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Miscellaneous Time Reduction Strategies during Machining of Bank Top Header by Vertical CNC Drilling Machine

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Abstract In the stream and water vapor drums, cutting holes are essential steps for manufacturing boiler. The machine is continuously running, requiring standard operating procedure needs to be formulated. The miscellaneous elements even though do not contributing directly in machining through vertical CNC drilling machine, it affects other productive elements during production. The resultant time study process reduced the miscellaneous time to 24 mins in two days shift from 69 mins.

Keywords —CNC Machining time. Time Study, Sequencing

I. INTRODUCTION

Due to header drilling operation, Vertical CNC machine is one of the critical machines. It requires productivity study for overcoming bottlenecking header manufacturing, which depends upon studying the steps involved in cutting holes on headers. For drilling operation, different sizes of headers are loaded in this machine from 1 meter length to 8 meter length. Variety of sizes results into frequent settings, need of operation of EOT cranes for shifting of headers, tail-stock arrangement causing the setting time loss.

The efficient and effective methods needs to be continuously evolved to generate optimal sequences to reduce manufacturing time during CNC machining [1]. The substantial improvement in machining process can be resulted from balancing the factors [2].

Vertical CNC machine is used to drill holes on headers for panel manufacturing. It is made up of a headstock, a tailstock, 2 guide ways, CNC operating system, with 2 manpower requirement.

Time study is a direct and complete observations of the task using time monitoring and control device such as computer assisted electronically enabled stopwatch, to record

1. Repetitive work cycles
2. Wide range of dissimilar work
3. Process control elements constituting the part of cycle.

In the stream and water vapor drums, cutting holes are essential steps for manufacturing boiler. Since the machine is continuously running, standard operating procedure needs to be formulated.

The miscellaneous elements even though do not contribute directly in machining, but largely affects the overall performance in order to keep machining ready in working condition whenever required.

In this present paper, an attempt is made to reduce the miscellaneous time spent during CNC machining.

Details of Vertical CNC Drilling Machine

A. Table 1: Header details for clamping between centers

CNC Parameters	Specifications
Min Length	1 meters
Max Length	7.5 meters
Min ID	145 mm chuck limit
Max ID	300 mm
Min OD	168 mm
Max OD	457.2 mm
Min Thickness	12 mm
Max Thickness	100 mm

B. Table 2: Header clamping on BED

CNC Parameters	Specifications
Min Length	0.5 meters
Max Length	12 meters
Min OD	168 mm
Max OD	457.2 mm
Min Thickness	10 mm
Max Thickness	100 mm

C. Table 3: Drill Sizes Available

CNC Parameters	Specifications
Min Diameter	14 mm
Max Diameter	124

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D.Table4: J-Cutters Available

CNC Parameters	Specifications
Min Diameter	33/35 mm
Max Diameter	133/135 mm

Table A – D reflects data sets of machining sequences.

For time analysis the data was gathered by taking time readings for 2 shifts on adjacent days after routine maintenance time. To identify various steps involved in the process of cutting holes on the header and in setting new header on the machine workplace, various observations were set up. The process was broken down elements along with its time required and the manpower for each broken-down element. The data gathered then complied under various heads and the cumulative time required for each head in a day was computed.

II. SEQUENCE OF OPERATIONS

Scheduling problem affects maximum in minimizing the completion time variance (CTV) for all jobs during machining [3]. The time variance is the critical factor to improvise precision and reduce uncertainty during machining. Variation reduces productivity and thereby improves complexity of the part.

The sequence in which the operations take place when change in row occurs is

1. Rotating the header
2. Brining combination device
3. Checking combinations
4. Modification in program
5. Checking the offset

After the change in rows the machining processes as

1. Drilling
2. J-Cutting 1
3. J-Cutting 2
4. Interpolation.

Steps performed before switching from one machining process to another action are taken as

A. Changing the tool and checking

The tool is changed by suing automatic tool changer and the inserts of the tool are checked. If the inserts of the tool are worn out then the inserts have to be changed.

B. Modification in Program

The modification in the program are made as per the specifications of the job and machining process.

C. Performing the process

Once the above steps are done the manufacturing process is done on all the holes designed in the row as per drawing.

Once all the holes are cut to the required specifications, the operator shifts to a new row.

Jobs finishing sequential processes in first to third machines are designated with the timer of precedence relationships [4]

III. SETTING TIME OF JOB

The header was then unloaded from the machining using EOT Crane and new job with the following specifications was loaded.

Table 5: Processing Time for Jobs

Parameters	Previous Step of Machining	Next Step of Machining
Job	Conventional Bank Top Header	Economizer Top Header
Part No.	1/1	½
OD x Thickness	323 mm x 21.4 mm	168 mm x 36 mm
Length	4693 mm	2830 mm
Drill Diameter	30 mm	22
Double J Diameter	39, 41, 52 and 54 mm	33, 35
J Cutter Depth	8 mm	7.95 mm
No. of holes in 1 row	38	38

The difference in length of two job is (4693 – 2830) 1863 mm, which is large and lot of time is required in setting job due to movement requirement of steady consuming extra manpower.

Due to the difference in length of two drums the time required for this process is 60 min excluding power failure and personal need time, which is very high and maximum manpower required for this process is 4.

Also it is observed that lot of time is wasted in waiting for the combination tool which was taken by another worker during the process. The total 69 mins were wasted in waiting for the combination device after cumulative time combination computation.

Breakdown element details are as per following

CNC block processing time results into low chord error and results into higher accuracy [5].

Table 6: Productive Time during machining

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Sr. No.	Unloading and Loading Activities	Time Taken in min
1.	Brining the crane in place	1 (Manpower 4)
2.	Declamping hydraulic cylinder	1
3.	Putting belt around the header and attaching to the crane	2
4.	Loosening the chuck of the tailstock	2
5.	Lifting the header using crane and keeping it at appropriate place	3
6.	Cleaning the burr	4
7.	Removing hydraulic connections of steady	2
8.	Moving the steady	1 (Manpower =2)
9.	Removing t-slot cover	1
10.	Cleaning the burr	2
11.	Sliding LHS steady and cleaning the burr	3
12.	Removing t-slot cover	1
13.	Removing the pneumatic connections of steady	2 (Manpower =2)
14.	Cleaning the burr	2

Sr. No.	Unloading and Loading Activities	Time Taken in (min)
15.	Sliding forward the tailstock and removal of hydraulic connections of tailstock	1 (Manpower = 3)
16.	Fixing hydraulic connection of tailstock	1
17.	Fixing the t-slot cover	3
18.	Fixing hydraulic and pneumatic connections of both the steadies	2
19.	Checking the connections and putting back the mat on the bed	5
20.	Personal Need	5 (Water Break)
21.	Setting the jaws of headstock	10 (Manpower =2)
22.	Brining the crane in place and loading the new header	6 (Manpower =2)
23.	Adjusting chuck and jaws of tailstock	5
24.	Referencing the machine due to power failure	4
25.	Brining Combination Device	2
26.	Checking of holes	1
27.	Work stopped due to unavailability of combination device	67

In third combination length of headers is reduced from 5097 to 5019, due to which steady does not have to be shifted which results in reducing the setting time [6,7,8].

Table 7: Processing time for second job

Sr. No.	Unloading and Loading Activities	Time Taken in (min)
1.	Loosening chuck on tailstock	4 (Manpower 2)
2.	Brining the crane in position to lift the header	3
3.	Putting belt around the header and attaching it to the crane	1
4.	Lifting the header and keeping it at appropriate place	4
5.	Setting jaws of headstock	8 (Manpower=2)
6.	Loading the new header using crane	4
7.	Adjusting the chuck and jaws of tailstock	5
8.	Removing the belt and taking the crane away from the machine	1
9.	Tightening the chuck of tailstock	6

The setting time for this drum is 36 min and manpower requirement is 2.

Therefore the reduction in time is 33 min (69-36) and manpower is 2 from 4 required.

The miscellaneous time noted during the result of adjustment of aligning the job sequence is

Table 8: Processing time for miscellaneous sequence

Sr. No.	Unloading and Loading Activities	Time Taken in (min)
1.	TBT Meeting	10
2.	House-keeping job	3
3.	Adjusting the bulb inside the machine arrangement and cleaning the glass window	3
4.	Checking the holes	2
5.	Waiting for combination device	3
6.	Bringing Combination	3
	Total Time	24 mins

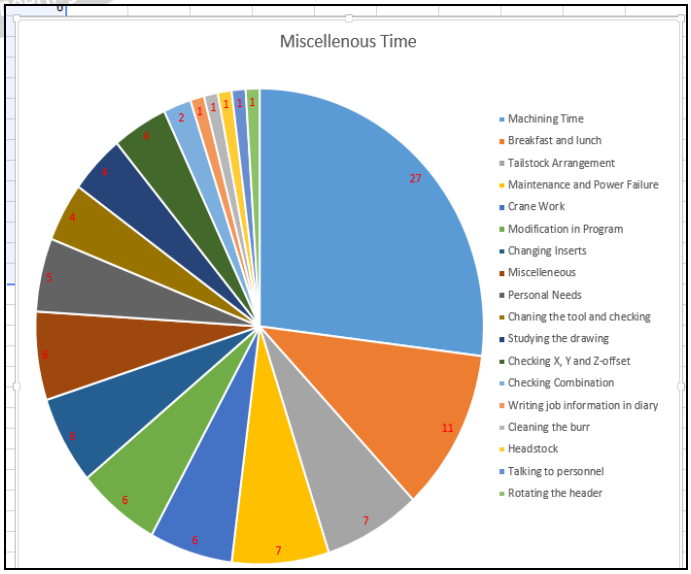

Fig 1:% Contribution of Miscellaneous Activities

The miscellaneous activities significantly contributes to the machining time and affects adversely.

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IV. Conclusion

It is observed that, correct housekeeping job and by arranging headers in order of minimum difference in their lengths, the productivity of the system can be increased. The uncertainty affects the production process. The resultant time study process reduced the miscellaneous time to 24 mins in two days shift from 69 mins.

Appendix

Data set for Fig 1

Parameters	% Contribution
Machining Time	27
Breakfast and lunch	11
Tailstock Arrangement	7
Maintenance and Power Failure	7
Crane Work	6
Modification in Program	6
Changing Inserts	6
Miscellaneous	6
Personal Needs	5
Changing the tool and checking	4
Studying the drawing	4
Checking X, Y and Z-offset	4
Checking Combination	2
Writing job information in diary	1
Cleaning the burr	1
Headstock	1
Talking to personnel	1
Rotating the header	1

Abbreviations

CNC – Computer Numerical Control

EOT – Electric Overhead traveling

ID – Inside diameter

OD- Outside diameter

MIN- MINIMUM

MAX – MAXIMUM

TBT – Todays big thing

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