

Implementing a Preventive Maintenance Planning Model for Computer Numerical Control (CNC) Milling Machine

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Abstract: Preventive maintenance is early access or pre-planned maintenance of the problems occur in any machinery units and it has become the important part of today's industry to avoid breakdown as it can save costly faults, keep Continues production with standardize machinery, reduce waste and also important for safety of deployment. The paper describes the way to avoid breakdown in CNC's by using time based scheduled preventive maintenance for different parameters, while taking 20 CNC machines under observation. PM sheet of CNC's is divided into parts over time for different parameters like chuck pressure inspection is kept in daily basis list while ATC Arm in 4 month check list. Some parameters set on the basis of theoretical studies of material fatigue life and some on experimental basis in the resultant sheet. The developed sheet could help manufacturers to figure out the problems in CNC's on their usage over time range, simply the sheet can be taken as survey of performance of CNC's. Also a proper planed PM sheet can save a valuable amount of money on maintenance.

Keywords: PM: Preventive Maintenance, CNC: Computer Numeric Control, BM: Breakdown Maintenance, CNC: Milling M/c, CNC: Machine Tools, Machining Materials

1. Introduction

Maintenance is a most important activity in production process since it accounts about 60 to 75% of its total costs; including material, transport and technical support costs. As the cost of maintenance is extremely high, industrial studies have revealed that the amount of replacing worn components may be up to 70% of the total maintenance cost [1] [2]. So, a proper scheduled preventive maintenance modal can be solution for increasing components life, decreasing cost factor also sudden breakdown in machines, which directly disturbs production process more specifically, loss of time and cost for technical work. Another important factor is control of quality, which directly depends upon the condition of equipment. To maintain the standard of product, performance of equipment can only be preserved by its preventive maintenance [3].

The research is focused on problems arising in CNC machines after scheduled preventive maintenance for different parts of CNC's. The main objective was to develop a Time based PM sheet that overcome all the possible issues of maintenance. Although mathematically analysis are best

describe by Marseguerra M, Zio E, Podofillini L. [4] Mazzuchi TA, Soyer R. [5].

PM sheet divided into daily, 5 day, 2, 4 and 8 month basis by taking single shift into account for a day which can may be adjusted for multiple shifts on the basis of time. Check sheet includes the following points Check Point Details, Standard, Check Method/ Method of Maintenance, Condition/Reading and Remarks.

Standard defines for which parameter you need to check although some standards used in following sheets may vary because it completely depends on types of application like hydraulic pressure used here is 4Mpa which can be different for any other application, while check method is basic inception method used for each check point. At the end you can may write for the condition and remarks for further improve the point you checking for. Method of maintenance for each check point been defined as per used for the following research.

2. Preventive Maintenance

Preventive maintenance is early access or pre-planned

maintenance of the problems occur in any machinery units and it has become the important part of today's industry to avoid breakdown as it can save costly faults, keep Continues production with standardize machinery, reduce waste and also important for safety of deployment. This maintenance includes adjustments, alignment, cleaning, lubrication, Oil changing, repairs, replacements, and the extension of equipment life [6] [7] [8]. These activities if not controlled increase the rate of occurrence of Breakdowns and also reduces effective age of equipment. Although Preventive maintenance can be categorized into two parts as unit repairing or unit replacement. If these activities controlled properly, it can minimize cost for replacement of tools by effectively increasing its life also controls the quality of production by the equipment.

U. S. Department of Energy estimates that preventive maintenance can be result in, if implemented properly [9];

1. Up to a 30% reduction in energy and maintenance costs
2. 35% to 45% fewer breakdowns
3. Reductions in downtime by up to 75%.

Preventive Maintenance Check Sheet Standards

Preventive maintenance sheet prepared include check points on following time periods,

1. Daily Check Points
2. 5 day Check Points
3. 2 months Check Points (single shift per day)
4. 4 months Check points (single shift per day)
5. 8 months Check points (single shift per day)

A complete Sheet is a prepared plan followed by monthly and daily schedules.

Check Sheets of specific type Machine units are prepared, which includes all the factors that should be maintained to avoid occurrence of any kind of Breakdown in equipment.

3. Checklists

Check lists are of great importance for preventive maintenance as it overcomes all weak memory points including in it. The checklists regarding CNC's in any production line has its importance in PM as failure in any point can cause drop in production of specimens on machinery. Therefore a proper PM sheet should be implemented in any industry regarding this issue.

As in Atlas Honda Sheikhpura, Pakistan CNC check sheets were made on the time schedule of 3 months and 2

shifts a day industry runs. So, these 3 month based check sheets were not sufficient to avoid Break down in CNC's. It has become big problem in industry as they having breakdowns in some check points after PM.

4. Cause of Breakdown

Breakdowns maintenance is maintenance, which performed on worn-out or unusable equipment. [10] [11] Breakdowns in machinery always costly. The major cause for the breakdowns in any part are because of improper modal of PM sheets also it can also be due to improper operation. Although, improper operation problems are easy to overcome, they only need proper training of operator.

5. Solution of Breakdown

Multiple breakdowns in machinery can be catastrophic and can be reason for mass destruction of unit and big loss of amount. Therefore breakdowns must be addressed properly with proper planning sheets. My check sheet totally based on time as base parameter for PM to avoid Breakdowns for different checkpoints although time chosen for maintenance is different for different parts of CNC's. As fatigue and failures in any working unit are based on the time so their maintenance should be time based. So, this check sheet named as Time-Based Check Sheet for Preventive Maintenance.

6. Collection of Data and Methodology

All the data collected from the previously recorded check sheets of breakdowns in CNC's. I checked for the breakdowns most occurring in CNC's over the period of time they occurs. After successful data collection, I analysed all breakdowns of previous five year which lend me to develop this sheet over problems occurring on time based e. g. the chuck pressure causing issues is in daily inspection checklist previously it was in monthly check sheet. The results been concluded on the basis of implementation of sheet for three completed schedule periods for 20 CNC milling machines.

During implantation process it's been decided that daily check points will be covered by operator, while other check points will be inspected by maintenance department.

7. Preventive Maintenance Improved Sheet for CNC

Table 1. Preventive Maintenance Check Sheet for CNC Milling machine.

Check Sheet for PM of CNC Milling Machine				
Check Point Details	Standard	Check Method/Method of Maintenance	Condition/Reading	Remar-ks
Daily Check Points				
Hydraulic pump Pressure	4Mpa	Gauge		
Hydraulic Fluids	Right Operating level	Gauge		
Chuck Pressure/tool stopper bar	Right Operating level	Gauge		
Check for Pipe leakage & connections	No leakage	Gauge		

Check Sheet for PM of CNC Milling Machine				
Check Point Details	Standard	Check Method/Method of Maintenance	Condition/Reading	Remarks
Lube level	Right Operating level	Gauge		
Grease any part if needed	Minimize friction	By Hand		
Chips	Pan should be clean	By Hand		
Glass of door	should be Clean	By Hand		
5 day Check Points				
Filter of Control Cabinet	Clean for air flow	By High air pressure		
2 months Check Points (single shift per day)				
Grease chains of Conveyers	Minimize friction	By Hand		
Mist Collector	should be Clean & properly working	Visual/By hand		
Filters of Coolant tank	should be Clean	Visual/By hand		
4 months Check points (single shift per day)				
Spindle run out	At Nose 08µm	Dial Gauge		
Spindle Rotation	Check rotation	Visually		
Spindle taper flange Condition	Visual Check	Visually		
Spindle Orientation	Orientation Position	Visually		
Spindle Clamp force	2.3 KgN	Pull meter		
Unclamp Stroke	0.5-0.7mm	Pull meter		
Spindle Vibration, Noise & Temp. check	20 C°	Thermometer		
Balance of CNC	Fix if needed	Bubble level		
ATC Arm	Check external watching	Visually		
Radiator Fins	Clean and straight	Visually		
Emergency Push Button	Machine should be OFF	Check By Hand		
Check earth Leakage Breaker	Check Connections	Check By Hand		
Take off Chuck and Jaws	Clean them	By Hand		
Hydraulic Oil Replacement	drain tank & replace	By Hand		
Check Wipers	Clean and Undamaged	By Hand		
Line Filter	Change	By Hand		
Suction Filter	Change	By Hand		
Lubricant	drain tank & replace	By Hand		
8 months Check points (single shift per day)				
Cam Box	Backlash check for Horizontal and vertical direction of Arm Axis	Visualize/By Hand		
Headstock & tailstock	Clean & taper check	By Hand		
Spindle	Check Radial & End Play misalignments	Dial Gauge		
Chuck Cylinder	Run out			
Z-axis motor brake	No down after Emergency	By Hand		
Backlash	X, Y & Z Axis	Dial Gauge		
Noise (Rapid Motion) Ball screw & LM guide	X, Y & Z Axis	Hearing		
Visual Check (Nut case, LM guide its seat & lead Ball screw)	X, Y & Z Axis	Visually		
X & Z axis Gibs	Adjust if needed	Dial Gauge		
Noise Check for support bearing	X-axis	Dial Gauge		
Tool Stopper bar	Loosening state of wear out	Visual/By hand		
Key	Loosening state of wear out	Visual/By hand		
Gripper for tool exchange	Loosening state of wear out	Visual/By hand		
Roller Stopper	Loosening state of wear out	Visual/By hand		
Magazine ZRN Position	Check Index Position	Visual/By hand		
Tool Magazine Ports	Properly Working	Visual/By hand		
Filter Replacement	check and replace	Visual/By hand		
Lubrication Blockage	shouldn't block	Visual/By hand		
Change Hydraulic Oil	check and replace	Visual/By hand		
Cabinet Filter	Replace	Visual/By hand		
Check for damage & tight terminals of breaker	Shouldn't loose	Visual/By hand		
Lubrication Tank	Check and Clean	Visual/By hand		
ATC Position	ATC Arm fixed and Z-axis home position	Visual/By hand		
Slide Cover Condition	X, Y & Z axis	Visual/By hand		
Main electrical Panel	Clean from dust	Visual/By hand		
Replace 4th Axis unit oil	Replace if require	Visual/By hand		

8. Results

The results from implemented sheets shows that above sheet overcomes most of the issues and a significant improvements have been done after implementation of sheet especially for daily check points. Over the years, Maintenance and its cost continue, unplanned failures decrease the reliability of the machine and also it costs amount for maintenance. Above implemented sheets can be a significant drop in costs. Proper maintenance of machine can save money and time factor specially cost of technical support for serious problems from manufacturers.

Results are concluded on the basis of three completion of schedule periods after implementation of PM sheet on 20 CNC units. A successful reduction of more than 80 percent been calculated for most check points after comparing with the breakdowns before implementation of sheet.

9. Conclusion

In this study, about CNC machine, I proposed a Preventive maintenance approach, which is used to find out time between preventive maintenance of different parts of CNC milling machine. The proposed PM methodology finally results that the preventive maintenance concerning to the operation of CNC Milling machine should be carried out according to the time as per given the sheet, which can help to increase the life of the tool and machine without any failure or breakdown occurring. Also it saves the time wasted because of breakdowns in units, which shows its reliability for continuous industrial processes. Although, PM sheet for CNC milling machines, which defines check point detail, standard for checking and check methods in such detail never developed before.

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