SEMI-AUTOMATIC CERAMIC SLEEVE SURFACE FINISHING MACHINE

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Abstract - *This paper deals with the design, development and fabrication of semi automatic surface finishing machine for ceramic sleeve.*

This machine is designed for the purpose of surface finishing of ceramic sleeves using grinding wheel which is driven by AC induction motor. Where work piece is mounted on shaft of another induction motor which is mounted on moveable platform operated by pneumatic cylinder. Material removal rate of sleeves is controlled by transverse feed given through lead screw. Except loading & unloading of sleeves whole operation is controlled by electronic control panel. Semi-automatic surface finishing machine decreases cycle time of surface finishing, decreases wastage of material, provides precise surface finishing and there is less interference of worker in machining process.

Key Words: surface finishing, ceramic sleeve, grinding wheel, automation.

1. INTRODUCTION

In present surface finishing system ceramic sleeve is finished using single point cutting tool on lathe machine which is oriented towards labour intensive & heavy reliance on operator skill. This process consumes more time and there is a lot of wastage of material.

Machine consist of grinding wheel which is driven by electric motor which is at fixed position. Workpiece is mounted on a specially designed shaft which is screwed to shaft of another electric motor. Workpiece Motor is fastened to a movable platform with the help of base plate. Vibration isolators are inserted between motor and base plate to isolate the vibrations caused by motor. Pneumatic cylinder is fixed below the bed. To transmit the motion of pneumatic cylinder to movable platform it is connected through a link. Flow control valve and solenoid valve is used to control the flow and motion of the pneumatic cylinder. Proximity sensor is attached to the end. Control panel is placed on the right side of a machine which consist of three buttons.

1. Work piece Motor start/stop

2. Grinding Wheel start/stop

3. Platform Movement.

2. SELECTION OF COMPONENTS

2.1Grinding Wheel

For selection of grinding wheel various properties of workpiece should be known. As material can not be tested to find out the properties of material, we decided to select the suitable grinding wheel which will provide smooth surface finish and required material removal rate from workpiece. According to data provided by industry, grinding wheels of different grain size suitable for grinding soft material are selected. Grinding wheels of following specifications are tested:

Table -1: Grinding Wheel Test Results

Grinding Wheel	1	2	3
Grain Size	54	80	150
Grade	M	M	M
Structure No.	9	9	9
Material Removal Rate	High	Medium	Low
Quality of Surface Finish	Poor	Better	Good

As material removal rate in grinding wheel 1 is high but quality of surface finish is low and in case of grinding wheel 3 quality of surface finish is good but MRR is low, this two grinding wheels are rejected. Based on above observations grinding wheel 2 has been selected.

2.2 Pneumatic Cylinder

Selection of right cylinder means better and longer cylinder performance and lowers operating costs.

For selecting pneumatic cylinder following factors are considered:

1) Weight of the load
2) Velocity
3) Air pressure

Weight of the load:

In order to carry load of a motor, cylinder is required that provides greater force than load. Additional factor of 25%

force over the load in needed to compensate for friction. Weight of the load is 25 kg.

Velocity: Velocity is also usually set by machine design, but there's often some latitude within a range. Low speeds (up to 101.6mm/sec) require 25% more force than the load, moderate speeds (101.6 to 416.4mm/sec) about 50% more and high speeds (greater than 416mm/sec) about twice as much.

In order to find optimum velocity for precise surface finishing of workpiece 10 observations are recorded

Table -2: Velocity Observations

Sr. No.	Velocity (mm/sec)
1	28
2	27.5
3	27
4	27.5
5	28
6	27.5
7	25
8	26
9	26.5
10	25.5

Calculating average optimum velocity :

$$V_{avg} = \frac{28+27.5+26+25+27+28+25.5+27+26.5+27.5}{10}$$

$$= 26.8 \approx 27mm/sec$$

Air pressure: To maintain the desired velocity consistent air flow at the minimum effective pressure is required. Seal wear accelerates at too high a pressure during operation and creates stress on the cylinder. Inconsistent pressure can cause system malfunction or failure.

Based on required average velocity and weight of the load seller recommended front flange mounted double acting cylinder with bore size 100mm and stroke length 300mm.

2.3 Inductive Proximity Sensor

Proximity sensor is necessary for automation in manufacturing process. Make bad sensor choice and the whole process will become less efficient, more costly and unreliable.

An inductive proximity sensor belongs to the category of non-contact electronic proximity sensor. It is used for positioning and detection of metal objects. The sensing range of an inductive switch is dependent on the type of metal being detected. It is used for close range detection of ferrous material. The sensing distance is 4mm to 40mm.

Since, plate is made up of mild steel and sensing distance is 20mm, inductive proximity sensor is selected.

2.4 Bearing

Workpiece motor is mounted on one end of a moving platform and other end is free. Due to weight of the motor free end of a platform will lift which will disturb the smooth motion of a platform during finishing operation. To overcome this issue the bearing is provided. Bearing is supported by two vertical L-section channels.

Fig-1: Bearing Support Arrangement

Sealed bearing fitted with two synthetic rubber seals to prevent leakage of lubricant and entry of dust, water and other harmful material with inner diameter 30mm and outer diameter 55mm is selected.

2.5 Solenoid Valve

A pneumatic solenoid valve used to control air flow in a pneumatic system. It is also called as solenoid air control valve, it is controlled by an electric current sent by solenoid. It is used to open or close the flow of air through a circuit.

For desired movement of a platform it is required to control the direction of flow of air in a pneumatic cylinder. The signal from proximity sensor is sent to control panel which then controls the direction of flow through ports of solenoid valve.

As per process requirement 3/2 solenoid valve is selected.

3. DESIGN OF COMPONENTS

3.1 Work piece Shaft

Fig-2: Workpiece Shaft

Dimensions of a shaft

Collar Dimensions:
Internal diameter -18mm
External diameter - 37mm
length - 40mm

Taper:
large diameter (D): 32mm
small diameter (d): 28mm
taper length (L): 100mm

Taper angle calculation

$$\alpha = \tan^{-1}\left(\frac{D-d}{2L}\right)$$

$$\alpha = \tan^{-1}\left(\frac{32-28}{2\times100}\right)$$

$\alpha = 1.14^{o}$

3.2 Motor Base Plate

As position of grinding wheel is fixed, the workpiece needs to travel in linear motion towards grinding wheel to make contact with the grinding wheel. So, to achieve this motor needs to be mounted on movable platform which will travel linearly in forward and backward direction. In order to mount the motor on platform there should be a rigid base which is capable to carry the weight of a motor.

So, to design the motor base plate the selection of proper material is necessary. Cast iron structures provide a rigid frame and thus, show resistance to deformation. Hence Cast Iron is used as a plate material.

As induction motor used is four pole foot mounted, the plate is drilled with four holes on four corners of a base plate and to fix the plate to movable platform three holes are drilled in triangular form in the middle of the plate. Bolt of 12 mm diameter is used to fasten the motor to the base plate and flat head bolts are used to fasten the plate to movable platform.

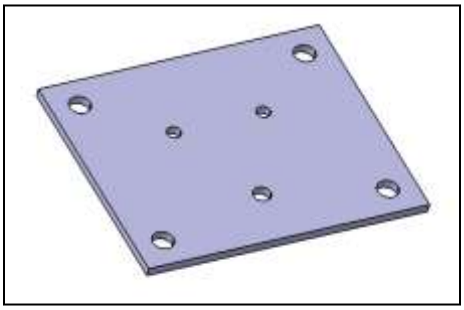

Fig-3: Motor Base Plate

3.3 Vibration Isolator

1. Spring Rate (K) = $\frac{4\,kg/mount}{2.590}$ = 1.54kg / mm

2. Select a mount with maximum load rating at least 4kg per mount and spring rate of 1.54 kg/mm or less. The 50 durometer K47 has a maximum load of 23 kg with a K Value of 12.05kg/mm. in the compression direction.

3.Transmissibility (T) = $\frac{1}{\left(\frac{Fd}{Fn}\right)^2 - 1} = 0.05$

4.Isolation = 1 – T = 1 – 0.05 = 0.95 (95% Isolation)

3.4 Control Panel

Control panel is a most important component for automation of a machine. It controls all electrical components of a machine. It also protects all electrical equipments from short circuit. Sai Soham Electrical, Hadapsar designed control panel for a machine as per following requirements:

1) Start / Stop button for workpiece motor.

2) Start/ Stop button for grinding wheel motor.

3) Button for operating pneumatic cylinder.

4) MCB.

5) Feedback control from proximity sensor.

Fig-4: Control Panel

3.5 TABLE

Requirements:

- Table should provide stability to machine and should be rigid.
- We should be able to mount heavy parts.
- It should be portable.
- Cleaning should be easy.
- It should accommodate all major parts of the machine.
- Fixture arrangement for pneumatic cylinder.

4. CONSTRUCTION & WORKING

4.1 Construction

It consist of grinding wheel which is driven by electric motor which is at fixed position. Workpiece is mounted on a specially designed shaft which is screwed to shaft of another electric motor. Workpiece Motor is fastened to a movable platform with the help of base plate. Vibration isolators are inserted between motor and base plate to isolate the vibrations caused by motor. Pneumatic cylinder is fixed below the bed. To transmit the motion of pneumatic cylinder to movable platform it is connected through a link. Flow control valve and solenoid valve is used to control the flow and motion of the pneumatic cylinder. Proximity sensor is attached to the end. Control panel is placed on the right side of a machine which consist of three buttons 1. Workpiece Motor start/stop 2. Grinding Wheel start/stop 3. Platform Movement.

4.2 Working

Workpiece is mounted on a electric motor shaft whose rotating speed is 1440 rpm. By pressing the 1st button workpiece motor is started. After that by pressing the 2nd grinding wheel motor is started. Then to start the surface finishing operation press the 3rd button after which platform will move towards the grinding wheel and surface finishing operation will take place. Proximity sensor located at the end sends signal to the control panel which then changes the direction of flow in pneumatic cylinder through solenoid valve and movable platform returns to its original position. The distance between grinding wheel and surface of workpiece can be adjusted with the help of lead screw .

5. TEST RESULTS

Table -3: Test Results

Parameters	Old System	New System
Cycle time	60sec/product	15sec/ product
Surface finishing	ough	Moderate
Material Wastage	More	Negligible
Production Rate	480 products / day	1920products/ day

6. CONCLUSION

1. Cycle time of previous machine was 60sec./product. Whereas, cycle time of present machine is 15 sec/product. Thus, cycle time is reduced by almost 75%..

2. As cycle time is reduced by 75%, production rate has been increased from 480 products/ day to 1920 products/ day.

3. In previous system on an average 13 products out of 100 used to get damaged. While in present system 2 products out of 100 get damaged. Thus, wastage of material got reduced by 85%.

4. Quality of surface finish has been improved considerably compared to old machining method.

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