Machining of AISI 52100 Steel: Statistical Insights into Dry Environment with Variable Tool Nose Radius

Songül KARABULUT[1], Rüstem BİNALİ[1]*, Mehmet Erdi KORKMAZ[2], Tayfun ÇETİN[3]

[1]Selçuk University, Faculty of Technology, Department of Mechanical Engineering, Konya
[2]Karabük University, Faculty of Engineering, Department of Mechanical Engineering, Karabük
[3] Hakkari University, Yüksekova Vocational School, Department of Electricity and Energy, Hakkari
*e-mail: rustem.binali@selcuk.edu.tr

DOI: 10.57244/dfbd.1708389
Geliş tarihi/Received: 28/05/2025 Kabul tarihi/Accepted:18/06/2025

Abstract

The present work studies the machinability of bearing steel, AISI 52100 in dry turning process with two different tool nose radius, i.e. 0.4 mm and 0.8 mm. A full factorial design was used to analyze the effect of cutting speed, feed, and depth of cut in terms of a cutting force, surface roughness, and energy consumption. The experimental data demonstrated that higher cutting forces and energy consumption always occurs when increasing the tool nose radius (0.8 mm), and the higher surface roughness in the case of the smaller (0.4 mm) nose radius. ANOVA and S/N ratio analysis indicated that the most important factor affecting cutting force was the feed rate of feed per tooth, and the depth of cut also had considerable effects on the surface roughness between the two depths of cut, particularly for the 0.4 mm radius tool. Although the trend in force and energy as a function of both radius were close to each other, the surface finish performance differed significantly. The results can be used in setting cutting parameters for high-hardness steels (AISI 52100) to balance productivity and surface quality.

Keywords: AISI 52100, Tool nose radius, Surface roughness, Cutting force, Energy Consumption

AISI 52100 Çeliğinin İşlenmesi: Değişken Takım Ucu Yarıçapına Sahip Kuru Ortama İlişkin İstatistiksel Bilgiler

Özet

Mevcut çalışma, iki farklı takım ucu yarıçapı, yani 0,4 mm ve 0,8 mm, ile kuru tornalama işleminde rulman çeliği, AISI 52100'ün işlenebilirliğini araştırmaktadır. Kesme hızı, ilerleme ve kesme derinliğinin kesme kuvveti, yüzey pürüzlülüğü ve enerji tüketimi açısından etkisini analiz etmek için tam faktöriyel bir tasarım kullanılmıştır. Deneysel veriler, takım ucu yarıçapı (0,8 mm) artırıldığında her zaman daha yüksek kesme kuvvetlerinin ve enerji tüketiminin meydana geldiğini ve daha küçük (0,4 mm) burun yarıçapı durumunda daha yüksek yüzey pürüzlülüğünün meydana geldiğini göstermiştir. ANOVA ve S/N oranı analizi, kesme kuvvetini etkileyen en önemli faktörün diş başına ilerleme hızı olduğunu ve kesme derinliğinin de özellikle 0,4 mm yarıçaplı takım için iki kesme derinliği arasındaki yüzey pürüzlülüğü üzerinde önemli etkileri olduğunu göstermiştir. Her iki yarıçapa bağlı olarak kuvvet ve enerjideki eğilim birbirine yakın olsa da, yüzey kalitesi performansı önemli ölçüde farklılık göstermiştir. Sonuçlar, üretkenlik ve yüzey kalitesini dengelemek amacıyla yüksek sertlikteki çelikler (AISI 52100) için kesme parametrelerinin ayarlanmasında kullanılabilir.

Anahtar Kelimeler: AISI 52100, Takım ucu yarıçapı, Yüzey pürüzlülüğü, Kesme kuvveti, Enerji tüketimi

Introduction

AISI 52100 is a bearing steel, and it is a high carbon chromium alloy steel with high wear resistance, high hardness and good strength. Thanks to its high wear resistance and strength, it is preferred in jobs requiring strength such as metalworking, aircraft engines and fastening jobs. The high hardness ratio increases the resistance of materials made of this material to surface fatigue, while allowing it to be actively used for many years in a way that will be resistant to corrosion together with the chromium alloy. With the addition of chromium to the high carbon ratio, the material offers equal hardness and strength on the surface. This allows it to be used in jobs that will meet difficult requirements while providing structural integrity. The high hardness of 52100 steel can cause quick breakage due to its limitation of flexibility. In this case, a stronger structure is obtained by changing its microstructures with the necessary heat treatment processes and used in bearing production machines and the automotive sector. Steels quenched with the tempering method are heated, and after heat protection, a cooling process is carried out in air, oil or water. Tempering increases the workability of the steel and minimizes brittleness. 52100 steel can be easily machined, but being harder than the reference steel wears out the mold faster, making it more difficult to machine. Therefore, considering that there may be differences in the first mass production of the tool produced and the final mass production, as well as changes in the technological developments of the tools produced with the developing technology, it is necessary to continue the experiments by taking into account factors such as each machine and each condition (Azizi et al., 2012; Uğur et al., 2022; Demirpolat et al., 2023).

Machinability input parameters are; cutting speed, feed rate, cutting environment, depth of cut. However, the most common ones are cutting speed, depth of cut, feed rate (Binali et al., 2022; Gupta et al., 2023; Günay et al., 2017; Işik et. al., 2024; Turan et al., 2025; Korkmaz et al., 2019; Özlü, 2022; Machado et. al., 2024; Yamaner and Kul, 2025). Many studies have been done on this subject. These studies are as follows; Demirpolat et al. have examined the effects of machining parameters on surface roughness, cutting temperature and cutting force in turning AISI 52100 steel in their experiments. As a result of the experiments, machining of bearing steel at high cutting speed decreased the surface roughness value, it was seen that the most effective factor on surface roughness was the feed rate followed by the depth of cut, and the most effective parameter in increasing the temperature value was the depth of cut (Demirpolat et al., 2023).

Tool life refers to the time between the moment the cutting tool starts cutting the workpiece and the time the tool tip becomes unworkable (Cook, 1973; Khadka et al., 2025; Mikolajczyk et al., 2022). When the tool life is long, the tool is changed less frequently. This ensures more efficient production and therefore reduces costs. As the tool life decreases, the cutting efficiency of the cutting tips decreases, reduces the surface quality of the workpiece, and causes rapid wear of the machines. Cutting tools with long tool life should be preferred for high quality workpieces.

Agar et al. have examined the cutting tool life of AISI 52100 bearing steel with the ultrasonic turning method in their experiments. As a result of the study, it was seen that the increase in cutting speed in all machining methods caused the cutting tool life to decrease. It was determined that the highest tool life occurred in ultrasonic turning performed at 30 kHz in all cutting speeds, and the lowest tool life occurred in conventional turning. It was observed that increasing vibration frequency values in ultrasonic turning caused the cutting tool life to increase, and CBN cutting tools exhibited longer tool life than carbide cutting tools in all machining methods and cutting speed values (Çaydaş et al., 2017). Motorcu experiment dealt with the predictive modeling of the surface roughness obtained in the turning of AISI 52100 steel with uncoated ceramic, coated ceramic and coated carbide cutting tools. As a result of the experiment, it was observed that the most effective parameter on the surface roughness was the feed rate, the surface roughness improved at the lowest value of the cutting speed and the highest value of the cutting depth, but this situation was not parallel with the increase in the cutting speed. In the machinability experiments, it was observed that coated and uncoated ceramic tools showed better surface roughness results than coated carbide tools under all cutting conditions. It was predicted that this situation could be explained by the minimum plastic deformation of the ceramic tools (Motorcu, 2013). Çaydaş et al. investigated the machinability of AISI 52100 bearing steel according to the surface roughness, tool life and temperature criteria in their experiments. In their experiments, they turned by applying global heat treatment as the medium and by applying a small amount of lubrication. It has been found that the tool life of the samples with spheroidizing heat treatment is increased when they are machined with ceramic tools at low cutting speeds. In addition, the machinability of the material is also increased by applying the spheroidizing heat treatment. Surface roughness values decreased with the increase in cutting speed. While better quality surfaces were obtained in spheroidized samples, it was observed that the type of cutting tool did not have a significant effect on the surface roughness. In general, in this experiment, the processes were carried out under dry machining conditions (Çaydaş et al., 2017). Siraj R. et al. investigated the formulation techniques in regression analysis to estimate tribological parameters in hard turning of AISI 52100 steel. As a result of the experiment, it was concluded that tribological parameters have a high effect on roughness, and the most effective parameters are speed, feed and depth of cut. In this research, the experiments were carried out in wet flat turning process on CNC lathe (Siraj et al., 2016). Biček et al. In their experiments, cryogenic machining was considered as an alternative turning process of normalized and hardened AISI 52100 bearing steel. As a result of the experiments, it was observed that cryogenic machining significantly extended the tool life of the cutting inserts and increased their productivity. On the other hand, cryogenic machining of normalized bearing steel increased the tool life more than machining of hardened bearing steel (Biček et al., 2012). Azizi et al. investigated the effects of cutting parameters and workpiece hardness of AISI 52100 steel on surface roughness and cutting force components in their experiments. As a result of the experiment, it was observed that surface roughness increased with the increase in feed rate and decreased with the increase in workpiece hardness. It was concluded from the experiment that the most important factors affecting the cutting forces in general were the depth of cut, workpiece hardness and feed rate (Azizi et al., 2012).

In the studies, evaluations were generally made on force and temperature. These evaluations were generally made according to dry and MQL environments. Our innovation in our study is that the effect of two different tool nose radius was evaluated graphical and statistically in the machinability tests in dry conditions. In this case, the effect of the nose radius will give an idea about the effect of the output parameters.

Material and Method

The AISI 52100 steel used in the experiments was selected as 100 mm in processing length and 40 mm in diameter. The cutting tools used were TiC coated CCMT-09T308 and CCMT-09T304 with PVD method. The full factorial method was used for the experiments of cutting speed, cutting depth, feed rate and tool nose radius parameters. A total of 16 experiments were conducted, 8 for each nose radius. All experiments were conducted in the Central Laboratory-2 of the Mechanical Engineering Department of Selcuk University, Faculty of Technology. The input and output parameters used in the machinability tests of AISI 52100 material are given in Figure 1. Mahr Perthometer M1 was used for surface roughness, TelC DKM 2000 for cutting force and KAEL Multiser 02 PC TFT Network Analyzer for energy consumption.

The values obtained as a result of the experiments were evaluated both graphically with the Excel program and ANOVA. ANOVA analyses were performed using Minitab. The processing parameters of the AISI 52100 material are given in Table 1, and its chemical composition is given in Figure 2. Additionally, the experimental setup is given schematically in Figure 3.

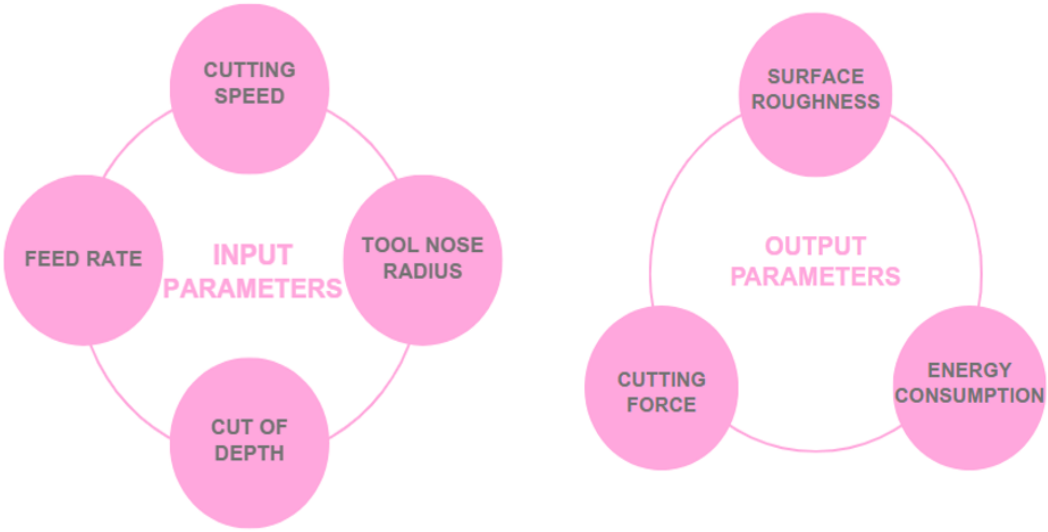

Figure 1. Input and Output Parameters of AISI 52100 Material.

Table 1. Cutting parameters for 52100

Cutting parameters	**Levels**
Cutting Speed (m/min)	40-50
Feed Rate (mm/rev)	0.1-0.15
Depth of cut	0.1-0.2
Tool nose Radius	0.4-0.8

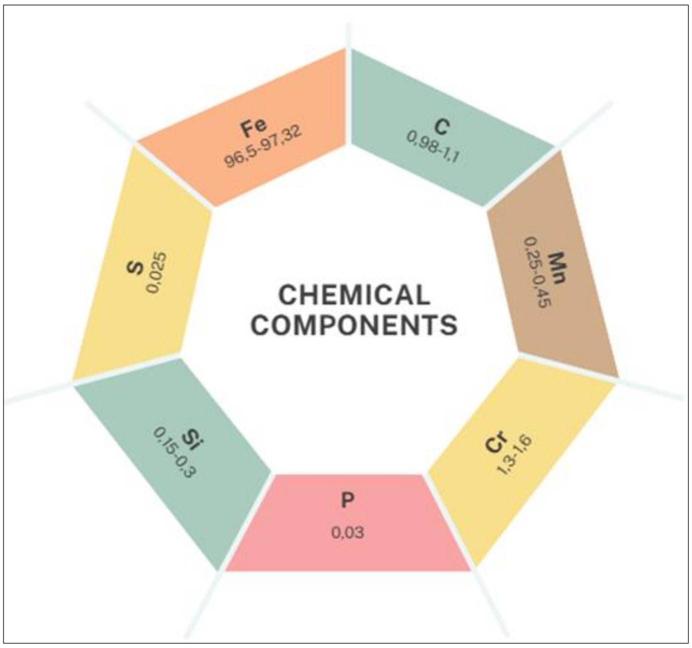

Figure 2. Chemical components for AISI 52100.

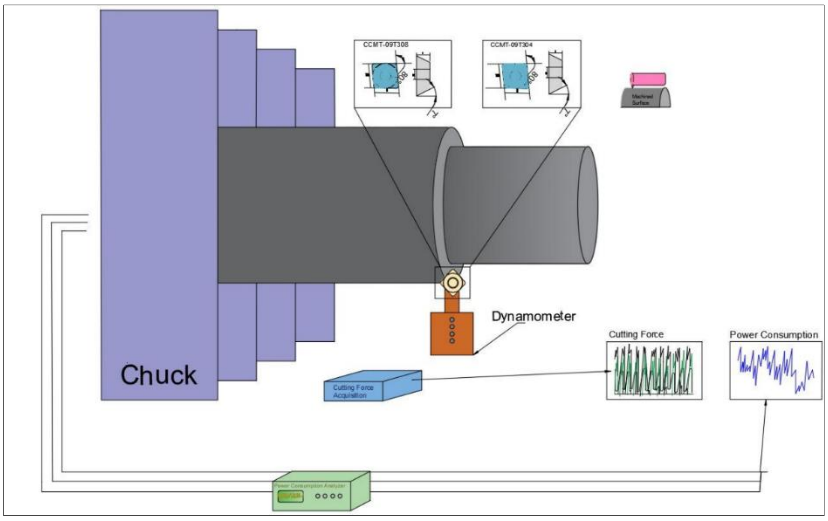

Figure 3. Experimental setup.

Results

Experimental results are shown in the cutting force graph in Figure 4, surface roughness graph in Figure 5 and energy consumption graph in Figure 6. The cutting force is the evaluation output used in the machinability tests (Özlü, 2021; Kul and Yamaner, 2025). Cutting force directly affects tool life in machining. Operations performed at high cutting forces shorten tool life due to rapid wear of the tool. Cutting force also directly affects other parameters. As a result of good analysis of cutting forces, efficiency of parameters such as cutting speed and feed rate increases.

When Figure 4 is examined, it is seen that cutting force changes depending on cutting depth, cutting speed, feed rate and tool nose radius. The maximum cutting force value for 0.8 tool nose radius was obtained in experiment number 7 with 0.2 mm depth of cut, 40 m/min cutting speed and 0.2 mm/rev. The maximum cutting force value for 0.4

tool nose radius was reached in experiment number 7 with 0.2 mm depth of cut, 40 m/min cutting speed and 0.2 mm/rev. For both tool nose radius, under constant speed, increasing the depth of cut caused the cutting force to increase, while increasing the cutting speed caused the cutting force value to decrease.

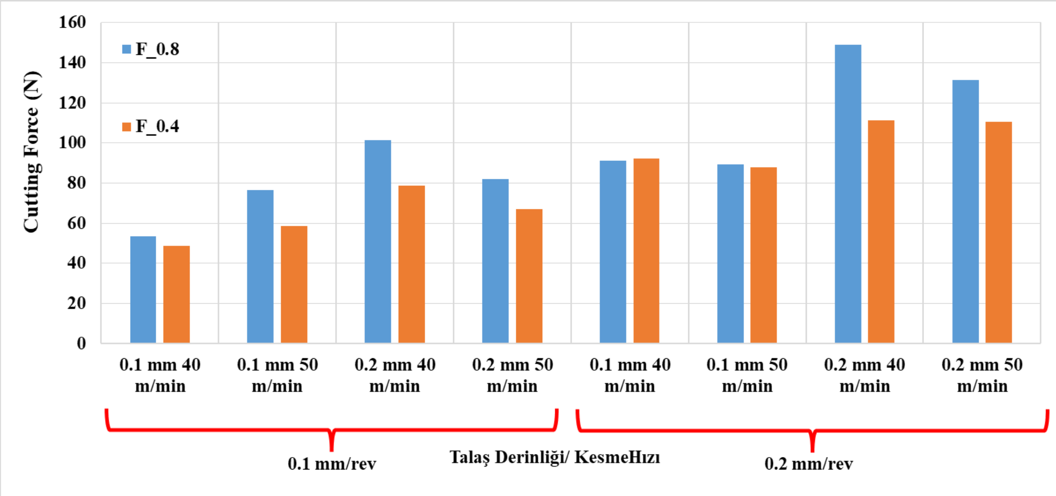

Figure 4. Cutting force results.

Surface roughness is an important parameter for the durability of the material (Kuntoglu, 2022; Salur, 2022; Machado et. al., 2024). While low surface roughness allows the material to work more easily with other parts, high roughness causes more friction and causes breakage in the part. This reduces tool life (Kuntoglu, 2022). Evaluation was made by measuring the average surface roughness (Ra) values created according to ISO 4287. When Figure 5 is examined, it is seen that the experiment in which the maximum surface roughness was reached for 0.8 tool nose radius was experiment number 7, where 0.2 mm depth of cut, 40 m/min cutting speed and 0.2 mm/rev conditions were applied. The maximum surface roughness value for 0.4 tool nose radius was obtained in experiment number 7, where 0.2 mm depth of cut, 40 m/min cutting speed and 0.2 mm/rev were applied.

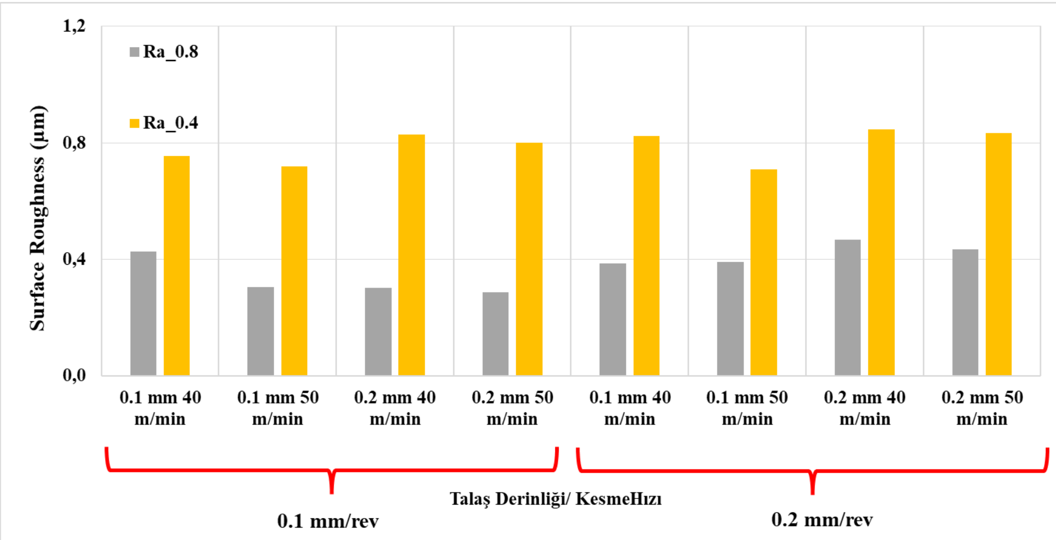

Figure 5. Surface roughness results.

In the surface roughness results, it was observed that the depth of cut and cutting speed decreased with the increase of the cutting depth under 0.1 fixed speed for 0.4 tool nose radius. Under 0.2 fixed speed, it increased with the increase of the cutting speed at 0.1 mm depth of cut, while the increase of the cutting speed at 0.2 mm depth of cut caused the surface roughness to decrease.

Energy consumption is quite important in terms of cost (Binali et al., 2022; Binali et al., 2025). It is directly affected by parameters such as cutting force. High cutting force causes more energy consumption. Thus, a more costly process is performed. Energy analysis provides an understanding of how efficiently the machines operate. Necessary improvements and optimizations can be made to machines that consume more energy than normal. As a result of examining Figure 6, the maximum energy consuming experimental data for the experiments where 0.8 tool nose radius was used was reached in experiment number 8 with 0.2 mm depth of cut, 50 m/min cutting speed, and 0.2 mm/rev values. The maximum energy consumption experimental data for 0.4 tool nose radius was also seen in experiment number 8, which has the values of 0.2 mm depth of cut, 50 m/min cutting speed, 0.2 mm/rev. In the energy consumption change graph, it is seen that the increase in cutting speed and depth of cut under the constant feed rate of 0.1 and 0.2 for both tool nose radius increases the energy consumption.

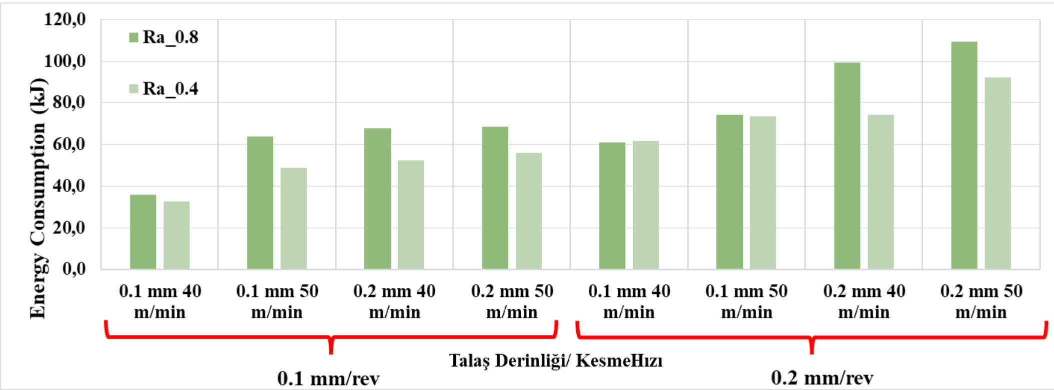

Figure 6. Energy consumption results.

Statistical Evaluation

Evaluation for the cutting insert radius of 0.8

According to the average S/N graph as a result of the surface roughness given in Figure 7, optimum results were achieved at values where the slope was low. The effect orders in Table 2 are indicated by rank. When the graph is examined, it is understood that the factors that affect the surface roughness the most are feed rate, cutting speed, and cutting depth, respectively. Cutting depth is the parameter where the slope has the lowest value, so the second level of feed rate and cutting depth and the first level of cutting speed can be used to reach the optimum value.

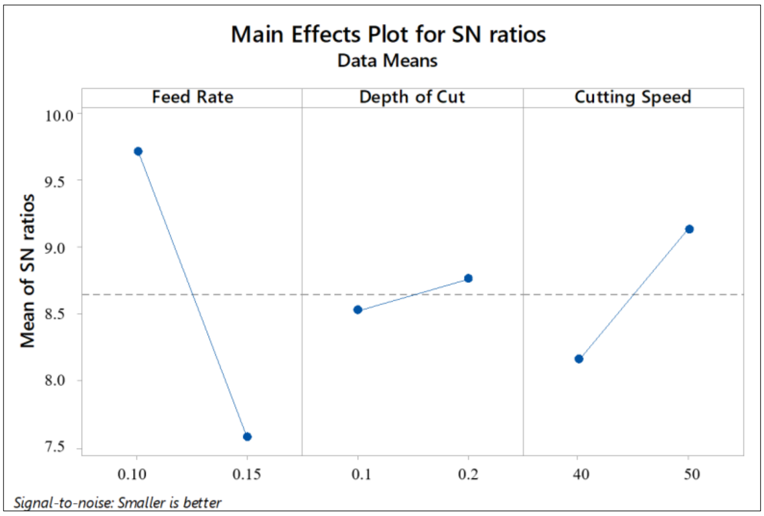

Figure 7. S/N graph for surface roughness.

Table 2. Average S/N response for surface roughness.

Level	Feed Rate	Depth of Cut	Cutting Speed
1	9.716	8.529	8.156
2	7.574	8.762	9.134
Delta	2.142	0.233	0.978
Rank	1	3	2

The results of the ANOVA analysis for surface roughness are given in Table 3. When examined according to this table, the order of the effect values, as in S/N, is the feed rate, cutting speed and cutting depth. Significance levels are expressed with P-value (Binali et al, 2024; Kuntoğlu and Sağlam, 2019; Güneş et. al., 2021; Mutlu et. Al., 2022). However, since the P-values are greater than 0.05, it is seen that it is not significant. The decision of whether it is significant alone cannot be determined with a single output parameter value. Although the P-values obtained in the analysis are above 0.05 and are not statistically significant, the fact that the P-value of the feed rate is quite close to this limit and the effect size is higher than the other parameters shows that this parameter can have a practically important effect on surface roughness.

Table 3. ANOVA for surface roughness.

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Feed Rate	1	9.1790	9.1790	9.1790	5.04	0.088
Depth of Cut	1	0.1088	0.1088	0.1088	0.06	0.819
Cutting Speed	1	1.9136	1.9136	1.9136	1.05	0.363
Residual Error	4	7.2861	7.2861	1.8215		
Total	7	18.4875				

The average S/N graph for cutting force is given in Figure 8. The optimum values of cutting force are obtained in places where the slope is low. The parameter with the lowest slope is the cutting speed. The most effective parameter in achieving optimum results is the feed rate and cutting speed (Table 4), the second level of feed rate and cutting depth can be used, while the first level of cutting speed can be used.

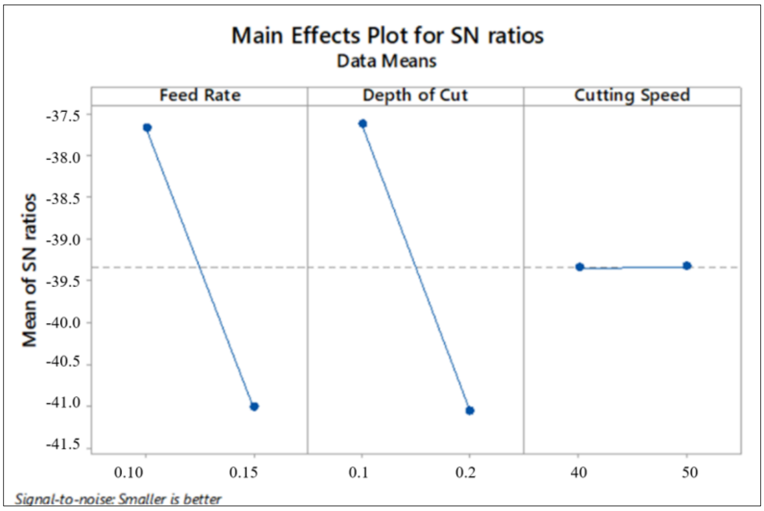

Figure 8. S/N graph for cutting force.

Table 4 Average S/N response for surface roughness.

Level	Feed Rate	Depth of Cut	Cutting Speed
1	-37.67	-37.62	-39.35
2	-41.01	-41.06	-39.33
Delta	3.34	3.45	0.01
Rank	2	1	3

Anova analysis for cutting force is given in Table 5. When the table is examined, it is seen that the feed rate and cutting depth are significant with a P-value less than 0.05. The fact that the effect value of the cutting speed is 0.00 can be expressed that the cutting speed can be neglected in the effect ratios.

Table 5. ANOVA for cutting force

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Feed Rate	1	22.3643	22.3643	22.3643	12.02	0.026
Depth of Cut	1	23.7905	23.7905	23.7905	12.79	0.023
Cutting Speed	1	0.0002	0.0002	0.0002	0.00	0.992
Residual Error	4	7.4403	7.4403	1.8601		
Total	7	53.5953				

Evaluation for the cutting insert radius of 0.4

The average S/N results of surface roughness for 0.4 tool nose radius are given in Figure 9. When the graph is examined, it is seen that the optimum results are approached at low slope and the most effective parameters in this are cutting depth, cutting speed and feed rate, respectively (Table 6). The lowest slope was encountered at feed rate. It was concluded that the optimum value could be reached by using the first level of cutting speed and the second level of feed rate and cutting depth.

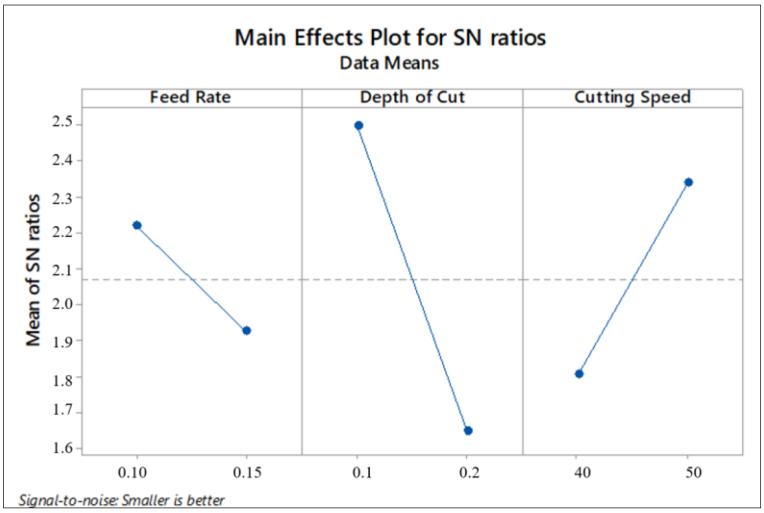

Figure 9. S/N plot for surface roughness.

Table 6. Average S/N response for surface roughness

Level	Feed Rate	Depth of Cut	Cutting Speed
1	2.221	2.497	1.805
2	1.924	1.648	2.340
Delta	0.297	0.848	0.535
Rank	3	1	2

In the ANOVA given in Table 7, it can be stated that the depth of cut is significant and the feed rate has a negligible effect rate.

Table 7. Anova analysis for surface roughness

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Feed Rate	1	0.1760	0.1760	0.1760	1.73	0.259
Depth of Cut	1	1.4398	1.4398	1.4398	14.16	0.020
Cutting Speed	1	0.5723	0.5723	0.5723	5.63	0.077
Residual Error	4	0.4068	0.4068	0.1017		
Total	7	2.5949				

The average S/N graph of the cutting force for a 0.4 tool nose radius is given in Figure 10. The optimum result was approached at low inclination. The lowest inclination was reached at cutting speed. The most effective parameters in achieving the optimum result are feed rate, cutting depth, and cutting speed, respectively. The optimum value can be reached by using the second level of feed rate and cutting depth and the first level of cutting speed (Table 8).

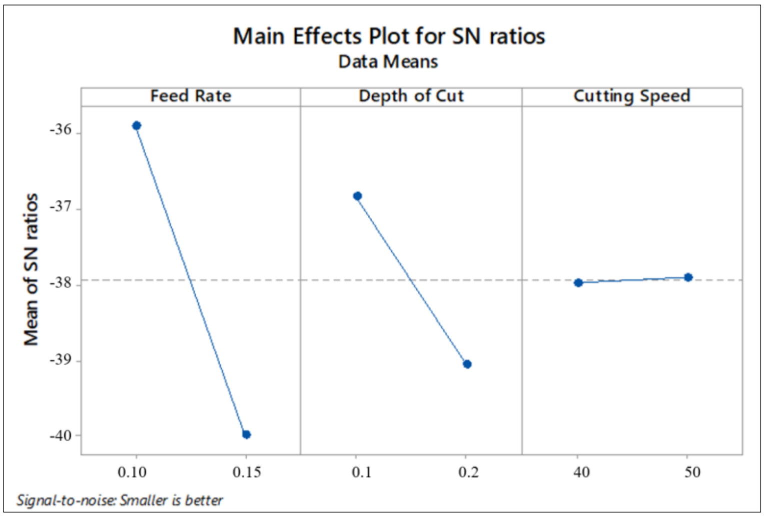

Figure 10. S/N graph for cutting force

Table 8. Average S/N response for cutting force

Level	Feed Rate	Depth of Cut	Cutting Speed
1	-35.88	-36.82	-37.97
2	-40.00	-39.05	-37.90
Delta	4.12	2.22	0.07
Rank	1	2	3

According to the ANOVA in Table 9, the input parameters used to achieve significant results in the cutting force values of feed rate and cutting depth are suitable. It can be stated that the cutting speed is at a negligible level with an effect ratio of 0.01.

Table 9. ANOVA for cutting force

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Feed Rate	1	33.8980	33.8980	33.8980	50.14	0.002
Depth of Cut	1	9.9001	9.9001	9.9001	14.64	0.019
Cutting Speed	1	0.0099	0.0099	0.0099	0.01	0.909
Residual Error	4	2.7045	2.7045	0.6761		
Total	7	46.5125				

Conclusion

In this study, the force, roughness and energy consumption results obtained in the turning of AISI 52100 bearing steel according to two different tool nose radius were evaluated both graphically with the Excel program and with ANOVA analysis. The following conclusions were made as a result of the obtained values.

Under all conditions, the cutting force gave higher results at 0.8 tool nose radius.

In all change tables, the maximum results were reached at the same values for both tool nose radius. These values are in the experiment where 0.2 mm depth of cut, 40 m/min cutting speed and 02 mm/rev values were accepted.

The highest surface roughness values for all experiments were reached at 0.4 tool nose radius.

In all applied conditions, the energy consumption results were higher at 0.8 tool nose radius.

In the energy consumption and cutting force change results, the two tool nose radius generally produced closer results to each other compared to the surface roughness parameter.

Low slope factor is valid for optimum value in all S/N results.

In ANOVA results, it was seen that the most effective parameter for both tool nose radius was depth of cut for surface roughness and feed rate for force.

The significance level in Anova results was generally below 0.05.

In the Anova results, it was concluded that the most effective parameter for cutting force at 0.8 nose radius was the depth of cut with 12.79%, and the most effective parameter for surface roughness was the feed rate with 5.04%.

In the Anova results, it was concluded that the most effective parameter for cutting force at 0.4 nose radius was the feed rate with 50.14%, and the most effective parameter for surface roughness was the depth of cut with 14.16%.

In ANOVA results, it was seen that when it is desired to reach optimum value for all graphs, it can be reached by using second level of feed rate and depth of cut and first level of cutting speed.

To conduct such studies more comprehensively, analysis can be done with machine learning.

References

Azizi, M. W., Belhadi, S., Yallese, M. A., Mabrouki, T., & Rigal, J. F. (2012). Surface roughness and cutting forces modeling for optimization of machining condition in finish hard turning of AISI 52100 steel. *Journal of mechanical science and technology*, *26*, 4105-4114.

Biček, M., Dumont, F., Courbon, C., Pušavec, F., Rech, J., & Kopač, J. (2012). Cryogenic machining as an alternative turning process of normalized and hardened AISI 52100 bearing steel. *Journal of Materials Processing Technology*, *212*(12), 2609-2618.

Binali, R., Yaldız, S., & Neşeli, S. (2022). Investigation of power consumption in the machining of S960QL steel by finite elements method. *European Journal of Technique (EJT)*, *12*(1), 43-48.

Binali, R., Yaldız, S., & Neşeli, S. (2024). Finite element analysis and statistical investigation of S960ql structure steel machinability with milling method. *Journal of the Brazilian Society of Mechanical Sciences and Engineering*, *46*(5), 260.

Binali, R., Patange, A. D., Kuntoğlu, M., Mikolajczyk, T., & Salur, E. (2022). Energy saving by parametric optimization and advanced lubri-cooling techniques in the machining of composites and superalloys: A systematic review. *Energies*, *15*(21), 8313.

Binali, R., Korkmaz, M. E., Özdemir, M. T., & Günay, M. (2025). A Holistic Perspective on Sustainable Machining of Al6082: Synergistic Effects of Nano-Enhanced Bio-Lubricants. *Machines*, *13*(4).

Cook, N. H. (1973). *Tool wear and tool life*.

Çaydaş, U., Kuncan, O., & Çelik, M. (2017). AISI 52100 rulman çeliğinin işlenebilirliğinin yüzey pürüzlülüğü, takım ömrü ve sıcaklık kriterlerine göre araştırılması. *Politeknik dergisi*, *20*(2), 409-417.

Demirpolat, H., Kaya, K., Binali, R., & Kuntoğlu, M. (2023). AISI 52100 Rulman Çeliğinin Tornalanmasında İşleme Parametrelerinin Yüzey Pürüzlülüğü, Kesme Sıcaklığı ve Kesme Kuvveti Üzerindeki Etkilerinin İncelenmesi. *İmalat Teknolojileri ve Uygulamaları*, *4*(3), 179-189.

Gupta, M. K., Niesłony, P., Korkmaz, M. E., Królczyk, G. M., Kuntoğlu, M., Pawlus, P., ... & Sarıkaya, M. (2023). Potential use of cryogenic cooling for improving the tribological and tool wear characteristics while machining aluminum alloys. *Tribology International*, *183*, 108434.

Günay, M., Korkmaz, M. E., & Yaşar, N. (2017). Finite element modeling of tool stresses on ceramic tools in hard turning. *Mechanics*, *23*(3), 432-440.

Güneş, A., Şahin, Ö. S., Düzcükoğlu, H., Salur, E., Aslan, A., Kuntoğlu, M., ... & Pimenov, D. Y. (2021). Optimization study on surface roughness and tribological behavior of recycled cast iron reinforced bronze MMCs produced by hot pressing. *Materials*, *14*(12), 3364.

Işik, U., Demir, H., & Özlü, B. (2024). Multi-objective optimization of process parameters for surface quality and geometric tolerances of AlSi10Mg samples produced by additive manufacturing method using taguchi-based gray relational analysis. *Arabian Journal for Science and Engineering*, 1-19.

Khadka, S., Rahman Rashid, R. A., Stephens, G., Papageorgiou, A., Navarro-Devia, J., Hägglund, S., & Palanisamy, S. (2025). Predicting cutting tool life: models, modelling, and monitoring. *The International Journal of Advanced Manufacturing Technology*, 1-40.

Korkmaz, M. E., Çakıroğlu, R., Yaşar, N., Özmen, R., & Günay, M. (2019). Al2014 alüminyum alaşımının delinmesinde itme kuvvetinin sonlu elemanlar yöntemi ile analizi. *El-Cezeri*, *6*(1), 193-199.

Kul, B. S., & Yamaner, A. S. A Comparative Evaluation of Dry-MQL Turning Applications for AISI 5115 Steel. *Manufacturing Technologies and Applications*, *6*(1), 23-32.

Kuntoğlu, M., & Sağlam, H. (2019). Investigation of progressive tool wear for determining of optimized machining parameters in turning. *Measurement*, *140*, 427-436.

Kuntoglu, M. (2022). Machining induced tribological investigations in sustainable milling of Hardox 500 steel: A new approach of measurement science. *Measurement*, *201*, 111715.

Kuntoğlu, M. (2022). Measurement and analysis of sustainable indicators in machining of Armox 500T armor steel. *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, *236*(13), 7330-7349.

Machado, A. R., da Silva, L. R. R., Pimenov, D. Y., de Souza, F. C. R., Kuntoğlu, M., & de Paiva, R. L. (2024). Comprehensive review of advanced methods for improving the parameters of machining steels. *Journal of Manufacturing Processes*, *125*, 111-142.

Mikolajczyk, T., Paczkowski, T., Kuntoglu, M., Patange, A. D., & Binali, R. (2022). Research on using an unconventional tool for increasing tool life by selective exchange of worn cutting edge. *Applied Sciences*, *13*(1), 460.

Motorcu, A. L. İ. (2013). AISI 52100 Çeliğinin Farklı Kesici Takımlarla Tornalanmasında Yüzey Pürüzlülüğünün Tahminsel Modellenmesi. *1. Genç İstatistikçiler Sempozyumu* 10-11 Eylül 2013 – Hacettepe Üniversitesi – ANKARA

Mutlu, B., Binali, R., Demirsöz, R., & Yaşar, N. (2022). Machinability of CoCrMo Alloy used in Biomedical applications: Investigation of Cutting Tool Type. *Gazi Mühendislik Bilimleri Dergisi*, *8*(2), 215-227.

Özlü, B. (2021). Sleipner soğuk iş takım çeliğinin tornalanmasında kesme parametrelerinin kesme kuvveti, yüzey pürüzlülüğü ve talaş şekli üzerine etkisinin incelenmesi. *Gazi Üniversitesi Mühendislik Mimarlık Fakültesi Dergisi*, *36*(3), 1241-1252.

Özlü, B. (2022). Evaluation of energy consumption, cutting force, surface roughness and vibration in machining toolox 44 steel using taguchi-based gray relational analysis. *Surface Review and Letters*, *29*(08), 2250103.

Salur, E. (2022). Understandings the tribological mechanism of Inconel 718 alloy machined under different cooling/lubrication conditions. *Tribology International*, *174*, 107677.

Sayyed Siraj, R., Dharmadhikari, H. M., & Kshirsagar, J. M. Formulation Techniques in Regression Analysis to Estimate the Roughness Value from Tribological Parameters in Hard Turning of AISI 52100 Steels.

Turan, İ., Özlü, B., Ulaş, H. B., & Demir, H. (2025). Prediction and Modelling with Taguchi, ANN and ANFIS of Optimum Machining Parameters in Drilling of Al 6082-T6 Alloy. *Journal of Manufacturing and Materials Processing*, *9*(3), 92.

Uğur, L., Kazan, H., & Özlü, B. (2022). Investigation of the Impacts of Cutting Parameters on Power Usage in Cryogenic-Assisted Turning of AISI 52100 Bearing Steel by FEM. *İmalat Teknolojileri ve Uygulamaları*, *3*(3), 55-61.

Yamaner, A. S., & Kul, B. S. (2025). Evaluation of tool radius and machining parameters on cutting forces and surface roughness for AA 6082 aluminum alloy. *European Mechanical Science*, *9*(2), 125-138.