ANALYSIS OF MACHINE MECHANICAL VARIABLES ON GEOMETRY WEAR TEST OF HSS TOOLS TYPE M2 HRC-66 USING THE TAGUCHI METHOD

Febi Rahmadian¹⁾, Eko Edy Susanto²⁾, Gerald A.P³⁾

Mechanical Engineering
National Institute of Technology Malang
Industrial Technology Faculty
Jalan Karanglo Km.2, Malang
Email : rahmadian15@gmail.com

Abstract

The selection of auxiliary chisels is required in a lathe process. Because if you use a chisel that is not suitable, it can cause damage to the workpiece or the chisel itself. A workpiece that is too hard can make the tool fast, because it is not able to process the workpiece optimally. Tool wear can occur naturally in the metal cutting process. The complexity surrounding tool wear stems from a variety of factors including the material or workpiece being serviced, machining tools, cutting tools, coolant and condition. In its development, the results of the lathe process are expected to produce a product that is precise and can be used optimally both in the manufacturing industry, automotive industry, and in the field of education. Things that are considered important in a product result but are found to have low roughness (smooth), accurate cuts, minimal cutting defects that can cause damage to objects and also the selection of tools that match the workpiece being turned on. Based on the analysis carried out on the effect of variations in the effectiveness of the M2 HRC-66 hss tool wear test and the ST-42 steel material surface roughness, it was found: The independent variable that most influences the effectiveness of the M2 HRC-66 type wear test based on Taguchi analysis is speed or RPM. The independent variable that has the most influence on the surface roughness of the st 42 steel material based on Taguchi's analysis is the depth of cut or Depth Of Cut. Comparison of variations in surface roughness of ST-42 steel material on the CNC EMCO TU 2A machine which produces the best results at 2000 rpm, 2 mm, and 2 revolutions/minute variables. Comparison of variations in tool wear of the M2 HRC-66 type on the CNC EMCO TU 2A machine that produces the best results at 2000 rpm, 2 mm, and 1.5 revolutions/minute variables.

Key Words ST 42 Steel, CNC, Surface Roughness

BACKGROUND

At present the use of machine tools is needed to make it easier for humans to meet their needs in the manufacturing industry. One of the machine tools that are often found in the middle and upper-scale manufacturing industry as well as in the field of education and training is the lathe. A lathe is one of the machine tools used to cut objects by inserting the workpiece or specimen into the cross section and then holding it so that the workpiece can rotate and cutting can occur on the object or specimen.

Lathe itself has a meaning that is a process of feeding or cutting the workpiece. The cutting is done by rotating the workpiece. Then the workpiece is applied to the chisel that has been placed parallel to the axis of rotation of the workpiece. The rotary motion of the workpiece placed on the cross section will produce a cutting motion which will produce a new surface on the workpiece. And the movement in the tool position is called translational movement where the tool moves on the same path where the path can be a straight line or not.

The selection of the chisel is very necessary in a lathe

process. Because if you use an inappropriate tool, it can cause damage to the workpiece or to the tool itself. A workpiece that is too hard can make the tool wear out quickly, because it is not able to process the workpiece optimally. Tool wear can occur naturally in the metal cutting process. The complexity surrounding tool wear stems from a variety of factors including the material or workpiece being processed, machining tool, cutting tool, coolant and cutting conditions.

In its development, the results of the lathe process are expected to produce a product that is precise and can be used optimally both in the manufacturing industry, automotive industry, and in the field of education. The things that are considered important in a lathe product are getting a low roughness (smooth), accurate cutting, at least defects in cutting that can cause damage to the object and also choosing the right tool for the workpiece being processed. turning (Karayel, 2009).

Based on some of the things above where the low roughness (fine) and the tool selection process is an important part of a lathe product. So the author took the initiative to make a comparison of a lathe result by

differentiating the speed of each feeding or cutting on the results of the lathe. Where the speed, cutting feed, and feed movement are made to vary. Which is expected to produce a low level of roughness (smooth) on the ST 42 steel workpiece being observed and lower the tool wear value of HSS M2 HRC-66.

LITERATURE REVIEW

Previous research

S. Thamizhmanii and S. Hasan (2006), conducted an analysis of roughness, force, and wear in turning gray cast iron. From the various tests that have been carried out, it shows that there is a decrease in the value of surface roughness at the cutting speed level and an increase in the feed rate.

A. Arunnath P. and Syeddu Masooth (2021), conducted a surface roughness analysis. The experimental results showed that the optimized values of the surface roughness were observed by feed rate of 0.10 mm/rev, depth of cut 0.5 mm, cutting speed of 800 rpm in a combination tiCN/Al₂O₃/TiN carbide tool. The optimal value of surface roughness (Ra) for coated carbide tools is 0.2534 m and for uncoated carbide tools is 0.5588 m.

B.Radha Krishnan and M.Ramesh (2020), conducted a study on surface roughness with the result that carbide cutting tools are preferred for cutting processes that have less wear and tear and maintain good strength during the machining process.

Lathe

The lathe is one of the most widely used machine tools in the manufacturing and automotive industries. Which is useful as a metal cutting machine or metal material cutting tool that has a characteristic where the material or workpiece is rotated in the cutting process. A lathe is a production machine that is used as a cylindrical shaper of the work material, but can also be used for other purposes such as cutting the workpiece, leveling the surface of the workpiece and making threads on the workpiece.

HSS Chisel

High Speed Steel chisel or the so-called HSS chisel is a tool that is very commonly used in the manufacturing industry, especially in machine tools. This type of chisel is one of the chisels that has a fairly high hardness. HSS tools are widely used in the manufacturing industry because their operational costs are not too high and they can be used several times for several materials.

The alloying elements used in the HSS chisel are among others Tungsten/tungsten (W), Chromium (Cr), Vanadium (V), Molybdenum (Mo) and Cobalt (Co). These elements give the HSS tool certain properties that are desired, such as increasing the hardness, wear resistance and strength of

the HSS tool used. These characteristics allow HSS tools to have higher cutting speeds and better performance on carbon steel materials.

Among the above factors, the use of HSS chisels is widely used for the cutting process of materials such as alloy steel, stainless steel, and materials that are resistant to high temperatures. And also generally HSS chisels are used as cutting tools if the workpiece has complex geometric conditions and requires several times of tool sharpening in the process.

ST steel 42

ST 42 steel is a low carbon steel containing chemical composition, Carbon (C): 0.07 – 0.1%, Silicon (Si) : 0.15 – 0.25%, Manganese (Mn): 0.3 – 0.6%, Phosphorus (P): 0.03% and added other elements (Callister, 2001). Generally ST 42 steel is used as general construction steel, building frame profile steel, motor vehicle frames, plates, pipes, etc. The structure of ST 42 steel which consists of ferrite and a little perlite causes this steel to have low tensile strength but high ductility.

The tensile strength of ST 42 steel is 42 Kg/mm². The tensile strength shows the maximum strength of toughness before the steel finally breaks. This tensile strength is the maximum ability of a material before the material breaks. Prior to fracture, it usually undergoes a change in shape which is initially elastic or can return to its original shape to become plastic. Plastic is a change in the nature of the steel material and cannot return to the original shape of the steel. This process affects the function of the steel and will not be optimal if the machining process is carried out.

Surface Roughness

Every surface of a workpiece that has undergone a machining process will experience surface roughness. Surface roughness is the arithmetic mean deviation from the surface mean line (Myers, 1962). These lines are used to determine the average of the surface roughness. In the manufacturing industry, the surface of a workpiece has different surface roughness values, according to the application of the workpiece and the processing process. Surface roughness values have different quality values (N). The surface roughness (Ra) values range from 0.0025 m to 50 m.

METHOD

The research method is a scientific method in research design to obtain certain data or information. The method used in this research are:

1. Literature and Field Studies

Literature Study and Literature Review aims to find references from theories that are linear with the problems found. As a basis for conducting research and strengthening the theoretical basis of testing

2. Experimental Method

By direct testing of the material/specimen to be studied.

Fig 1 Research flow diagrams

Table 1: Level Setting Factor

Rotation Per Minute	Depth Of Cut	Feed Rate
1000 rpm	1 mm	1 rev/min
1500 rpm	1,5 mm	1,5 rev/min
2000 rpm	2 mm	2 rev/min

Workpiece

Fig 2 Shape of the workpiece (a) before turning (b) after turning.

Fig 4 Taguchi Test Data Surface Roughness

Fig 5 Surface Roughness Test Graph

Taguchi Design

Taguchi orthogonal Array Design

L9(3**3)

Factors: 3
Runs: 9

columns of L9(3**4) Array

1 2 3

223

JREAS, Vol. 07, Issue 01, Jan 22

Taguchi Analysis: uji 1; uji 2; uji 3 versus rpm; doc; feed rate

Response Table for Signal to Noise Ratios
Smaller is better

Level	rpm	doc	feed rate
1	-6,646	-3,231	-6,324
2	-5,020	-6,099	-6,782
3	-9,865	-12,201	-8,426
Delta	4,844	8,971	2,102
Rank	2	1	3

Response Table for Means

Level	rpm	doc	feed rate
1	2,493	1,603	2,337
2	2,030	2,030	2,493
3	3,170	4,060	2,863
Delta	1,140	2,457	0,527
Rank	2	1	3

Taguchi Test Data Chisel Wear

Fig 7 Taguchi Test Data Chisel Wear

Taguchi Design

Taguchi Orthogonal Array Design

L9(3**3)

Factors: 3
Runs: 9

Columns of L9(3**4) Array

1 2 3

Taguchi Analysis: uji 1; uji 2; uji 3 versus RPM; DOC; Feed Rate

Response Table for Signal to Noise Ratios
Smaller is better

Level	RPM	DOC	Feed Rate
1	2,65209	0,81205	0,11101
2	-0,67766	-0,04227	-0,34116
3	-2,99501	-1,79036	-0,79043
Delta	5,64710	2,60241	0,90144
Rank	1	2	3

ISSN (Print): 2456-6411 | ISSN (Online): 2456-6403

10.46565/jreas.2022.v07i01.003

Response Table for Means

Level	RPM	DOC	Feed Rate
1	0,6456	0,8513	0,9587
2	0,9648	0,9408	1,0000
3	1,3317	1,1500	0,9834
Delta	0,6861	0,2987	0,0413
Rank	1	2	3

Fig 8 Chisel Wear Test Chart

Conclusion

Based on the results of the analysis carried out on the effect of variations in the effectiveness of the hss type M2 HRC-66 tool wear test and the surface roughness of the ST-42 steel material, it was found:

- The independent variable that has the most influence on the effectiveness of the M2 HRC-66 fatigue test based on Taguchi's analysis is cutting speed or RPM.
- The independent variable that has the most influence on the surface roughness of the st 42 steel material based on Taguchi's analysis is the depth of cut or Depth Of Cut.
- The comparison of variations in the surface roughness of ST-42 steel material on the CNC EMCO TU 2A

engine that produces the best results is at the variable 2000 rpm, 2 mm, and 2 rev/min.

- d. Comparison of variations in tool wear type M2 HRC-66 on the CNC EMCO TU 2A machine that produces the best results is at 2000 rpm, 2 mm, and 1.5 rev/min variables.

REFERENCES

- [1] Karayel, D., 2009. Prediction and control of surface roughness in CNC lathe using artificial neural network. *Journal of materials processing technology*, 209(7), 3125-3137.
- [2] Callister, W.D. Jr., 2001, *Fundamentals of Materials Science and Engineering*, 5th edition, John Wiley and Sons, Inc., USA.
- [3] A.ArunnathP. dan Syeddu Masooth, 2021, Optimization of process parameters in CNC turning process on machining SCM440 steel by uncoated carbide and TiCN/Al₂O₃/TiN coated carbide tool under dry conditions. <https://www.sciencedirect.com/science/article/pii/S221478532038322X>
- [4] Myers, N.O., 1962. Characterization of surface roughness. *Wear*, 5(3), pp.182-189.
- [5] B.Radha Krishnan dan M.Ramesh, 2020. Optimization of machining process parameters in CNC turning process of IS2062 E250 Steel using coated carbide cutting tool.<https://www.sciencedirect.com/science/article/pii/S2214785319314270>
- [6] Kurniawan, M. A., & Tjahjadi, G. (2016). PENGAMAN OTOMATIS KOMPOR GAS LPG SATU TUNGKU BERBASIS MIKROKONTROLER. 14, 19–34.
- [7] Kusbandono, W., & Untuk, C. (2015). Mesin Pengereng Pakaian Energi Listrik Dengan. *Snttm Xiv*, 7–8.
- [8] Mesin, J. T., Industri, F. T., Teknologi, I., & Nopember, S. (2006). Pengaruh Posisi Difuser dan Variasi Kecepatan Udara Masuk terhadap Distribusi Temperatur Ruang Terkondisi Sebuah Studi Numerik. *Jurnal Teknik Mesin*, 8(1), 1–7. <https://doi.org/10.9744/jtm.8.1.pp.1-7>
- [9] Novita, D. M., & Damanhuri, E. (2009). Perhitungan Nilai Kalor Berdasarkan Komposisi dan Karakteristik Sampah Perkotaan di Indonesia dalam Konsep Waste To Energy. *Jurnal Teknik Lingkungan*, 16(2), 103–114. <https://doi.org/http://dx.doi.org/10.5614/2Fjtl.2010.16.2.1>
- [10] kreith Frank, Prijono Arko., Prinsip - prinsip perpindahan panas., 1994, Penerbit Erlangga.Setyo Muji, Waluyo Budi, P. Candra Bagio, Munahar Suroto, Setyawan Chandra .I , K. W. Djoko, Efek Perubahan Komposisi LPG Terhadap Energy Delivery Pada Spark Ignition, www.researchgate.net , ISSN 2407-9189, 2017, Universitas Muhammadiyah Magelang, di akses pada 10:00 WIB, 9 Maret 2020.
- [11] Sukardi Chandrasa, Bendatu Monika, Laras, Pramesta Arie., Termodinamika Dasar Mesin Konversi Energi. , 2014, Universitas Mercubuana, ANDI.