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COMBUSTION CYLINDER BLOCK SURFACE MILLING APPLICATION

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ABSTRACT

The evaluation of machining processes has progressed day by day in the new era of manufacturing science. All machining techniques depend heavily on achieving a high level of surface quality. In this project, a surface finishing performance milling machine and work on various parameters, including cutting speed, feed, and depth of cut with various types of materials to improve machining processes to achieve high-quality surface roughness, and by changing the cutting tool tooth material (Tungsten carbide into CBN), a gear ratio of the existing machine (1:9 into 7:1) for significantly improve surface finish or reduce surface roughness. This implies that it would be beneficial to enhance the machining procedures or certain features of the surface finish.

Keywords: - *milling machine, surface roughness, different parameter*

1. INTRODUCTION

After China and the USA, India is the third-largest manufacturing nation in the world. The goal of definitive interferences is to promote and advance manufacturing competition. One of the main foundations of sustainability in the global market is quality. Numerous sectors, both small and large scale, have become recognized for concentrating on and increasing quality. The standard of something is judged against other items of the same kind; the level of quality. A distinctive quality that something possesses. using a variety of quality tools, such as control charts, Pareto analyses, fishbone diagrams, histograms, etc., across the entire production process to reduce product rejection. Four categories, including machining, joining, shaping, and finishing operations, are used to categorize manufacturing businesses. Machining is the last step in the majority of manufacturing industries before a product is considered finished.

The main issue facing contemporary machining businesses in achieving high quality, or high surface roughness, in terms of the dimensional accuracy of the workpiece and surface finish. The smallest abnormalities in the surface texture, such as feed marks after machining, are referred to as surface roughness. When assessing the productivity of machine tools and machined products, the quality of a surface is a crucial consideration. The regulation of surface texture is now increasingly crucial due to the more exact requirements of modern technical goods.

2. MILLING MACHINE

The work is tightly secured on the machine's table or held between centers while a rotating multi-tooth cutter is installed either on a spindle or an arbor. This is the basic operating principle used in the metal removal process on a milling machine. The work is fed slowly past the cutter as it rotates at a pretty high pace. Vertical, longitudinal, or cross directions can all be used to feed the task. The cutter teeth remove metal from the work surface as the task is completed, creating the desired form Power feed might result in a better surface quality since it is smoother than hand feed. On lengthy cuts, power feed also lessens operator fatigue.

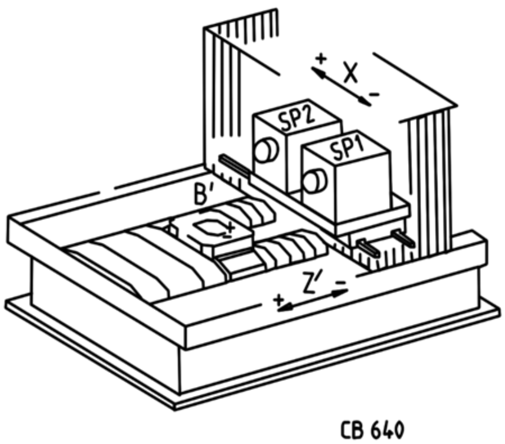

Fig -1: Milling Machine CB-640

2.1 Main Components of Milling Machine

Fixture - An object used to "fix" (constrain all degrees of freedom) a workpiece in a specific coordinate system with respect to the cutting tool is called a fixture.
Spindle - A spindle is a revolving axis seen in machine tools, frequently with a shaft at its center. The spindle is the name given to the shaft itself.

Fig-2 spindle

Ball screw - A mechanical linear actuator called a ball screw can convert rotational motion into linear motion.
Servo motors - This motor can be positioned with great accuracy and precisely controlled as needed for the application.

2.2. Cylinder block(workpiece

Fig-3 Cylinder block

The cylinder block and cylinder head, the two major components of the engine, are assembled. The high pressure in it makes linkages more likely, while the roughness of the side surfaces helps to prevent them. Working on the surface's roughness is necessary. The raw material has a 25 micron surface roughness. Modern considerations need it to be within 10 microns of 13 microns after machine processing.

3. MACHINING PARAMETERS

The amount of feed and needed depth of cut, along with the hardness of the material being machined, all affect the appropriate cutting speed for a given task.

3.1 Cutting Speed:

Speed is the rate at which work moves in relation to the tool (usually measured in feet per minute). It is important to distinguish between the cutting speed, which is expressed in FPM, and the lathe's spindle speed, which is expressed in RPM. For workplaces with small diameters and those with big diameters, the spindle speed needs to be increased to achieve a uniform cutting speed.

- Calculation:

The rate at which the cutting tool removes metal from the workpiece is known as cutting speed. Cutting speed is the speed of the work moving past the cutting tool on a machine. It is measured in meters per minute (mm/min).

Cutting speed (V) = π DN/60 × 1000 mm/min
Where D = diameter of the workpiece (mm)
N =rpm of the work

Cutting speed depends upon the following factors:
i. Tool material.
ii. Work material.
iii. Depth of cut
iv. Tool geometry.
v. Type of machine tool.
vi. Surface quality required.

3.2. Feed rate:

The distance the tool covers during one rotation of the component is known as the feed rate. Surface finish, power needs, and material removal rate are all influenced by cutting speed and feed. The material being cut is the main determinant of feed and speed. However, one should also take into account the depth of cut, size and condition of the machine, the rigidity of the workpiece, and substance of the tool. Divide the required cutting speed by the work's circumference to determine the suitable spindle speed. To get the finish you want, experiment with feed rates. It's crucial to keep in mind that the working diameter decreases by two thousandths for every thousandth of the depth of cut while thinking about the depth of cut.

3.3. Depth of Cut:

The tool's penetration depth into the work is measured in distance. Reduce the depth of cut if chatter marks or machine noise appear. It is the entire volume of metal eliminated by the cutting tool during each pass. It is written in millimeters. Depending on the kind of tool and work material, it may change. According to math, it is equal to half of the diameter difference.
Spindle speed-N=v/(pi*D_0)(rpm)
V=cutting speed
D_0= outer diameter
Feed rate-fr=N*f(mm/min or in/min)
F= feed per rev
Depth of cut-d=(D_0-D_t)/2
D_t=final diameter

	Previous parameter values	After changed Value (current)
Spindle speed	375 RPM	1000 RPM
Gear ratio	1:9	7:1
Feed rate	250 mm/min	600 mm/min
torque	120(At 300 rpm)	87(At 600 rpm)

Tab-1 parameter value

Fig -2: before and after gear arrangement

4. CUTTING TOOL

4.1. Factors Affecting Parameters on Cutting Tool

1. The following factors often have an impact on cutting speed, depth, and feed rate:
2. The workpieces', cutting tools, and machine tools' stiffness,
3. Surface roughness and workpiece accuracy,
4. Expected tool life
1. Cutting fluid types and cooling techniques
2. The machine tool's lifespan.

Cutting speed, cutting depth, and cutting feed rate are the primary variables among the aforementioned components.

	TANGUSTAN CARBIDE	CARBON BORON NITRIDE
density	15.25(g/cm³)	3.48 (g/cm³)
hardness	17(GPa)	70(GPa)
thermal conductivity	0.11(kW/m.K)	1.3(kW/m.K)
melting point	2870ºC	2350ºC
heat capacity	292 J/gK	19.7
bulk modulus	350(Gpa)	367(Gpa)

Tab-2 properties of tool material

4.2. cutting tool material (tungsten carbide vs CBN)

Cutting parameters and cutting tools both have a significant influence in extending cutting tool life and reducing cylinder block roughness values. When the level of roughness is higher, tungsten carbide is the material utilized for cutting tools. However, we needed a cutting tool with a lower roughness value, therefore we used CBN. Particularly in terms of tool life, surface finish, and metal removal rate, the machining performance of CBN in comparison to traditional carbide cutting tools. The cutting tests involved two materials: grey cast iron, a typical engineering material, and Vitallium, a cobalt-based alloy used in the production of orthopedic implants. Turning and face milling of Vitalium and grey cast iron were the machining processes employed.
Using carbide cutting tools, grey cast iron may be machined very simply. However, the usage of these materials is appealing in mass production systems involving extended batch runs due to the stated longer tool life and improved surface polish for CBN. By doing this, tool changes can be minimized, increasing productivity in the process. Test results on grey cast iron support the assertions of longer tool life and better surface polish. A comparison of shoe properties is in table no. 2.

1. ANALYSIS

Analysis before and after changes Cutting tool and parameters		
	Before	After
Backlash(micron)	11	9
Vibration(horce)	7	8
Working temp	27.5	31
Surface finish	13 micron	8 Micron
Coolant pressure	6	8 bar

Tab-3 Analysis before and after changes Cutting tool and parameters

1) **Backlash** –

Backlash is a wasted motion in the screw caused by the clearance between the ball bearing components and the screw and nut tracks. Preload refers to a ball nut that has had all backlash eliminated. All milling machine servo axes frequently experience backlash. Designing a durable servo axis without the inclusion of resonant frequency and backlash detection through condition monitoring would both benefit greatly from machines that define the bandwidth of frequency of vibration in a servo axis with the presence of backlash and estimate the frequency. It was demonstrated using straightforward models for the mechanical components of a servo axis and the backlash itself that the frequency of vibration in a servo axis with backlash is determined by the position control gain rather than the backlash value. Limitations for the bandwidth of the frequency of vibration in a servo axis were established by conducting several experiments on five different milling machines.

2) **Vibration** –

The tool and workpiece frequently make contact during milling operations, which causes vibration in both. The vibration amplitude of the milling tool during the milling operation can be measured using a variety of vibration measuring tools, such as the SLAM stick and NI accelerometer. The vibration behavior can be simulated using methods like FEM implementation.

3)**Noise** –

Noise is produced by the machining equipment used to cut metal. The acoustic wave signal makes up the noise signal. Each noise source has its own characteristic frequency that is used to combine the noise signals that are gathered during high-speed machining. After the interfering noise signal is removed, the target signal has a high applicability value.

2) **Thermal conductivity** –

The ball screw mechanism's temperature plainly rises as rotational speed increases. Ball screws' location precision is reduced as a result of this phenomenon's thermal elongation. The position precision of the ball screw is impacted by thermal elongation. In a ball screw system, different rotating speeds cause various temperature variations at various places.

Vertical Horizontal tapper by checking CMM-

3) Temperature / Running temperature-

Because it impacts the characteristics of the machined surface, the temperature of the workpiece during machining has a significant impact on the parameters that are selected. In addition to rising with increased feed and pace, the emperature would rise when cut depth was raised. In terms of temperature, the depth of incision is the most important factor. In order to reduce the temperature of the workpiece during machining, a lower depth of cut is preferred.

4) Surface finish -

The impact of the cutting settings on surface roughness can be divided into two states based on the results. One parameter is mutable and the other two parameters are constant in the first state. The second state has two interactive parameters and one constant parameter. As a result, the two parameters can be modified to see the surface roughness while the other parameters remain the same. surface roughness as a result of four input variables. It has been discovered that the surface roughness assessed increases with decreasing cutting depth. The workpiece's surface gets smaller as spindle speed increases. The surface decreases with decreasing feed rate. We discover that the milling gap decreases as it gets smaller, the smaller the surface roughness.

As the table below illustrates, increasing cutting speed unquestionably affects a number of machine parts, including those impacted by vibration, working temperature, and coolant pressure.

4. CONCLUSIONS

We had to modify a present machine because it wasn't practical given the surface roughness, as per our problem statement. Therefore, we changed the material of the cutting tool and gear ratio on that machine to increase surface finishing. We discovered during this procedure that the most crucial surface characteristics for reducing surface roughness are cutting speed, feed rate, depth of cut, and lubricating pressure.

For milling operations, the most effective combination of high feed rate and radial depth with low cutting speed and axial depth produced better surface roughness. The surface roughness under 10 microns, or 8 microns, is thus obtained based on the study and adjustments to the aforementioned parameters, and it is practical for the current machine.

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