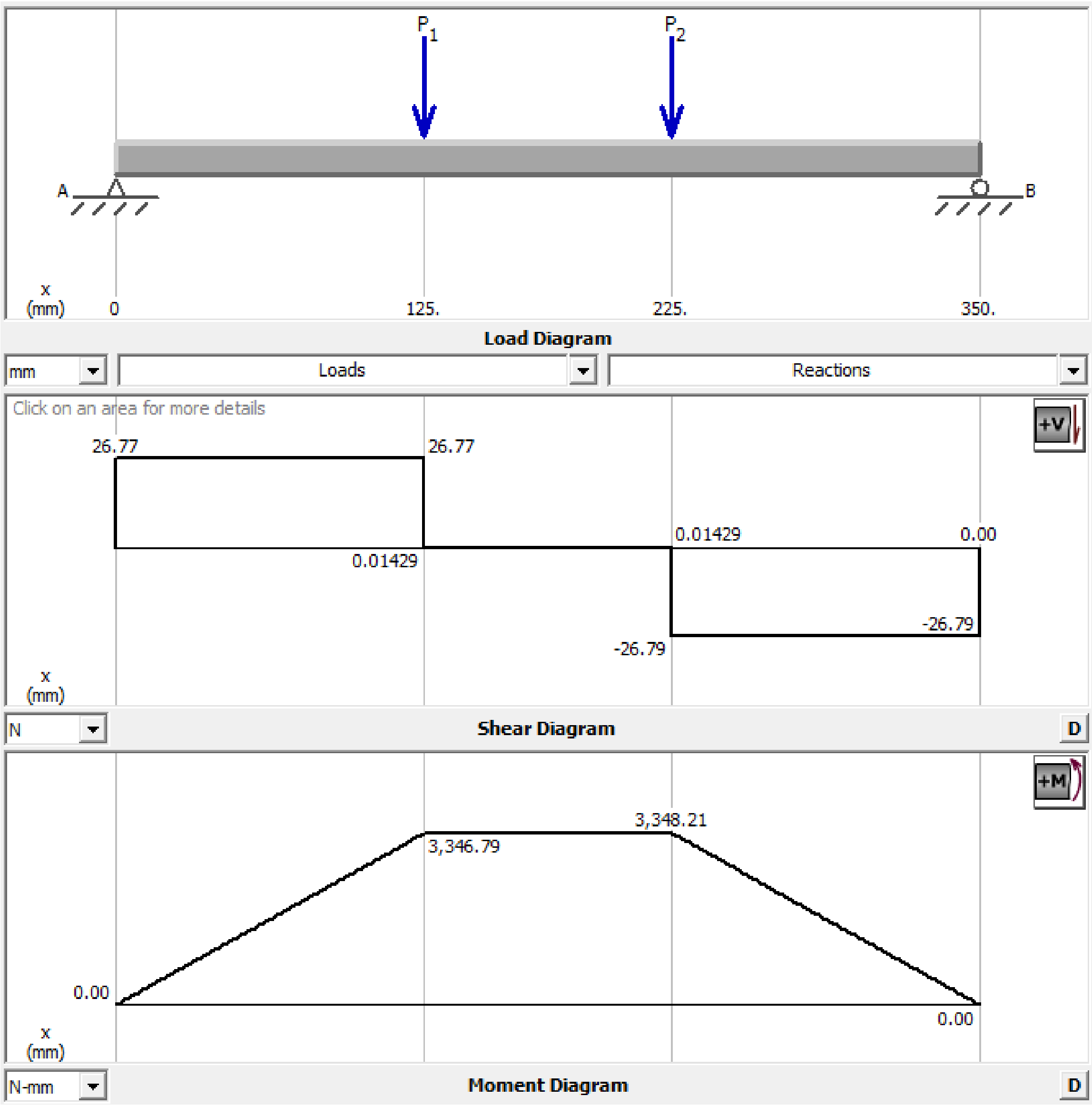

Figure No. 3.6.6 SFD & BMD of Section FH

Maximum slope = - 0.1312rad
Maximum deflection = - 0.5836 mm

3.7 Design of Shaft

Material selection: M.S.
S_{yt}=370MPa=370N/mm^2=370×10^{6}N/m^2
S_{ut}=440N/mm^2=440×10^{6}N/m^2
1) Permissible Shear Stress
$\tau_{permissible}$=0.3 S_{yt}=0.3×370×10^6=111×10^{6}N/m^2
=0.18 S_{ut}=0.18×440×10^6=79.2×10^{6}N/m^2
$\tau_{permissible}$=79.2×10^{6}N/m^2
Key ways are present, hence there is 25% reduction in strength.
C_{max}=0.75(79.2×10^6) =59.4×10^6 N/m^2
Torsional moment=
$M_t=\frac{60\times10^{\wedge}6(0.72)}{2\pi\times1440}$= 2466.80 N.mm

=2.4669 N.m
2) Weight
Net drum = 3.1157 kg, Burr = 6Kg
Disc=2.2 Kg
Total Weight = 11.3157 kg ≈ 11.5 Kg= 112.815 N
3) Belt Tension =
T_1= 173.846 N(tight Side)
T_2=86.1138 N (stack Side)

4) Torque(drum)
F=112.815 N (weight of drum)
T=F×r
=112.815×110
=12409.65 N
=12.409N.m
5) Weight of Pulley
= 2×9.81=19.62 N
6) Reaction Forces

a) Vertical-

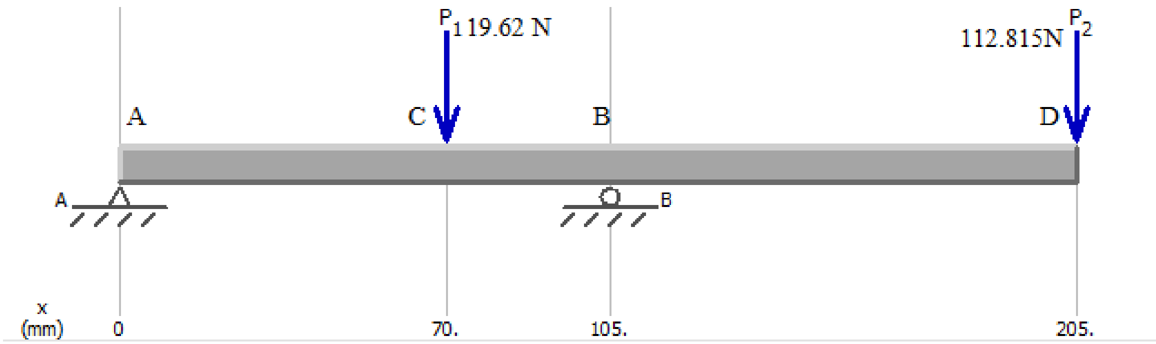

Figure No. 3.7.1 Load Distribution of Shaft in Vertical Plane

M_A= 0
= (19.62×70)- (R_B×105) + (112.815×205) =0
R_B=23.3378 N
R_A+ 233.3378-19.62-112.815=0
R_A=-100.9028 N

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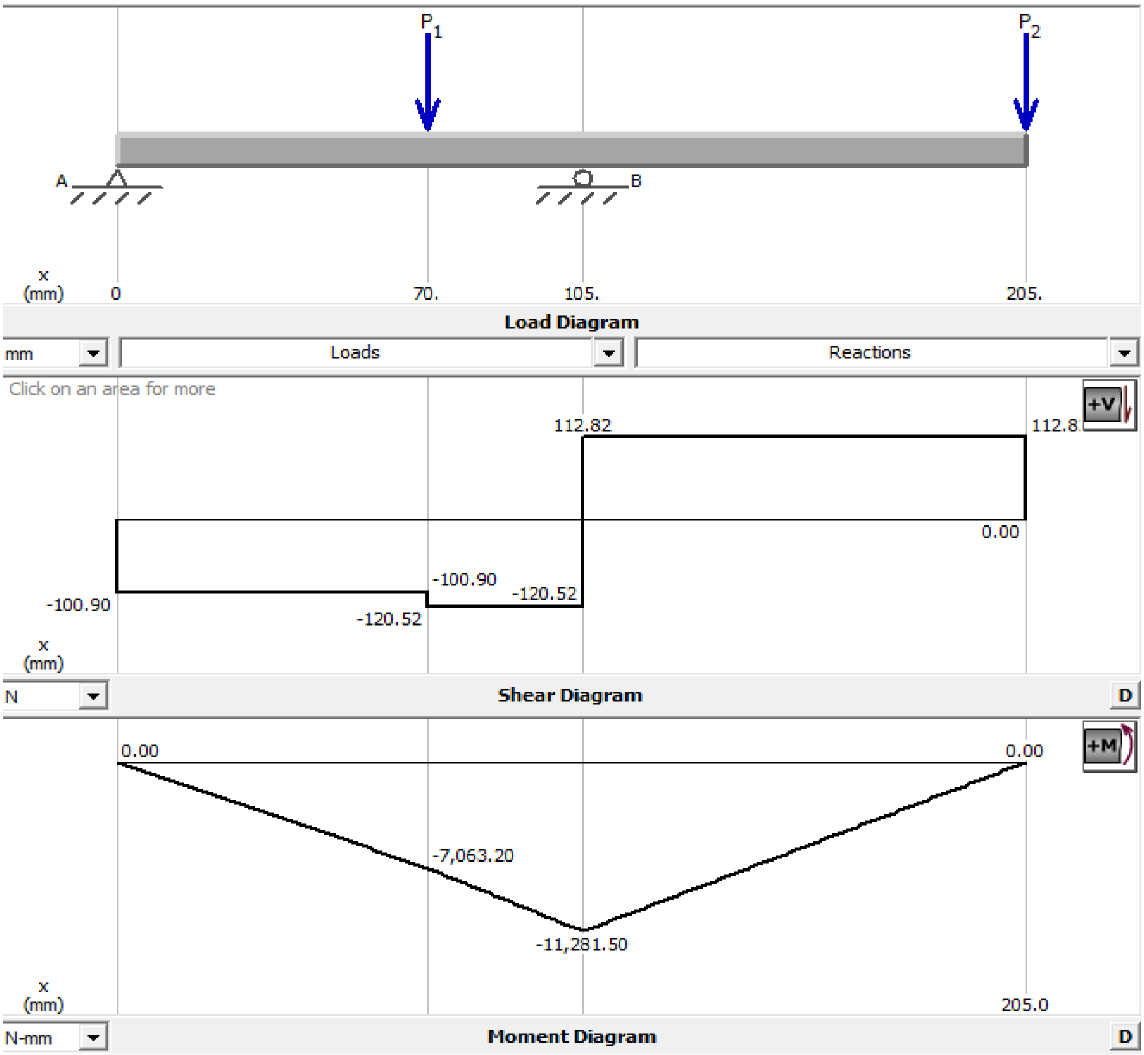

Figure No. 3.7.2SFD & BMD of Shaft in Vertical Plane

b) Horizontal-

T=173.846+86.1138 = 359.959 N

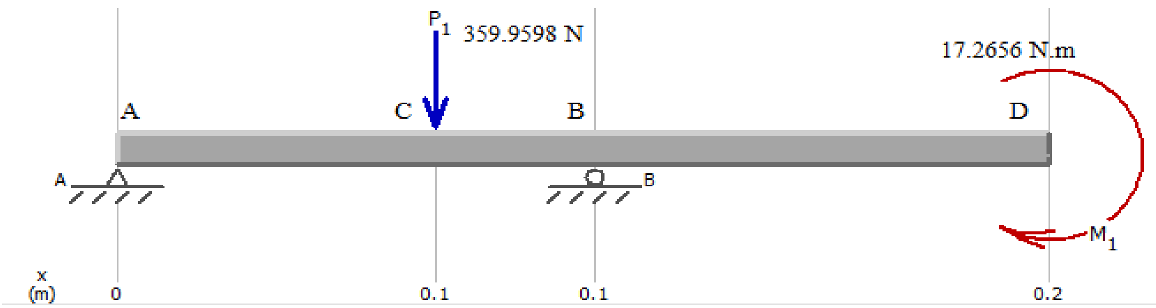

Fig 3.7.3Load Distribution of Shaft in Horizontal Plane

$M_A=0$

= (359.9598×0.07)- (Rb×0.105)+12.4096=0

R_B=358.1598 N

R_A+358.1598-359.9598=0

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R_A=1.8 KN

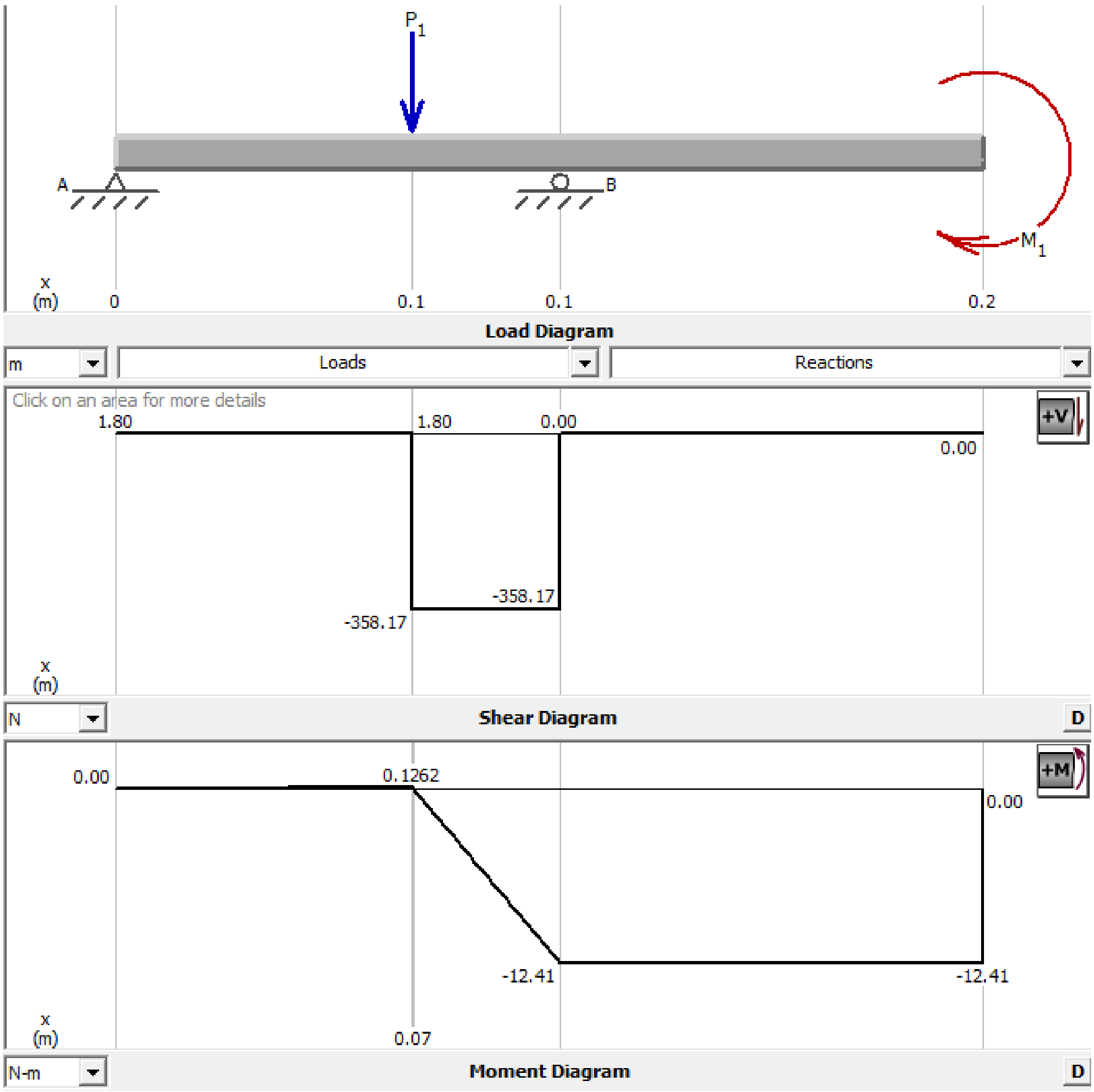

Figure No. 3.7.4SFD & BMD of Shaft in Horizontal Plane

Max. bending moment at point B

$MB_{(B)} = \sqrt{11.2814^2 + (-12.7875)^2}$

=17.05250N.m

Equivalent torque

$T_e = \sqrt{(Kb \times M)^2 + (Kt \times T)^2}$

$T_e = \frac{60\times10^{\wedge}6(0.372)}{2\pi(1440)}$

= 2.4669 N.m

where, K_b&K_t= combined shock & fatigue factor for rotating shaft

K_b=1.5

K_t=1.0 (pg. No. 442, Table No. 14.2 -V.B. Bhandari Data Book)

$Te = \sqrt{(1.5 \times 17..0525)^2 + (1.0 \times 2.4669)^2}$

= 25.6974 Nm

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Diameter:

$\tau_{max} = \frac{16 \times Te}{\pi d^3}$

$59.4 \times 10^6 = \frac{16 \times (25.6974)}{\pi d^3}$

d =13.012 mm

The large value is considered for safety purpose and bearing is selected for shaft size 25 mm

3.8 Bearing Selection

We used angle for frame because it is convenient to mount machine component. The aim is to manufacture an efficient machine in minimal cost. The two bearings are selected namely, flange mount bearing and pedestal bearing in order to support the shaft. These bearings do not require special housing. They can be mounted easily with the help of nut and screws to the frame. It will also reduce the cost of housing.

a) Flange mount bearing with 2 bolt
For 25 mm shaft diameter
Medium duty load
UCFL X05
(ASAHI Bearing catalogue, Page No. 27) [9]

b) Pedestal bearing
For 25 mm shaft diameter
Medium duty load
UKP X06 + H2306, 25
(ASAHI Bearing catalogue, Page No. 8) [9]

Figure No. 3.8.1 Pedestal and Flange Mount Bearing

3.9 Summary Table of Design and Selected Component

Table No.3.9.1 Summary Table of Design and Selected Component

Sr. No	Components of Machine	Specification
1	Motor	AC Motor, Flange Mounting Speed = 2880 rpm, Frequency = 50 Hz Phase = Single, HP = 0.5 = 0.372 kW
2	Belt	Type = A, Belt length = 900 mm, C. D = 310, Power rating = 3.98 kW
3	Pulley	Driver =100 mm Driven=200 mm
3	Rotating Net Cylinder	Height = 28 cm Diameter = 22cm
4	Fixed Outer Drum	Height = 32 cm Diameter = 28cm
5	Base Plate	Diameter = 22cm Thickness = 0.7cm
6	Support Frame	Dimension = 610 * 350 * 200
7	Shaft	Diameter =25 mm

		Length = 205 mm
8	Flange Mount Bearing	UCFL X05
9	Pedestal Bearing	UKP X06

IV. OPERATIONS AND EXPERIMENTAL VALIDATION

4.1 Operations Involved

Following operations are involved in manufacturing of this project.

4.1.1Design of Model and Selection of Proper Part

In this stage different components of the system was designed and selected as per the requirement.
Designed Parts – Shaft, Drum, Net cylinder, Base plate, Frame
Selected parts **–** Motor, Bearings, Belt, Pulley

4.1.2 CAD Modelling

Depending on the design data the CAD model of the system is developed using solidworks.

4.1.3 Raw Material Purchased

As per the requirement, raw material is purchased. Materials used for the manufacturing of the machine are metal plate, MS bar, net of steel, nut, bolt, metal strip etc.

4.1.4 Raw Material Cutting

As per the required size material is cut into desired final shape.

4.1.5 Manufacturing of Parts

Different parts of the machine are manufactured in this stage. Most of the components are readily available in the market, which are selected as per the requirement of the system. Apart from them, the machine parts like-frame, shaft, net drum, base plate, etc. are manufactured. As per the specification pulley is bored.

Sr. No.	Part Name	Manufacturing Process	Machine Used
1	Shaft	Facing	Lathe Machine
		Turning	Lathe Machine
		Thread Cutting	Lathe Machine
2	Base Plate	Drilling	Drill Machine
		Turning	Lathe Machine
3	Frame	Cutting	Power Hacksaw
		Surface Grinding	Grinding Machine
		Welding	Arc Welding Machine
		Drilling	Drill Machine
4	Net Cylinder	Cutting	Hand Hacksaw
		Welding	Arc Welding Machine

Table No. 4.1.5.1 Manufacturing Details of Parts

4.1.5.1 Facing

Facing on the lathe uses a facing tool to cut a flat surface perpendicular to the work piece's rotational axis. Facing will take the work piece down to its finished length very accurately and also faces can get flat surface. In this project facing is done to manufacture shaft

4.1.5.2 Turning

Turning on lathe is the operation of reducing a cylindrical surface by removing material from the outside diameter of a work piece. It is done by rotating the work piece about the lathe axis and feeding the tool parallel to the lathe axis. Turning is used in this project for shaft and base plate.

4.1.5.3 Drilling

Drilling is the operation of producing cylindrical hole in work piece. It is done by rotating the cutting edge of the cutter known as drill bit. In this Project the base plate for shaft and frame for mounting component, require holes. These holes are done by conventional vertical drilling machine.

4.1.5.4 Thread Cutting

Thread cutting is the operation of forming external thread of required diameter on rod by using a thread cutting tool is called thread. This process is used to produce threads on shaft.

4.1.5.5 Cutting

Cutting is the separation or opening of a physical object into two or more portions through the application of an acutely directed force. In this project there are two tools used for cutting i.e. Power hacksaw and cutting by hand hacksaw. Power hacksaws are used to cut large sizes (sections) of metals such as angle bar and hand hacksaw is used to cut net of metal.

4.1.5.6 Surface Grinding

Surface grinding is used to produce a smooth finish on flat surfaces. It is a widely used abrasive machining process in which a spinning wheel covered in rough particles (grinding wheel) cuts chips of metallic, making a face of it flat or smooth. For finishing the frame angle bar after cutting, grinding is done while manufacturing frame.

4.1.5.7 Welding

In this project arc welding is used. It is a type of welding that uses a welding power supply to create an electric arc between a metal stick (electrode) and the base material to melt the metals at the point of contact. Consumable electrodes. for joining the angle bar to produce support structure i.e. frame and to join net to produce net cylinder arc welding is used.

4.2 Components of oil-burr separator

Figure 4.2.1 Net Drum

Figure 4.2.2 Outer Drum

Figure 4.2.3 Pulley

Figure 4.2.4 Motor

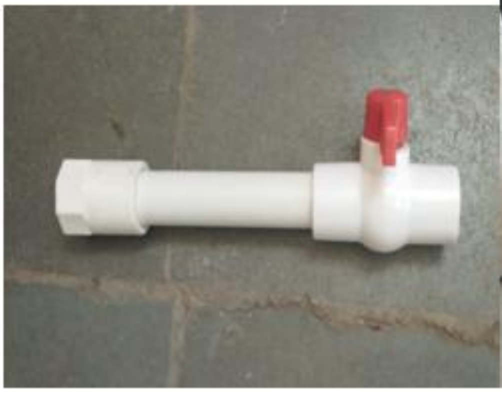
Figure 4.2.5 Outlet Pipe


Figure 4.2.6 Assembly

4.3 Experimental Validation
Apparatus:


Figure No. 4.3.1 Oil-burr Separator Machine

Procedure:
1. The burr is collected from various machines in a container.
2. The set-up is cleaned.
3. Then the burr is taken into the net tank.
4. Outer tank is closed for safety purpose.
5. The electrical supply is given to motor and the net drum is rotated with high speed for 3-4 minutes.
6. Collected oil is depleted out by opening valve located at the base of unit.
7. The amount of the oil recovered is measured.
8. And then the oil is filtered before further operation.

4.3.1Efficiency of System
In order to find out the efficiency of the machine dry burr is mixed with a known amount of oil and after operating the results were obtained.

Amount of the oil added=125 ml

Amount of the oil removed= 110 ml (Approx.)

Efficiency = $\frac{\text{oil recovered from burr}}{\text{total oil content in the burr}}$

$= \frac{110}{125}$

η= 0.88= 88 %

4.3.2Cost Saving Analysis

Table No. 4.3.2.1 Cost Saving Analysis

No. of hours per day	5 hrs. = 300 minutes
Time required for 1 oil recovery operation	3 to 4 minutes
No. of cycles per day	100 (300/3)
Chips loaded per charge	5 kg
Chips processed per day	500 kg. (100*5)
Qty. of oil recovered per charge	50 ml
Oil recovered per day	5 Litre (100*0.05)
Cost of cutting oil per Litre	Rs. 150
Savings per day per machine	Rs. 750(5*150)
Savings per month(25 days)	Rs. 18750(25*750)
Savings per year	Rs. 225000

4.3.3Energy Consumption of Motor

0.5 hp (440 V) = 0.373 KW

Energy consumed per hour = 0.373 kWh

Energy consumed per day = 0.373 (kWh) * 7 (Rs.) * 5 (Hr.)

= Rs.13.055

Energy consumed per month (25 days) = Rs.326.375

Energy consumed per year = Rs.4000

4.3.4 Performance Test

It is normal practice to subject engineering products to test after manufacture. This is significant step in the manufacturing process. Under tests the product is checked to see if functional requirements are satisfied, Identify manufacturing problems; certain economic viability, etc. Testing is therefore employed to prove the effectiveness of the product.

Table No. 4.3.4.1 Performance Test.

Testing	Fault	Solution
First trial	Vibrations occurred	Net drum is fixed to the shaft at top end (shaft length is increase till top end of drum).
	Oil removed contain much amount of fine particle of burr.	Finer net is used.
Second trial	Less vibrations occurred	-
	Oil quality/ is much better.	-

V. COST ESTIMATION

The accurate estimation of the cost is taken into account for a project to come into its successful conclusion.

5.1 Cost of Material

The cost of raw material which is required for the manufacturing of model is as follows:

Table No.5.1.1 Cost of Material

Sr.No	Part Name	Weight (kg)	Rate/kg (Rs/kg)	Total cost (Rs.)
1	Metal Plate (Steel)	3	62	186
2	Metal Bar (M.S.)	3	62	186
3	Net	1.5	150	225
4	Angle Bar (M.S.)	3	60	180
5	Metal Strips (M.S.)	3	60	180
6	Nut & Bolt (M10)	10 Bolt 10 Nut	5 Rs./Piece	100
TOTAL				1,057 /-

5.2 Cost of Machining

There are various machining operations required to be performed for manufacturing a model. There are different rates (charges) for different machining operations. It is decided on the basis of working hours and operational charges per hour (Rs.).

Table No 5.2.1 Cost of Machining

Sr.No	Part	Time (Hr.)	Rate (Rs/Hr.)	Total Cost (Rs.)
1	Power Hacksaw	2	100	200
2	Lathe m/c	3	200	600
3	Drilling m/c	2	150	300
4	Welding m/c	4	150	600
5	Grinding m/c	1	100	100
TOTAL				1,800 /-

5.3 Cost of Standard Parts

The cost of parts that are readily available in market are as follows:

Table No.5.3.1 Cost of Standard Parts

Sr.No	Part	Quantity	Rate/unit	Total Cost
1	Motor	1	4985	4985
2	Pulley (Big & Small) Set	1	790	790
3	Belt	1	190	190
4	Pedestal Bearing	1	450	450
5	Flange mount bearing with 2 bolt	1	450	450
6	Outer Drum	1	170	170
TOTAL				7,035/-

5.4 Total Project Cost

Cost of material + Cost of machining + Cost of std. part = 1,057 + 1,900 + 7,035

= 9,892 /- Rs

After considering the cost of material, the cost of machining and the cost of standard parts used, it is concluded that the cost is economic for the company

VI. CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

The aim of project was to develop a user friendly machine with minimal cost. The oil separator machine separates cutting fluid from burr using centrifugal action. The centrifugal oil burr separator is used for maximum removal of the oil from swarf which will be processed before further use. This separator aims to save cost and reduce the oil consumption which will be going to increase the profit of industry. It will provide environmental and health benefits along with economic growth of industry.

6.2 Future Scope

In order to enhance the performance of machine, an electromagnet placed in the way of outlet oil could be a feasible solution for removal of fine burr particles except the drawback associated with it that only magnetic burr particles can be removed.

As metalworking fluid needs have changed and costs have increased, it is very important for industry to implement a fluid management program. The areas of fluid selection, water quality, fluid controls, contaminants removal equipment, wastewater disposal and overall economics must be evaluated. Through careful fluid management, metalworking industries can generate substantial improvements in fluid performance and economics.

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ANNEXURE- I

I. Machine Maintenance

I.I Preventive Maintenance

i. Lubricate all the moving parts regularly.
ii. Regularly check the fasteners and tighten.
iii. Check that the electrical connections is secured properly.
iv. Frequently cleaning the drum to remove the extra fine burr that has clogged in the outlet pipe.
v. Damaged and defective part must be changed.
vi. Check for leakages and rectify.

I.II Performance Check

The frequent maintenance is strongly recommended. The following are suggested for regular checks.

i. Check time cycle of machine.
ii. Check noise level.
iii. Check clogging of the outlet pipe.
iv. Clean exterior of all equipment.

II. Precautions

i. Please observe general safety of working environment.
ii. Use safety equipment like hand gloves, shoes etc.
iii. Avoid accidental starting, be sure switch is 'OFF' before plugging in.
iv. Before starting the operation firmly tighten rotating drum with the help of screw.
v. Prior to start, properly close the lid.
vi. Do not overload the drum.

ANNEXURE- II

List of formulae

- Power required, $P = \frac{2\pi NT}{60}$
- $T_{Design} = 2T$
- Weight of component, W = volume ×density
- Permissible shear stress, $\tau_{Permissible} = 0.3\ S_{yt} = 0.18\ S_{ut}$
- Torque, $T = F \times r$
- Equivalent torque, $T_e = \sqrt{(Kb \times M)^2 + (Kt \times T)^2}$ stress,
- Maximum shear stress, $\tau_{max} = \frac{16 \times (Te)}{\pi d^3}$