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Experimental Setup for Hot Machining Process to Increase Tool Life with Torch Flame.

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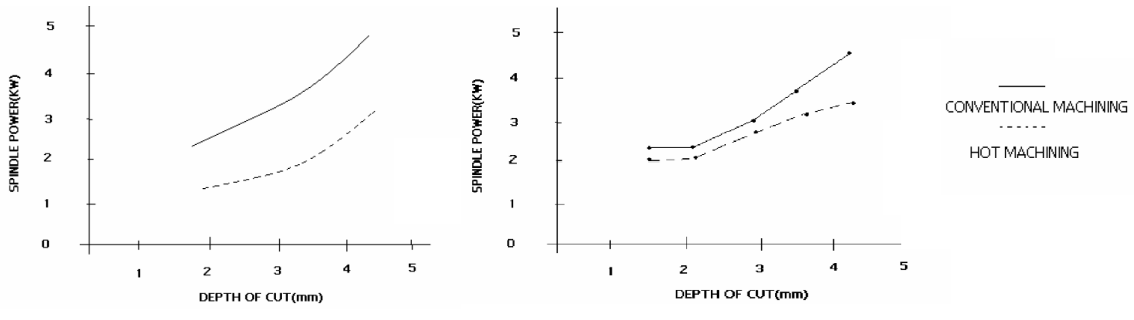
Abstract: *Now days, to satisfy industrial requirements we should have materials with very high hardness and shear strength. So manufacturers are intended to manufacture such materials having high hardness and shear strength. There are various conventional methods for machining, but use of such methods reduces tool life with increase in tool wear and it results in increase in cost of manufacturing. Hot Machining can be used to decrease tool wear, power consumed and increase surface finish. In Hot Machining the temperature of the work piece is raised to several hundred Celsius above ambient, which causes reduction in the shear strength of the material. There are various heating methods, like bulk heating using furnace, area heating using torch flame, plasma arc heating, induction heating and electric current resistance heating at tool-work interface. We used torch flame method for heating the work piece. In this paper experimental setup of hot machining process is explained.*

Key words: *Hot Machining[1], Torch flame, Tool life*

I. INTRODUCTION

Dealing with materials having very high hardness and shear strength ,Hot Machining can be used to decrease tool wear, power consumed and increase surface finish. In Hot Machining the temperature of the work piece is raised to several hundred Celsius above ambient, which causes reduction in the shear strength of the material. We are using torch flame method for heating the work piece because this method can help us to heat the work piece material immediately ahead of cutting tool because torch flame assembly moves along with cutting tool. Fixture we used can be mounted on any other lathe by minor changes in design so reducing need of separate fixture for each and every lathe, and it is also detachable so it will not disturb regular operations of lathe machine.

From the past experiments it was found the power consumed during turning operations is primarily due to shearing of the material and plastic deformation of the metal removed. Since both the shear strength and hardness values of engineering materials decrease with temperature, it was thus postulated that an increase in work piece temperature would reduce the amount of power consumed for machining and eventually increase tool life. In figure 1(A) and figure 1(B) the variation of Spindle power with Depth of cut is shown for different materials.



(A) MAT- Alloy steel (B) MAT - SSIO

Fig.1 Spindle Power Vs Depth of Cut [1]

II. PROPOSED WORK

There are various conventional methods for machining, but use of such methods reduces tool life with increase in tool wear and it results in increase in cost of manufacturing. In conventional machining methods as tool life decreases tools required for particular material increases, and time require also increases results in decrease in rate of production. Life of tool is inversely proportional to the manufacturing cost. So we should have a Machining process which can help us to deal with the materials having high strength and which are hard to cut. Hot machining process is turns out to be a great option with use of Torch flame method. We can use oxygen-LPG for flame preparation.

III. DESIGN AND FABRICATION DETAILS

3.1 Basic considerations

The Fixture designed and fabricated should be simple, detachable, reliable, efficient and affordable. While designing this fixture following points need to be considered

- <u>There should be no permanent attachment to the lathe:-</u>

  The fixture should be mounted in such a way that it can be removed as and when we want without affecting any other arrangement on the lathe machine. It should be detachable. No fixed welds should be done with the lathe machine
- <u>Both the torch and thermocouple should move parallel to the lathe axis:-</u>

  The torch and thermocouple should be mounted in such a way that it should move parallel to the lathe along with the tool and this motion should be controlled by the motion of carriage itself.
- <u>The torch should also move perpendicular to lathe axis:-</u>

  The torch should have cross motion to the lathe axis i.e. motion perpendicular to the lathe axis & should be moved as and when the user wants. And its inward and outward motion should be adjusted wherever we want.
- <u>This can be done manually as well as by Automation:-</u>

  All this movement of both torch and the thermocouple should be done by manual way as well as by automation.

3.2 Fabrication details:

The main considerations made while designing the fixture were to reduce the vibration of fixture caused due to machining operation, longitudinal & transverse propagation of torch & easy fitment of fixture on the cross slide without restricting the motion of cross slide. Fixture mainly consists of five important parts:

1. The C- channel.
2. The L - type plate.
3. 12V DC Motor.
4. Guide Bolt.
5. Extension for torch mounting.
6. J-TYPE THERMOCOUPLE (TEMPERATURE SENSOR)

1. The C–channel: As shown in Fig. 2 the C- Channel forms the base of the fixture which is made from cast iron. The upper face is provided six holes which are prepared by drilling & tapping operation for fitment of L plate. The side face consists of two drilled holes of the fitment of C- channel on the cross slide of lathe machine with the help of nuts & bolts.

Fig.2 C- Channel

Fig.3 L-Type Plate

2. The L- type plate: As shown in Fig. 3 the L-type plate is second important part of fixture . Its base is provided with two slots for mounting of C-channel on L plate, this is done by using nuts, bolts & washers for adjustable mounting of L plate. The main face of L plate is drilled with three eccentric holes for fitment of wiper motor & a central hole is for the provision of motor shaft. L plate is provided with a guide which guides the nut on the rotating bolt.
3. 12V DC Motor:- In this experimental set up a wiper motor as shown in Fig. 4 is used for to & fro movement of torch. The wiper motor used is of Hyundai Accent. It has a speed of 34 rpm and high torque at 2.4 ampere & 12 volt. The motor is then mounted on the L plate. This motor is then connected to the guide bolt. It gives rotation to guide bolt.

Fig.4 D.C. Motor

Fig.5 Guide Bolt

4. Guide Bolt: - A guide bolt is mounted on the wiper motor shaft. Its rotational movement along motor shaft causes the forward and reverse motion of nut parallel to wiper motor shaft. Guide bolt is important for the forward and reverse motion of the heating torch as shown in Fig. 5.
5. Extension for torch mounting: - An extension for torch mounting is provided so that the heating torch can be clamped properly for constraining it movement & providing proper angle for flame to heat the work piece.

Fig.6 Carbide Tool

Fig.7 J-Type Sensor

6. The tool which is used consists of carbide tip As shown in Fig. 6 which is mounted on a holder. To fix the carbide tip on the tool holder we required an Allen key which can tight the carbide tip with the tool holder. The carbide tip which is used in our experimental setup is of ATP grade which consist high amount of carbon and manganese which provide it with high strength and hardness during machining.
7. The above shown fig. 7is a J-TYPE THERMOCOUPLE which is a type of temperature sensor. This type of temperature sensor is a contact type temperature sensor in which does not give reading without its contact with the material. The temperature of the thermocouple ranges from -210^{o} C to 750^{o}C which is appropriate for our experimental setup.This thermocouple also consist of an adjustable arm which can be adjusted according to the requirement of the user by just rotating the provided knob and it gives the thermocouple a motion same as the shock absorber in motor cycle. This thermocouple gives a voltage output which is in millivolts & has got two terminals one of which is ground and other is positive terminal.

3.3 AUTOMATION

The automation helps Torch movement perpendicular to lathe axis and keep temperature at constant value. Above figure shows the basic blog diagram of automation of movement of the torch perpendicular to lathe axis. When temperature reaches specified value it will be sensed by sensor and torch moves away from the work piece.

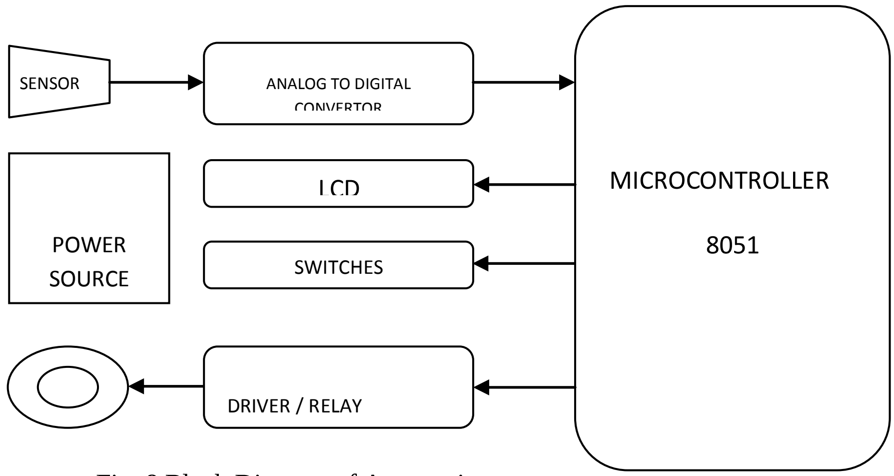


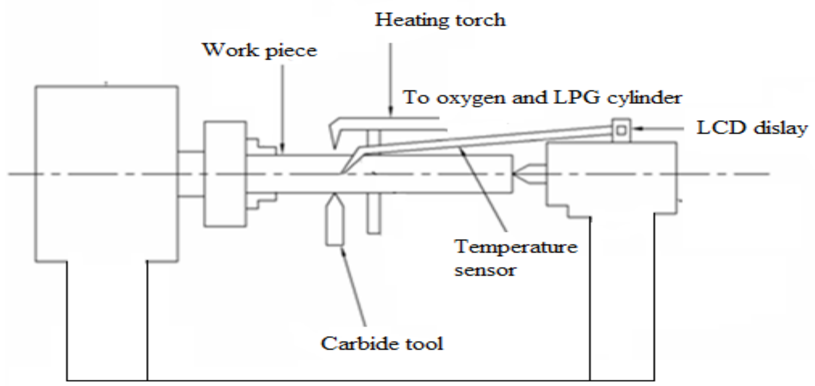
Fig. 8 Block Diagram of Automation

Block diagram shown in Fig. 8 can be divided in following pats:-

1. Sensor:- Sensor is required to convert the physical quantity into the electrical quantity.
2. ADC:- ADC is used to convert analog signal to digital, for interfacing with microcontroller.
3. Switches:- Switches are used to give inputs to the microcontroller.
4. LCD:- It is used to the status of micro controller and current temperature .
5. RELAY:- It is used to start and stop the motor.
6. Motor:- Motor is used as actuator in this project to move flame front and back.
7. Microcontroller:- It is the heart of the system which process the signals and take decision according to program loaded.
8. Power source:- It is used to give power to all the elements used in circuit.

IV. EXPERIMENTAL SETUP

The bellow fig. 9 consists of the Experimental Setup which we have implemented. Work piece is mounted



between lathe headstock and tail stock, and in front of tool carriage the fixture is mounted.

Fig.9 Experimental Setup

This experimental setup mainly consists of eight important components and they are as follows:-

1] Lathe Machine. 2] Work piece
3] Carbide Tool. 4] Heating Torch.
5] J-Type Thermocouple 6] Oxygen Cylinder.

7] LPG Cylinder. 8] LCD Display

WORKING:

The work piece is held, between the lathe head stock and tail stock on the lathe machine. As shown in fig. 9 torch is fitted. Torch is connected to LPG cylinder and an oxygen cylinder. Torch can move with the cutting tool. We can adjust the flow of oxygen and LPG by using valves. Handle is provided to adjust the distance of the torch nozzle and it can be done automatically with DC motor. Temperature indicator can measure the temperature of the work piece. Temperature can be set in the temperature indicator and when the temperature is reaches the specified value the torch automatically moves away from the work piece. This is done by using the automation s provided and temperature sensor senses the temperature and physical quantity is converted into electrical quantity and as a result the movement of the torch is done with the help of 10 volt DC motor. The machining is done by a carbide tool insert as shown in the Fig. 6. Fig.9 shows working setup for the hot machining process using oxygen and LPG gas flames. Fig. 10 Shows actual setup.

Fig.10 Actual Setup

V. CONCLUSIONS

So Hot Machining is efficient machining process for hard to cut materials. So we mounted fixture on to the lathe carriage, Oxygen and LPG flame is used. The main objective of this experimental setup is to machine the high strength hard to cut materials by carbide tools with increase in tool life and decrease the tool wear which is achieved. The movement of the torch has been successfully done manually as well as with the help of automation. The experiment was carried out on the high Mn steel and this hard to cut material has been successfully machined. Finally in future experiment will be run to check the optimization of cutting parameters and the optimum values of cutting speed, Feed, Depth of Cut and Temperature obtained can be compared, so as to get optimized values.

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