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DESIGN OF ABRASIVE CUT

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ABSTRACT

Srushti engineering works is a small scale company situated in M.I.D.C. Satara at present and engaged in job work. It is actually in simple words the fabrication unit. The products of this fabrication unit are:

- Health club equipments

- Children's play path equipments

- Garden equipments

- Decorative steel furniture

- Industrial & Civil Fabrication

Raw materials in the form of bars, pipes of different size and diameter at a plant. For economy, this raw material is purchased in sizes larger than needed for each work piece or product to be manufactured. The first operation is then to cut this material into usable sizes. This process of cutting off is performerd in Srushti Engg. works by hacksaw blade. Cut of poeration of cutting raw material by hand hacksaw is very time consuming and the worker gets tired. This hand hacksaw is generally used in small companies or workshops like one of this. The company required to eliminate above problems. So we think over this problem and to eliminate drawbacks of hand hacksaw cutting operation, we talk with workshop proprietor and decides to make a new machine. This gave rise to the need of project titled "Abrasive Cut Off Machine" which will give comfort to operator and properitor also.

I. INTRODUCTION OF ABRASIVE CUT-OFF MACHINE

In ancient days people used to cut the metal by using some conventinal tool or by some hard metal. But as time passes development took place and many new cutting tools and cutting ideas came into existance.

For cutting any component, common practices are as follows:

1) Power Hacksaw machine:-

By power hacksaw pipes and rods are cut by this machine. The advantage of this machine is that once the cutting process is given automatic cutting feed, there is no use of operator to supervise it. Coolant also flows automatically.

The main disadvantages of this machine are as follows :-

i) It is very much time consuming method of cutting as the return stroke is not useful for cutting.

ii) The machine cuts thin and slender work pieces with vibrations.

2) Hand cutting :

It is very time consuming method and the worker gets tired. It is generally used in very small companies. It required large eff0l1. By holding pipe in a vice and using hacksaw blade cutting operation being done. Hence it is manually done for the mass production. This is undesirable because it is time consuming and gives rough furnish. Process is not reliable and it is difficult to cut material to exact and accurate size.

The process is also slow. There is also probability of breaking of hack –saw blade.

The only advantage of this process is that unskilled or semiskilled operator may be used.

In abrasive cut-off machine continous cutting is possible and time is saved. This machine is used for mass production by using stop-bar.

Nowadays hollow pipes of various diameters are required in no. of places. They are not only required for water supply purposes, but now their demands are increased in various fields such as the for toys which are effected in parks, for industrial purpose and for domestic purposes. In the past the pipes were cut with the help of hacksaws and by manually, which required more time and more manpower. At that time it was difficult to cut the pipes of various diameter. But now this problem has been solved as many cutting machines are invented which has made cutting process easy. "Abrasive cut off machines" is one of the machine which is effectively used for pipe cutting process.

Abrasive cut off machine consists of a abrasive curt off wheel rotated by an electric motor. The rotating wheel with light force cuts the pipe effectively. This machine is widely used in the various industries.

This machine is already available in the market. Kulkarni power tools i.e. K.P.T. are one of the big manufacturer of this machine. It costs about Rs. 15,000 in the market. But our main aim behind preparing or manufacturing this machine is to add in it some additional functions and development which increases the efficiency of machine.

This modification is :-

Provision for cutting the pipes in various angles by providing an etching plate.

This machine may be used more widely. This machine may make the work more easy and comfortable. It gives more flexibility and higher efficiency.

II. GENERAL CONSIDERATIONS IN DESIGN OF ABRASIVE CUT OFF MACHINE

Following are the general considerations in designing "Abrasive cut off machine" and its components.

1. Type of load and stresses caused by the load :-

The load, on a machine component, may act in several ways due to which the internal stresses are set up. In our project, radial load acts on the bearings.

2. Motion of the parts or kinematics of the machine :-

The successful operation of any machine depends largely upon the simplest arrangement of the parts which will give the motion required.

In our project motion required is rotary motion to abrasive cut off wheel. 1 H.P. single phase motor is used as electric drive for providing rotary motion to a cut off wheel shaft by means of v belt and pulley.

3. Selection of materials:-

It is essential that a designer should have a through knowledge of the properties of the materials and their behaviour under working conditions. Some of the important characteristics of materials are strength, durability,

flexibility, weight, resistance to heat and corrosion, ability to cast, welded or hardened, machine ability electrical conductivity etc. C-20 and C-45 is selected as material for machine components.

4. Form and size of the parts :-

The form and size are based on judgement. The smallest practicable cross section may be used, but it may be checked that the stresses induced in the designed cross-section are reasonably safe. In order to design any machine part for form and size, it is necessary to know the forces which the pat1 must sustain.

5. Frictional resistance and Lubrication :-

There is always a loss of power due to frictional resistance and it should be noted that the friction of starting is higher than that of running friction. A careful attention must be given to the matter of lubrication of all surfaces, which move in contact with others, whether in rotating or ball bearings.

6. Convenient and economical features :-

In designing, the operating features of the machine should be carefully studied. If pa11s are to be changed on account of wear or breakage, easy access should be provide and the necessity of removing other parts to accomplish, this should be avoided if possible.

7. Use of standard parts:-

The use of standard parts is closely related to cost. These parts should be used whenever possible.

8. Safety of operation :-

Machine is dangerous to operate. Any moving part of machine which is within the zone of a worker is considered an accident hazard and may be cause of an injury. Hence design should always provide safety devices for the safety of operator. Hence we have provided safety guard for belt and safety guard for cut off wheel, in such way that they should in no way interface with operations of the machine.

9. Workshop facilities:-

A design engineer should be familiar with the limitations of his employer's workshop in order to avoid the necessity of having work done in some other work off.

10. No. of machines to be manufactured :-

The number of machines to be manufactured affects the design in a number of ways. The engineering and shop costs which are called fixed charges or overhead expenses are distributed over the number of machines to be manufactured.

11. Cost of construction :-

The cost of construction of machine is the most important consideration involved in design. The aim of design engineer under all conditions, should be to reduce the manufacturing cost to the minimum.

12. Assembling: -

Every machine or structure must be assembled as a unit before it can function.

III. SELECTION OF MATERIALS

Selection of a proper material for the machine component is one of the most important steps in the process of machine design. The best material is one, which will serve the desired objective at minimum cost. It is not always easy to select such a material and the process may involve the trial and error method. The following factors should be considered while selecting the materials.

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i) **Availability :-** The material should be readily available in the market, in large enough quantities to meet the requirement.

ii) **Cost :-** For every application, there is a limiting cost beyond which the designer has to consider other alternative materials. In cost analysis, there are two factors:-

a) Cost of material

b) Cost of processing the material into finished goods. It is likely that the cost of material might be low, but the processing may involve costly machining operations.

IV. ENGINEERING REQUIREMENTS OF MATERIALS

Engg. requirement of materials means as to what is expected from materials so that the same can be successfully used for making engineering components.

1) **Fabrication requirement: -** It means that material should be able to get shaped and joined easily, fabrication requirements relate themselves with materials machinability, ductility, castability, heat treatment, weldability etc.

2) **Service requirement :-** It implies that material selected for the lIpase must stand upto service demands like proper strength, wear resistance, corrosion resistance.

3) **Economic requirement :-** It demands that engg. part should be made with minimum overall cost which may be achieved by proper selection of technical and marketing variables.

Materials selected are :- C-20 & C-45.

CUT OFF WHEEL SPEED

Abrasive cut off wheel operating at speed 48 minute at periphery

But when force is applied on wheel at cutting process speed of wheel reduces by 200 to 300 rpm. Hence at low speed cutting of materials takes more time and does not' give accuracy. Hence to maintain speed multiplying by 1.25 as factor as safety to rpm of wheel and getting this rpm for required cutting of material.

N=3200rpm These 3200 rpm speed is required at cut off wheel to cut the material.

APPLIED FORCE

15 x 135 = (260 + 590) x X

15 x 135 = 850 X

X = 2.38 kg

X=23.8N

x = 24 N. Hence force applied = 24 N.

ELECTRICAL MOTOR

As a power source it is very important element of power transmission through which, we can convert electrical energy to mechanical energy level and obtain rotating for enabling the machine to take heavy loads.

Selection or choice of motors :-

The characteristics of motors are determined in accordance with the service conditions under which they are required to operate.

Consider force required to cut the material = 24 N

F = 24 N

Radius of abrasive cut off wheel = 175 mm

Torque required to cut the pipe = force applied x radius of the wheel

= 24 x 175 = 4200 N-mm

= 4.2 N-m

P = 2 / 60

where P = power transmitted by shaft in watts

N = speed of shaft in RP.M. = 1440 RP.M.

T = Torque or twisting moment = 4.2 N-m

P = 2 x 1440 x 4.2 / 60

p = 633.345 watts

from standard specification of motor, we select the motor having

P = 746 watts

p = 1 H.P

Single phase, 1 H.P motor is selected for power transmission.

V. MOUNTING OF MOTORS

Motors are so mounted as to be easily accessible for inspection, maintenance, lubrication and to allow for easy wiring of the conductors and for mounting of the motor. It should also be possible to tension or replace the belts or chains and to align couplings easily. Motors are also provided with readily accessible lubricating points. Shaft .A shaft is a rotating machine element, which is used to transmit power from one place to another. The power is delivered to the shaft by some tangential force and the resultant torque (or twisting moment) set up within the shaft permits the power to be transferred to various machines linked up to the shaft. In order to transfer the power from one shaft to another, the various members such as pulleys are mounted on it. These members along with the forces exerted upon them comes the shaft to bending. Hence shaft is used for the transmission of torque and bending moment.

shafts subjected to twisting moment

T = 1 / 16 x fs x d3

where, T = Twisting moment or Torque acting upon the shaft

Fs = Torsinal shear stress of shaft material (C-45) = 73 N/mm2

d = diameter of shaft in mm

4200 = 1 / 16 x 73 x d3

d=6.64 mm d = 8 mm appro.

Considering factor of safety = 3 for shaft diameter.

Shaft diameter = 8 x 3 = 24 mm

But the standard size of transmission shaft is 25 mm. d = 25 mm.

KEY

A key is a piece of mild steel inserted between the shaft and hub or boss of the pulley to connect these together in order to prevent relative motion between them. It is always inseI1ed parallel to the axis of the shaft. Keys are

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used as temporary fastenings and are subjected to considerable crushing and shearing stresses.A key way is a slot or recess in a shaft and hub of the pulley to accommodate a key.The sunk keys are provided half in the keyway of the shaft and half in the keyway of the hub or boss of the pulley.

w = t = d / 4.

w = width of key.

t = thicknes of key.

w = t = 25 /4= 6.125 mm.

w = t = 6 mm.

T = Torque transmitted by the shaft = 4200 N/mm^2

F = Tangential force acting at the circumference of the shaft.

1= 1.571 x d x Fs1/ Fs.

where Fs 1 = shearing stress for C-45 material of shaft = 73N/mm^2

1= 1.571 x 25 x 73 /56

1= 51.197 mm.

for simplicity of design, length of key = 1 = 50 mm is taken

1) Considering shearing of the key :-

The tangential shearing force acting at the circumference of the shaft

d = Dia. of shaft = 25 mm.

1 = Length of key.

F sand Fc = shear and crushing stresses for material of key.

Fs = 56 N/mm^2 Fe = 112 N/mm^2

F = Area resisting shearing x shear stress =1.w.Fs

Torque transmitted by the shaft = T = F x d/2

4200 = F x d/2 =1.w.Fs x d/2

4200 = 50 x 6 x Fs x 25/2

Fs=1.12N/mm^2

This Fs value is within permissible shear stress. Hence design of key is safe for shearing of the key.

2) Considering crushing of the key :-

The tangential crushing force acting at the circumference of the shaft F = Area resisting crushing x crushing stress = 1 x t/2 x Fc

Torque transmitted by the shaft,

T = F x d/2 = I x t/2 x F c x d/2

4200 = 50 x 6 /2 x Fc x 25/2

Fc = 2.24 N/mm^2

This Fc value is within permissible crushing stress. Hence key design is also safe for crushing of the key. So key designed dimensions are (w x t x 1) = 6 x 6 x 50.

BELT

The belts are used to transmit power from one shaft to another by means of pulleys which rotate at the same speed or at different speeds.

The following factors upon which the selection of a belt drive depends :-

1. speed of driving and driven shafts.
2. speed reduction ratio.
3. power to be transmitted.
4. centre distance between the shafts.
5. positive drive requirements.
6. shafts layout.
7. space available.
8. service conditions.

'V' belt is selected. It is mostly used in factories and workshops where a great amount of power is to be transmitted from one pulley to another when, the two pulley are very near to each other.

Advantages of V-belt drive:-

1. It gives compactness due to the small distance between centres of pulleys.
2.The drive is positive, because the slip between the belt and the pulley groove is negligible.
3. Since the V -belt are made endless and there is no joint trouble, therefore the drive is smooth.
4. It provides longer life, 3 to 5 years.
5. It can be easily installed and removed.
6. The operation of the belt and pulley is quiet.
7. The belts have the ability to cushion the stock when machines are started.
8. The high velocity ratio (maximum 10) may be obtained.
9. The power transmitted by V -belt is more than flat belts from the same coefficient of friction, arc of contact and allowable tension in the belts.
10. The V-belt may be operated in either direction with tight side of the belt at the top or bottom. The centre like may be horizontal vertical or inclined.

BELT MATERIAL

Belt material is cotton or fibric. These fabric belts are impregnated with some filler like linsed oil in order to make the belts water proof and to prevent injury to the fibres. These belts are cheaper and suitable in warm climates in damp atmosphere and in exposed positions.

Type of belt drive - **open belt drive.**

It is used with shafts arranged parallel and rotating in the same direction.

According to Indian standards (IS : 2494 - 1974) the B-type of V-belt is selected. According to IS standard, dimensions of standard V-belt are

minimum pitch dia. of pulley (D) = 125mm

Top width (b) = 17 mm

Thickness (t) = 11 mm

min. pitch dia. = (Dia of larger pulley+Dia.of maller pulley) / 2

= (156 + 116) /2

= 196 mm.

200> 136> 125

Hence, **B- Type V-belt** is selected.

Length of open type V-belt drive

L= Total1ength of the belt

d1 = Diameter of larger pulley = 156 mm

d_2 = Diameter of smaller pulley = 75 mm.

x = centre distance between two pulleys = 355 nun

$L = \ / 2(d_1 + d_2) + 2x + (d_1 - d_2)2/ 4x$

$= \ / 2(156 + 75) + 2 \times 355 + (156 - 75)^2 / 4 \times 355$

= 1077.47 mm

L=1.07747 metre=1077.47 / 25.4 = 42.42 inch = 42 inch std. size

$\sin \ = (r_1 - r_2) / x = (78 - 37.5) / 355 = 0.1141$

= 6.55°.

While determining the angle of contact, angle of contact is at the smaller pulley. If both the pulleys are of the same material.

Angle of contact or lap = =(180 - 2) / 180 radian

$= (180^o - 2 \times 6.55) \times 1180 = 166.9°.$

= 2.91 radian.

PULLEYS

The pulleys are used to transmit power from one shaft to another by means of V -belts. The pulleys dia. should be carefully selected in order to have desired velocity ratio. The pulleys must be in perfect alignment in order to allow the belt to travel in a line normal to the pulley faces.

The pulleys are made of steel pulleys: The steel materials have great strength and durability. They have lower friction.

According to IS standard: 494 - 1974, dimension of standard v grooved pulleys are

width = w = 14, d=15 = depth

d_1 = Dia. of larger pulley mounted on motor sbaft

= 156 mm

N_1 = speed of motor shaft = 1440 rpm

N_2 = speed of abrasive wheel shaft = 3200 rpm

d_2 = Dia. of smaller pulley mounted on abrasive wheel shaft

$N_1 / N_2 = d_2 / d_1$

1440 / 3200 = d2 / 156

d2 = 70.2 for simplicity d2 = 75mm is taken.

Dia. of smaller pulley mounted on cutter shaft = 75 mm

MOTOR BASE PLATE

For mounting the motor on movable L-channel a plate is required which can be placed over one end of movable L channel and motor is bolted to the plate. It is necessary that plate should have slots at same distance as that of motor base. This base plate is manufactured out of C - 20 sheet of thickness 5 mm. For cutting operation of a sheet metal gas cutting is used and burr is removed by grinding operation.

SUPPORTING PLATE

For mounting the abrasive wheel, on shaft, the supporting plates are very much required. As abrasive cut off wheel cannot be bolted directly as it is made up of abrasive material. Hence one supporting plate on either side of abrasive cut off wheel is placed and then they are mounted on the shaft and bolt is tightened. The supporting plate not only supports the abrasive wheel but also increases the area of contact which facilitate relative motion between shaft and abrasive cut off wheel. Dia. of supporting plate should be greater than 0.25 d.

Dia. of Supp0l1ing plate = 0.25 x Dia. of abrasive cut off wheel

= 0.25 x 350

= 87.5 mm.

For simplicity, Dia. of supporting plate = 100 mm is taken.

SOLID SQUARE BLOCK

On this solid square block, whole machine rests. Solid square block is made up of C-45 material. As it is solid. it can bear all the load of machine over it.

CIRCULAR DISC

Base plate of Abrasive cut off machine has hole for moving the machines so as to abrasive wheel can be set at an angle. So the base of solid square block may get weak. Hence for providing stronger base for solid square block and for bolting the machine to appropriate position, circular disc is required. It is solid parts and it is made up of C-20 material and can also bear the load.

CYLINDER

It is the part which is being welded to the same end of both L-sections. Shaft is accommodated within the cylinder, stepped bore in which bearings are to be accommodated and inside that bearing the shaft is fitted.Material used for cylinder should have good machinability and good weldability. Hence C-20 material is used for cylinder.

PIN

Pin pivots the movable L-channels which is going to clamp the whole machine. The pin is to be fixed in solid square block, for these purpose collar is to be provided on both ends. For easiness of insertion, we provide collar on end only and to other end, collar can be fitted by providing screw arrangement with a separate collar disc.

MOVABLE L-CHANNEL

It is main element of machine which is pivoted at the comer portion. At one end of movable L-channel, motor is fitted. C-20 material is used for movable L channel.

SAFETY GUARD FOR BELT

It is very important part from the safety point of view whenever, there are rotating parts, safety of operator should be considered. The safety guard can be fabricated by bending a strip and welding a net to it. For safety guard ship, calculations for length of strip are as follows :-

From Geometry of fig. AC = 100 - 70 = 30

AB = 350

tan = AC / AB

tan = 30 1 350 a = $\tan^{-1}$ (30 / 350)

= 4.90

cos = AB / BC

cos 4.9 = 350 / BC

BC=351.28mm

Total distance = /12 + D / 2 + 2 x BC

= X 200 / 2 + x 140 / 2 + 2 x 351.28

= 1236.63 mm.

Hence we take strip of 1237 mm and cut it and welded it according to required shape.

SAFETY GUARD FOR ABRASSIVE WHEEL

It is important from point of safety of worker as well as abrasive wheel. In abrasive cut off machine, material is removed in the form of particles heated at temp, So also there is a possibility of breaking the abrasive cut off

wheel both cases, The particles will be thrown off under the action of centrifugal so these should be safety guard over the abrasive wheel. But this guard should not affected working of abrasive cut off wheel and easiness of replacing Wheel. This guard is made up of C-20 sheet of thickness 60 mm.

tan = 50/202.5

= 13.ST)

=3600-(ISO+2x 13.S7)

= 152.26°.

So such two plates are welded to another plate of width = 60 mm and length = circumference of plate manufactured.

In the outer plate, at the centre another circular hole is cut for easy removal of abrasive cut off wheel.

SELECTION OF BEARING FROM

MANUFACTURER'S CATALOGUE

The basic procedure for the selection of bearing from the manufacturer's catalogue consists of the following steps

1) Calculate the radial and axial forces acting on the bearing and determine diameter of the shaft where the bearing is to be fitted.

Fr = Radial force = 24N, Fa = Axial Force = ON

Diameter of shaft = 25 mm

2) Select the type of bearing for the given application

Type of bearing:- Ball bearing

3) Determine the values of x (Radial factor) and y (Thrust or axial factor), from the catalogue.

X = 1, Y = 0.

4) Calculate the equivalent dynamic load (P), from the equation

p = X Fr + Y Fa

P= I x24+0xO

p = 24 N

Equivalent dynamic load = P = 24 N.

5) Make decision about the expected bearing life and express the life L in million revolutions.

$L=60.n.Lh/10^6$.

Where L = Bearing life in million revolutions

n = 3200 rpm at shaft

Lh = 8000 hours (i.e. machine is used intermittent)

L = 60 x 3200 x 8000 / 106

L = 1536 million revolutions

Bearing Life = 1536 million revolutions.

6) Calculate the dynamic load capacity (C) from the equation

$L=(C)^P/P$

where p = 3 for ball bearing

$C = Px (L)^{1/P}$

$= 24 x (1536)^{1/3}$

C= 276.91 N.

Dynamic load capacity of bearing = 276.91 N.

The selected bearing of designation 6205 ball bearing double Z.E. has following Parameters :-

Principal Dimensions (in m.m.)

d= inner ,diameter of the bearing = 25

D = outer diameter of the bearing = 52

B = axial width of the bearing = 15

Basic load ratings (in N) :-

C = dynamic load capacity of the bearing = 14000 N

C_o = static load capacity of the bearing = 6950 N

Hence the selected bearing has required dynamic capacity. Single row deep groove ball bearings are required in 2 numbers.

SPECIFICATIONS OF MACHINE

1. Motor single phase, 1 H.P, 230 V, 50Hz. Motor R.P.M. = 1440 rpm.
2. Floor space required = 660 x 520 mm2.
3. Height of machine = 1 metre
4. Weight of machine with motor = 90 kg
5. Max. size of workpiece to be cut diameter = 125 mm
6. Belt V belt, B40
7. Cut off wheel size O.D=350,J.D.=25.4, Thickness = 3.2 mm
8. Cut off wheel speed = 3200 rpm.

VI. CONCLUSION

To become a successful engineer, it is necessary that theoretical knowledge should be backed up by practical application. In fact, there is always a definite relationship between theory learnt at college and practical experiences obtained from an industry.

Our project work gave us the chance to understand these practical aspects which no book can provide. As our project work carried out in industry, we were exposed to real life situations faced in any company. This bas caused our industrial outlook to take a new form. The applicability of various processes, techniques which we had been reading and studying. We have seen actually performing in industry. We were also involved in performing in industry. We were also involved in performing managerial activities like planning, decision making, getting work done from workers, supervision etc.

The success of our project was important as it was a sponsored one. The project was not going to be kept as model but was to be utilised for regular production and it had to sustain all the working conditions, which a general machine tool has to face. Secondly we had to see that we justified the investment and faith, our sponsor had placed in us. It was a must for us to succeed in the project, since doing otherwise would have brought a bad

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name not only to our group but also for our college. We are very happy to have fulfilled the promise we had given to our sponsor.

Thus, the experience which we had gained from this project work has boosted our confidence level to a great extent.