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Design and Manufacturing of Automatic Cable Stripper

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Abstract - *The aim of this project is to produce the mechanical design of an automatic machine for manufacturing segments of heavy gauge insulated electrical wire with both ends stripped. Automatic Cable Stripper is machining which separate core from coaxial cable for recycling use. In this project, the mechanism of cable stripper is investigated to study its application from existing machines. The suitable and material were identified for the application of stripping the cable. The relevant information was analyzed to know the size of the cable and speed of motor that is used in stripping process. The relationship is made for different size of cable and pulley height to injure various size of cable can be fed. In theory the expected result was the Automatic Cable Stripper machine will strip and separate between core and coaxial cable automatically. Design of the machine is performed using Computer Aided Design (CAD) software to produce a 3D model of the machine.*

Key Words*: *Reducing labor cost, Reducing waste, Improving quality, Increasing repeatability, reducing employee injuries, and allowing uninterrupted production.

1. INTRODUCTION

It should be noticed that waste minimization to zero can't be achieved for many manufacturing processes at present, and only second principle in waste management hierarchy can be realized in many companies. It is not very difficult to recycle clean and homogeneous waste, but there can be serious problems with composite products made of different materials (for example, plastic mixed with metals, rubber, paper, other kinds of plastics, etc). In such a case, the waste separation (mostly multistage and high-priced) must be included in waste recovery process. One such composite product is waste cables. The cable scrap can be produced during manufacturing process (for example, rejected for insulating material defects) and due to the end of life of cables (for example, during repair of electric devices and buildings). The most valuable component of the cable that must be recycled is non-ferrous metals (copper, aluminum). The main cable waste recovery problem is how to remove plastic insulator from metal conductor. In the past cables were recycled by simply burning them. The copper remained solid and could be collected after burning. Although burning cables was a simple and efficient technology, such thermal recycling is no longer allowed in many countries owing the release of heavy metals, dust, and harmful gases (hydrogen chloride, dioxins, etc) into the environment. In addition, it is not economic to recover only the metals, without considering the insulating material.

1.1 Objective

The objectives of this project are to design and develop an automatic wire stripper machine to achieve low cost cutting. It works fast and reduces the stripping time. This equipment is not designed using complicated components. This machine is simple and portable. This machine is designed using angle plates, rollers, guide tubes, cutter and V pulley. The practical objective of the automatic wire stripper machine is to strip required length of wire in required separation of conductor & cable.

The objectives of the project are to design a system for an automatic wire stripper machine which is:

1) Automation
2) Efficient
3) User-friendly
4) Transportable
5) Cost-effective
6) Reduce strenuous and repetitive task

1.2 Working Principle

At present mechanical separation technologies are used. In general two technologies are being used to recycle cable scrap.

1) Shredding of cables (Cryogenic),
2) Simply burning them.

Further, the stripping process the insulating material is being split and peeled of the conductor. By using stripping technology to process cable scrap, higher metal grades and recoveries can be achieved. The stripping machine is often manually fed, because it is necessary to straighten and precisely orient the cable in respect of the cutting rolls. Cables with a small diameter can be stripped and must be

shredded by using of fine adjustment screw in the present on the top of the rotating rollers. The insulator can be also removed from cable manually.

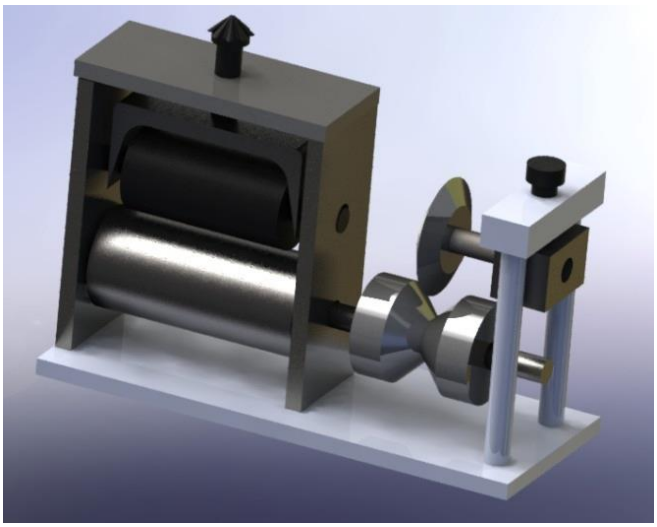

Figure 1: Initial Concept

1) Elements of Automatic Cable Stripper-

1. DC motor
2. Gear box
3. Roller
4. Adjustable screw
5. Cutting frame
6. V Pulley
7. Coupling
8. Chain sprocket
9. Shaft.

In cable stripping machine, cable are fed into a machine that tears the plastic from the electric cable, and very little metal ends up in the plastic fraction. The plastic fraction (PVC and PE) is sorted and used for products like shoe soles and substitutes newly produced PVC and PE. The insulation material is being split and peeled of the conductor. The stripping machine is manually fed and therefore has a low capacity. Cables with a small diameter cannot be stripped and must be shredded. Four fractions are being produced during stripping of the energy cable. The results show that a copper product is produced with a grade of 99%, recovering 97% of the copper. All the lead is recovered with a grade of 98%. The residual waste contains 4% copper and 3% copper is lost. The results of cable stripping machine depend on the type of cable and process. Some conclusion can be made. Firstly, by using stripping technology to process cable scrap, higher metal grades and recoveries can be achieved. This mean can prevent higher metal grades from waste. Because of money constrain and high maintenance of cable stripping machine, copper separation is often not practiced. Usually, only one or two company offer cable stripping in one big location.

Following table shows "E waste generation in top 10 cities of India".

Table -1: E waste generation in top 10 cities of India

Sr. No.	City	Electronics & Electrical waste tonnes per year
1	Mumbai	11017.1
2	Delhi	9790.3
3	Bangalore	4648.5
4	Chennai	4132.2
5	Kolkata	4084.2
6	Ahmadabad	3287.5
7	Hyderabad	2833.5
8	Pune	2584.2
9	Surat	1836.5
10	Nagpur	1768.9

2. SCOPE

As guidance to this project, the project scopes are required for assisting development of the project. The scope of this project will cover on the design and fabrication of a cable stripper machine. The design will involve on intended modification features as the machine is already in the market. The design work will include the Automatic Cable Stripper of modeling so that the features of modification can be clearly observed. The software used to draw the design is AUTOCAD and Solid Works. The modification features will be design to achieve optimum design efficiency of productivity by removing large amount of coaxial in short time. The fabrication of cable stripper machine will also involve manufacturing process and also assembly. The manufacturing processes that involved are cutting, bending, drilling and welding.

3. SPECIFICATION OF MACHINE

The basic need of automatic wire stripper is to strip the wire of required length in required separating parts, without labor, efficiently. So we decided to make a project named 'Design & Manufacturing of Automatic Cable Stripper'.

For that we decided some specifications given below:

1) To strip required length of wire.
2) The diameter of cable should be manually adjustable.
3) The cutter is provided to cut the out portion of cable.
4) Rollers are provided to strip after the cable passing through cutter.

Figure 1: Final Project

3. DESIGN CALCULATION

4.1 Selection of Motor

We know that,

Power (P) = $\frac{2\Pi*N*T}{60}$

Where, T = torque transmitted in N-m

P = power req. for motor = 0.18kw = 186.5 W

N = speed of motor = 2790

Torque (T) = $\frac{P*60}{2\Pi*N}$ = $\frac{186.5*60}{2*\Pi*2790}$ = 0.63833 Nm

4.2 Selection of Gear box

We know that,

Using of helical gear box the speed can be reduction & torque may be increased.

So, by ratio of chain drive i.e. 3:1

Therefore,

Speed of G.B = Motor rpm/3

= 2790/3

= 930 r.p.m.

And,

Torque (T) = $\frac{P*60}{2\Pi*N}$ = $\frac{186.5*60}{2*\Pi*930}$ = 1.914 Nm

4.3 Shaft Design

We know that,

Power (P) = $\frac{2\Pi*N*T}{60}$

Where, T = torque transmitted in N-m

N = speed of shaft

By ratio of gear box to shaft is 7:1,

Therefore,

Speed of G.B = Gear box rpm/3

= 930/3

= 133 r.p.m.

Torque (T) = $\frac{P*60}{2\Pi*N}$ = $\frac{186.5*60}{2*\Pi*133}$ = 13.39 Nm

Using the shaft of material 45C8

According to Design Data book

S_{yt} = 380 N/ mm^2

D = 20 mm

Permissible shear stress;

0.30 (s_{yt}) = 0.30 × 380 = 114 N/ mm^2

When, Shaft is subjected to pure torsion moment. Then the torsion shear stress is given by;

M_t = $\frac{60*106}{2\Pi*n}$ (N-mm) = $\frac{60*106}{2\Pi*133}$ = 13390 N-mm

After these,

In this theory the bending moment is neglected because of here no load is applied on the shaft.

4.4 Cutting Force Calculation

Calculation for Cu wire

Syt = 70 Mpa

= 70 × (10)6 N-m^2

Sut = 0.577Syt

= 0.577 × 70 × (10)6

= 40.39 × (10) N-m^2

Force required cutting the Cu wire

σ = F/A

Where,

A = π/4 ×d^2

d = 3 mm = 3× (10)$^{-3}$m

∴ Force required to shear 3mm dia. Wire is,

40.39× (10)6 = 4F / π× [3× (10)$^{-3}$]

∴ F = 285.50 N

Assume,

L1= length of cutter arm to manual input.

P1= force applied by fine adjustment screw on cutter arm.

L2= length of cutting edge.

P2= cutting force required to shear the wire.

∴ L1×P1 = L2 × P2

Now we have,

L1 = 85mm

L2= 15mm

P2 = 285.50N

P1=?

∴ 285.50 ×0.015 = 0.085×P1

∴ P1= 50.38 N

1) Required Torque of Motor:

T = F × r

T = 50.38 × 0.050 (r = Radius of lower roller, m)

T = 2.519 N-m

5. CONCLUSION

1. One of the main advantages of machine is the possibility to keep the metal conductor of the cable undamaged and eliminate preparatory operations with the waste cables.

2. The recovered insulating material after the separation process is absolutely metal-free and can be reused without additional operations.

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