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Research Article

THE INFLUENCE OF COOLANT TYPES ON SURFACE ROUGHNESS IN THE TURNING PROCESS

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ABSTRACT

To lessen the friction that forms between the tool and the workpiece during the turning process, a variety of coolants are utilized. Each coolant type has benefits and drawbacks. The kind of coolant used directly affects how smooth or rough the surface of workpiece is. Two popular types of coolants were employed in this investigation. Emulsion is a mixture of 90% water and 10% oil. The first operation employed this kind of coolant. For the second procedure, synthetic oil is employed as coolant. The third procedure, known as a dry operation, uses no coolant to compare various types. The identical tools and conditions were utilized in all three types of operations to create 30 pieces of work for each. To obtain the results, each sample was evaluated using a surface roughness tester. The findings of this investigation indicated that when it comes to surface roughness, emulsion operations are the best coolant to employ.

KEYWORDS

Surface quality, machining coolants, turning process, lathing operation, emulsion, synthetic oil.

INTRODUCTION

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The study aims at the influence of coolant and coolant types on surface quality and surface roughness in the turning process. It is based on applied research with a special focus on literature review and research methodology. The literature review is based on a brief overview of the coolants and the types of coolants. The impact of coolants on surface quality and surface roughness in the machining process is also explained.

The methodological experiment of this study focused on the machining operations of the CNC machines through the usage of two different types of coolant and dry operation. The first coolant type that been used is oil and the second coolant type is an emulsion. After using each coolant, the surface roughness of the produced parts been checked and tested. The tests that will be applied are surface roughness based on the tester methods.

Turning is a process that removes unwanted materials in the form of rotational parts. This process is achieved through turning machines, cutting tools, and workpieces (Junior, Schueller, Pinto & Villibor 2020). CNC turning is computer-controlled, where the bars are held and rotated, and the tool is used in the piece to create a perfect shape and remove the material. In the cutting processes, traditional machining helps in removing particles and other materials from different surfaces in the workpiece in the form of chips. The process of conventional machining includes steps like drilling, boring, turning (Liew, Shaaroni, Sidik, & Yan 2017).

On the other hand, CNC or Computer numerical controlled machines are used to operate machine tools such as mills and lathes. For meeting specifications and requirements, the CNC machines cut and shape the raw materials and are a wide part of the manufacturing process (Maurya, Niranjan, & Dwivedi 2021). It performs complex tasks, and that is why it is widely used in the manufacturing industry.

The main impact of coolant in the CNC machines is to create a cooling effect on the workpiece and the grinding wheel. The mixture of water and oil is the widely used coolant type where water prevents rusting, and oil provides a great lubricant. Experimental investigation of thermal performance of engine coolant oil and water in helical coil heat exchanger. This mixture brings optimal results and also prevents thermal breakdown (Maurya, Niranjan, Maurya, & Dwivedi 2021). Apart from lubrication and cooling, this coolant type is environmentally safe. In machining operations, coolants are used as they reduce the possibility of friction and its effects.

In the turning process, surface roughness in a workpiece is impacted due to various machining parameters like cutting speed, cutting depth, and feed rate. Other factors include tool wear, tool coating, tool material, etc. Machining conditions also impact the surface roughness like dry turning or wet turning and the rigidity of machine tools (Devaraj, Malkapuram & Singaravel, 2021). Depending on the dimension and cutting of the workpiece, the coolant type is matched and applied. The right choice of coolant based on the type of machine through maintenance proper concentration levels can be enhanced in the life of tools, coolant, and the machine can be extended. MQCL is regarded as an effective cooling method as it helps in reducing cost and pollution and increases the overall functioning and performance. The cutting speed in the case of MQCL coolant decreases and then is increased gradually, thereby improving the machining process (Özbek & Saruhan 2020).

The functions of the coolant are based on the transfer of heat from the engine to the radiator. Coolant also

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helps in protecting boiling and freezing temperature and also from corrosion and rust.

For improving the surface roughness, the coolant will require a dynamic viscosity. Furthermore, high rates of evaporation can also help in improving the cooling effects. Geometric factors like tool shape, operations also influence the surface finish. Metrology causes surface roughness. Breakage of the workpiece during the cutting of metals and operations leads to surface variations and roughness. Irregularities in the shape of the machine tool led to surface roughness. Cooling of the machinery tools is very important as it will lead to the reduction of unnecessary heat effects and will also prevent the workpiece from corrosive effects. It also stabilizes the physical, chemical, and technical aspects involved in machining and turning (Li et al. 2019).

LITERATURE REVIEW

Coolants play an important function in the machining systems that include turning, grinding, and milling. They are essential in extending the quality of the tools and help in refurnishing by improving the surface finish of machined parts. Proper maintenance of the concentration levels helps in extending the quality of the coolants, machines, and tools (Fatima & Mativenga 2017).

There are 4 distinct categories of liquid Coolants, and they have various formulations. Based on the overall performance of the machines, the right coolant is selected in relevance to the materials used and the machining application.

According to Abdulkareem, Ogedengbe, Aweda, & Khan (2017), Soluble Oils are the most widely used cutting fluid, and it is water-soluble. It is commonly used for machining purposes. However, the drawbacks that lie are that these coolants often cause microbiological fungus growth and also bacterial growth if the coolant is not properly maintained. After the coolant is mixed with water, it forms an emulsion. These coolants are cost-effective and are widely used in industries for their good performance in lubrication and the diluted form.

As mentioned by Ejieji, Adedayo, Bello & Abdulkareem (2018), synthetic fluids provide the least lubrication and are the cleanest cutting fluid as they do not contain mineral oil and tramp oil. To prevent corrosion, they are formulated with inorganic compounds and additives. In the diluted form, these coolants provide the best results. From various cutting fluids, synthetic fluids provide the best cooling features. Synthetic fluids are mainly designed for the future.

As opined by Ejieji, Adedayo, Bello, & Abdulkareem (2018), cutting fluids in CNC machines help in machinery improvement and smooth functioning. Although the straight oils have poor cooling features, these types of coolants cannot be specifically mixed in water, and they have either a mineral or petroleum-based composition. They also contain various kinds of lubricants- fats, oils, and vegetables. These are non-emulsifiable for which they are in an undiluted form. Sometimes the straight oils may contain phosphorus and other additives.

As stated by Naje, Jasim, & Alfatlawy (2021), semi-synthetic coolants are used for broader machining purposes and contain less oil compared to other emulsion fluids. However, they retain the same lubrication, and they do not have a foul smell which makes them much more usable. These coolants are a mixture of synthetic fluids and soluble oils.

Furthermore, the liquid coolants are mainly used for preventing rusts and the capacity to function with

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thermal resistivity and various metals (Islam & Motaleb, 2019). Other types of coolants are gels, aerosols, and carbon-dioxide coolants. Gels or paste are used for drilling operations like sawing metal. Aerosols are cutting fluids where the air has tiny liquid drops that are thoroughly scattered. CO_2 coolant is another type of coolant where the application is performed through liquid pressurization.

In recent times, attention has been given during the turning operations for improved functioning, such as the cooling of the surfaces with a good finish. To analyze the surface quality, various types of coolants are used in the turning process. In the turning process, a good surface can be achieved through better cutting speed. High-pressure coolants are used for improving the surface finishes of machines. During the machining operations, a lot of heat is generated, which affects the surfaces and makes them all rougher. The use of coolants helps in releasing the heat and the chips that are formed during turning. According to Kaynak et al. (2018), the MQCL or minimum quantity coolant or lubrication has a productive impact on the surface quality. In the machining processes, along with surface quality, coolants enhance the tool life. In hard machining, cryogenic cooling is effective. On the other hand, a combination or a mixture of carbon dioxide snow and MQL are used for the improvement of chip breaking while turning titanium alloys. Although, it has also been recommended that CO_2 increases the greenhouse pollution effects, and that is why this coolant should not be used. As stated by Ogedengbe, Abdulkareem, & Aweda (2018), for machined parts, surface finish is a significant characteristic. If the temperature in the coolants is reduced during machining, then it will automatically improvise the surface finishes.

MATERIAL AND METHODS

This experiment is carried out through the machining operations of CNC machines with the use of two types of coolants and dry operations. The first type of coolant is a synthetic oil, and the second type is an emulsion which is a mixed of a 10% oil and 90% water. The three operations have same operation parameter and materials to produce 30 samples each. Each operation has a new finishing insert tool. The surface roughness of the produced parts (samples) checked after using every type of coolant. The tests used are surface roughness and hardness by surface roughness tester and hardness tester respectively. The results been extracted, and the impact of the different type of the three operations been known by test every 5 samples of 30 Samples for each operation.

In this work, a bar of steel made of the low-alloy steel with dimensions of 23 mm diameter and 3000 mm long were used as a raw material. The hardiness of it is 55.5 HRA (300 HB).

With three operations of turning, each operation produced 30 samples. Each sample were a cylindrical shape with dimensions of 22 mm diameter and 30 mm length as a final sample. figure 1 show the dimension and the shape of the samples.

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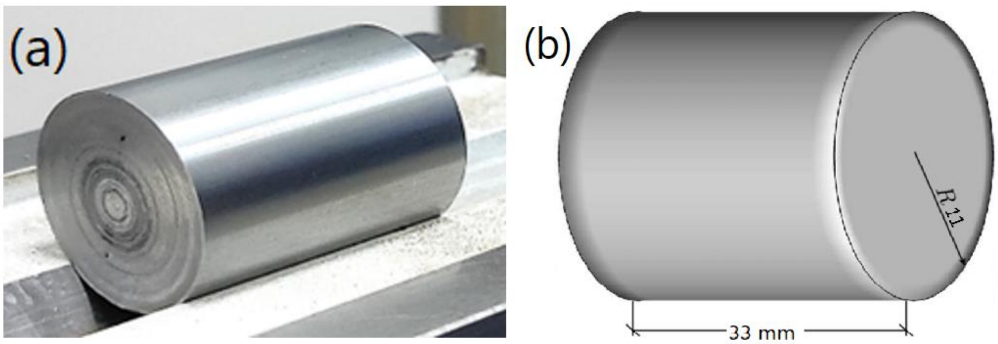

Figure 1. (a) The workpiece (final sample), (b) 3D schematic object.

The raw material used in this work is 42CrMo4 which is a typical round chromium-molybdenum steel with high hardenability and intensity that is typically utilized after quenching and tempering. High fatigue strength and exceptional low-temperature impact toughness are further properties of the 42CrMo4 alloy. The 42CrMo4 alloy steel is frequently used in engineering applications, including the production of shafts, gears, drill collars for oil exploration, and various types of machinery, automobile, and mining spare parts. It is also used to make connecting rods, pinchcocks under high pressure, and parts for power train applications. The 42CrMo4 alloy steel chemical composition of eight materials show in table 1 and mechanical properties show in table 2.

Table 1. The 42CrMo4 Alloy the chemical composition.

Element	C	Mn	Si	P	S	Cr	Mo
Composition %	0.38-0.45	0.60-0.90	0.40 max	0.035 max	0.035 max	0.90-1.20	0.15-0.30

Table 2. The 42CrMo4 alloy steel the mechanical properties.

Size Ø	Yield Stress	Ultimate tensile Stress	Elongation	Hardness	Toughness
<40 mm	750	1000-1200 N/m^2	11 %	295-355 HB	35 $J \cdot m^{-3}$ at 20ºC

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The work was done with a bunch of necessary equipment. The equipment includes machines, liquids and tools. The machines were used are CNC turning machine, surface roughness tester and hardiness tester. The liquids were used in this work are synthetic oil and emulsion as coolants. The tools used in this experiment are finishing and cut-off tools.

In the production process known as CNC turning, material bars are held in a chuck and rotated while a tool is being fed to the piece to remove material until the required form is attained. Subtraction machining is another name for the process, which involves removing material in order to create the required shape. In this work, the machine was used is a lathe with three movement axis and tow chuck heads (Dual-Spindle). The axis present horizontal movement called X axis. The axis present vertical movement called Z axis. The axis present rotational movement with 360° called Y axis. The specification of the machine summarized in table 3.

Table 3. The CNC lathe machine specifications.

Specs	Spindle Max Speed.	Spindle Nose	Federate Rapid on Z	Federates Rapids on X and Y	Max Cutting Diameter	Max Cutting Length
Value	4500 rpm	A2-6	24.0 m/min	12.0 m/min	457 mm	584 mm

The machining oil used in this experiment is a chlorine-free metal processing oil which is suitable as machining oil for all turning and milling operations, as thread cutting oil and for hobbing of higher alloyed gear-tooth materials. It is also used for operations on higher alloyed steel materials and stainless steel. Table 4 is showing the specification of the machining oil.

Table 4. The specification of the machining oil.

Specs	Form	Density: at 15°C	Viscosity: at 40 °C	Solubility in water	Flash point	Ignition temperature
Value	liquid	0.87 g/cm³	16 mm²/s	insoluble	180 °C	210 °C

Emulsifiable oil, also known as soluble oil, is a concentration that has a percentage of oil ranging from 50% to 85% (even was a petroleum oil or an oil with a natural source such as vegetable). In this work, the mixing percentage is 85 oil and 15 water. After blending with water, it usually looks milky or opaque. The emulsion used for metal cutting processes on individual machine tools as well as centralized systems. It is a special formulation result in high coolant stability

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and long coolant life. This emulsion with active EP-additives ensures long tool life and often allow to reduce concentration. The specification of the used emulsion showing in table 5

Table 5. The specification of the used emulsion.

Specs	Form	Density at 15°C	Kinematic Viscosity at 20 °C	Solubility in water	Corrosion protection GG25	pH (5%)
Value	liquid	0.98 g/cm³	252 mm²/s	soluble	4% no corrosion	9.5

For machining the samples, a finishing turning tool used in this work. The insert of the tool is made of carbide with high machining specs as show in table 6 and technical illustrations show in figure 2.

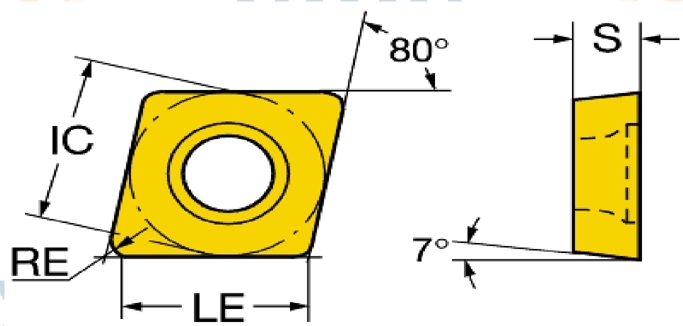

Figure 2. Tool insert's technical illustrations.

Table 6. The specification of the tool insert.

Specs	Inscribed circle diameter (IC)	Cutting edge effective length	Corner radius (RE)	Insert thickness (S)	Coating	Grade
Value	9.525 mm	9.271 mm	0.396 mm	3.97 mm	PVD TiAlN+TiN	1025

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A field or laboratory tool for determining an index of refraction is a refractometer (refractometry). The index of refraction then makes it possible to calculate the concentration for mixes using mixing laws. In this work we used a hand refractometer (figure 3) which an analogue tool for calculating the refractive index of a liquid is a typical portable refractometer. By using prisms and lenses to cast a shadow line onto a tiny glass reticule inside the instrument, it operates on the critical angle concept. The user then views the shadow line through a magnifying eyepiece.

Table 7. The specification of the handle refractometer.

Specs	Size (mm)	Weight (g)	Measurement range (%)	Measurement accuracy (%)	Minimum scale (%)	Division value (%)
Value	40 x 40 x 198	175	Brix 0 - 18	+/-0.1	0.1	0.2

Figure 3. The handle refractometer.

Roughness gauges, which are often referred to as surface roughness testers (figure 4), have a stylus with a tiny, smooth contact point that can be used to trace the surface of a workpiece to measure minute abnormalities. The surface measurements are displayed on the LCD screen. This tester can measure three types of measurement (measured roughness depth (Rz), mean roughness value (Ra) and (Rt) maximum peak to valley height) in micrometers or microns (μm).

Table 8. The specifications of the surface roughness tester.

Specs	Measuring principle	Accuracy class DIN 4772	Measuring range/resolution	Process temperature	Max relative humidity
Value	surface tracing	Class 1	± 8 mkm/1 nm	+10°C … + 45°C	85%

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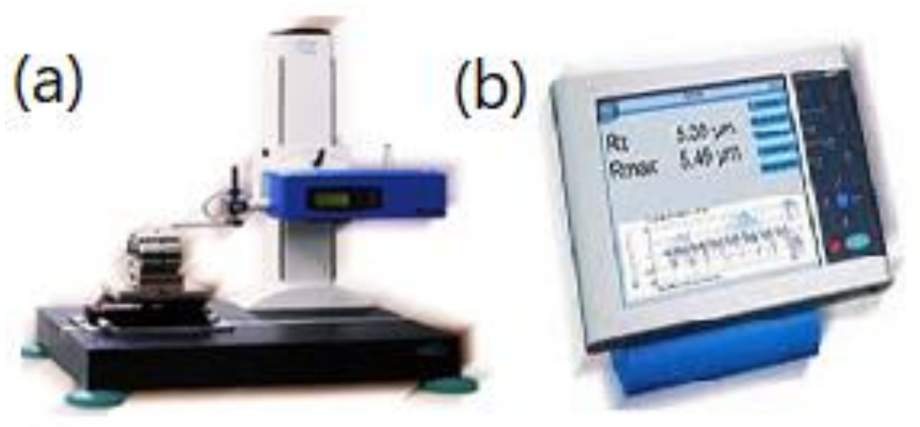

Figure 4. a) The surface roughness tester, b) surface roughness tester software interface.

The chosen of the machining parameters depend on certain factors. These factors include material type of the sample, the kind of tool and the operation type. Other factor such as depth of cut and length of cut are taken place. The parameters are Speed of rotation (n), Cutting speed (Vc), sample diameter (d), and Feed rate (Vf).

Table 9. The parameters of the machining.

Parameter	Spindle speed	Cutting speed	Feed rate	Depth of cut
Value	4000 rpm	180 m/min	0.8	0.5mm

RESULTS

The surface texture or surface roughness of a substance can be rapidly and precisely determined using the data from a roughness tester. The roughness tester shows the measured roughness depth (Rz) as well as the mean roughness value (Ra) and maximum peak to valley height (Rt) in micrometers or microns (µm) of samples for each three different operations. The tested samples are sample number 1, number 5, number 10, number 15, number 20, number 25, And number 30 for each operation.

Table 10 shows the mean roughness value (Ra) results of the tested samples.

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Table 10. The Ra results of Dry operation.

Sample Number	1	5	10	15	20	25	30
Value of Ra (µm)	0.59	0.66	0.71	0.74	0.96	1.13	1.19

The results start from 0.59 µm with sample number 1 and end with value 1.19 µm as shown in figure 5.

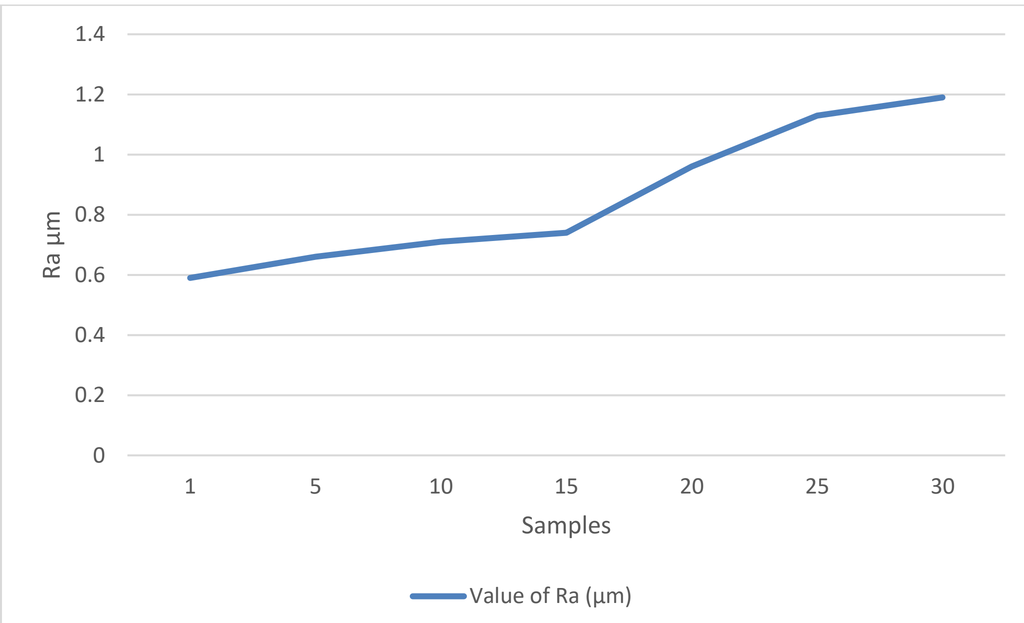

Figure 5. The Ra results of dry operation curve.

The maximum peak to valley height (Rt) results of the tested samples shows in table 11.

Table 11. The Rt results of Dry operation.

Sample Number	1	5	10	15	20	25	30
Value of Rt (µm)	3.83	4.1	4.22	5.33	5.57	5.99	6.93

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The results start from 3.83 µm with sample number 1 and end with value 6.93 µm as shown in figure 6.

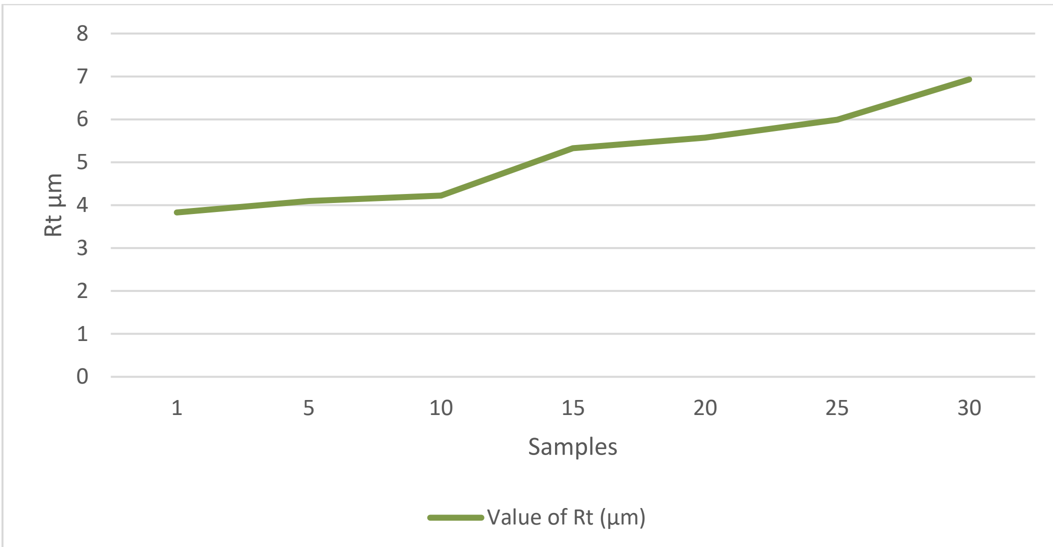

Figure 6. The Rt results of dry operation curve.

The roughness depth (Rz) results of the tested samples show in table 12.

Table 12 The Rz results of Dry operation.

Sample Number	1	5	10	15	20	25	30
Value of Rz (µm)	3.18	3.49	4.29	4.47	5.09	5.44	5.59

The results start from 3.18 µm with sample number 1 and end with value 5.59 µm as shown in figure 7.

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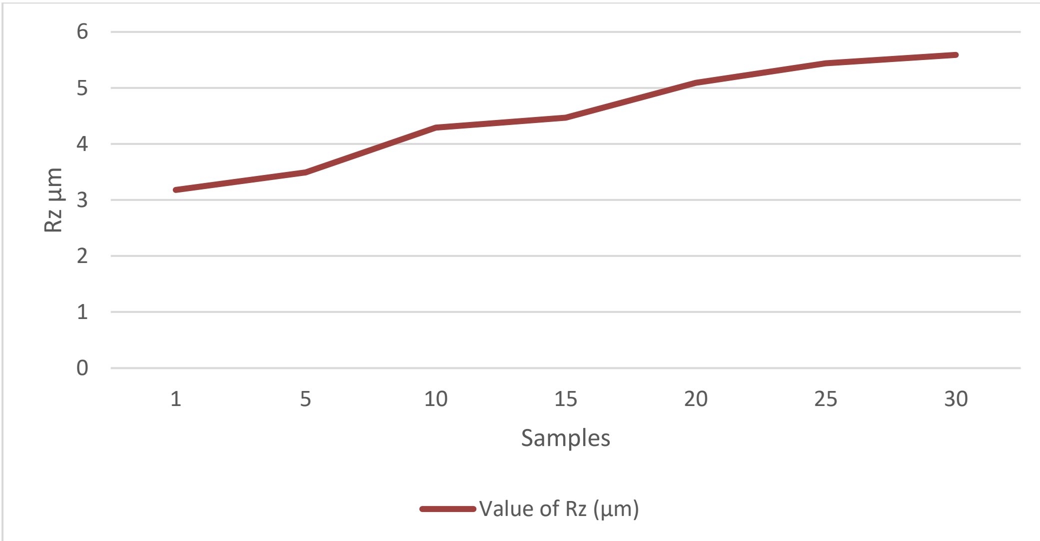

Figure 7. The Rz results of dry operation curve.

Table 13 show the results of the mean roughness value (Ra) for tested samples for turning operation using emulsion coolant.

Table 13. The Ra results of emulsion coolant operation.

Sample Number	1	5	10	15	20	25	30
Value of Ra (µm)	0.46	0.69	0.82	0.97	1.07	1.11	1.14

The results start from 0.46 µm with sample number 1 and end with value 1.14 µm as shown in figure 8.

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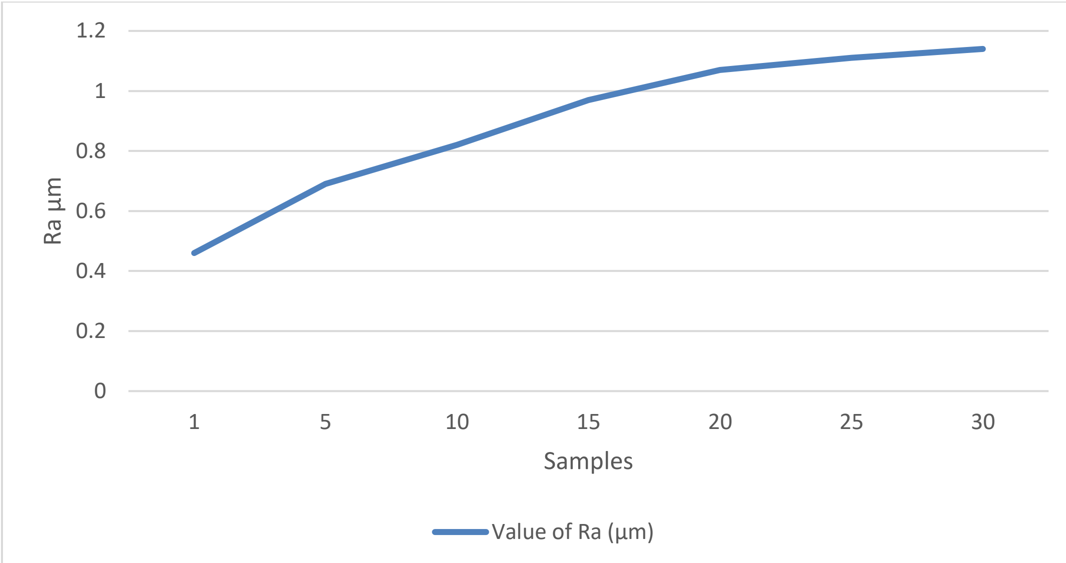

Figure 8. The Ra results of emulsion coolant operation curve.

The maximum peak to valley height (Rt) results of the tested samples shows in table 14.

Table 14. The Rt results of Emulsion Coolant operation.

Sample Number	1	5	10	15	20	25	30
Value of Rt (µm)	3.92	4.71	5.71	6.02	6.59	6.85	6.90

The results start from 3.92 µm with sample number 1 and end with value 6.93 µm as shown in figure 9.

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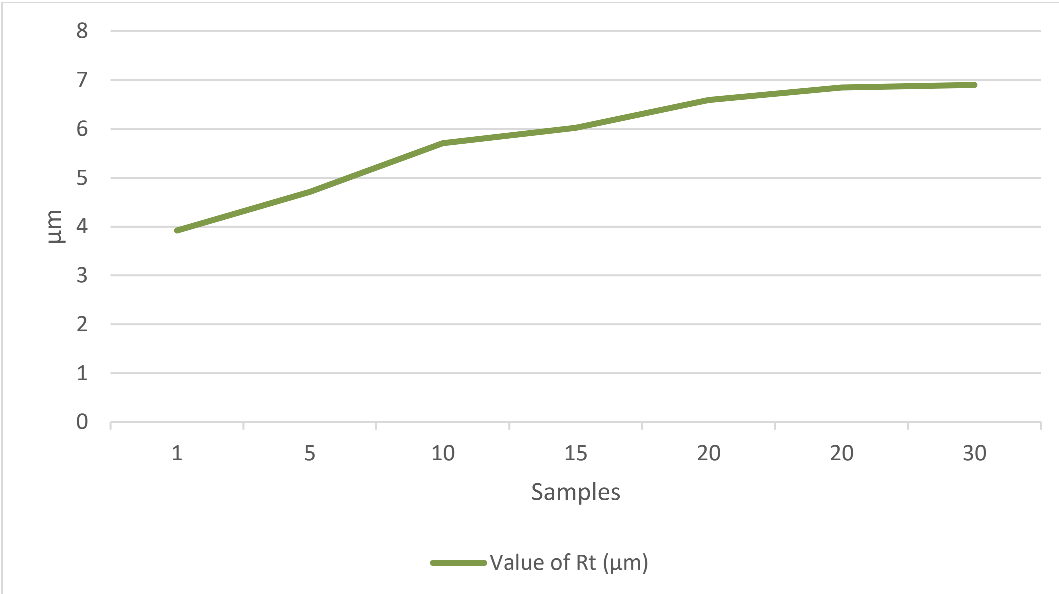

Figure 9. The Rt results of emulsion coolant operation curve.

The roughness depth (Rz) results of the tested samples show in table 15.

Table 15. The Rz results of Emulsion Coolant operation.

Sample Number	1	5	10	15	20	25	30
Value of Rz (µm)	3.43	4.31	5.28	5.72	5.74	5.88	5.97

The results start from 3.43 µm with sample number 1 and end with value 5.97 µm as shown in figure 10.

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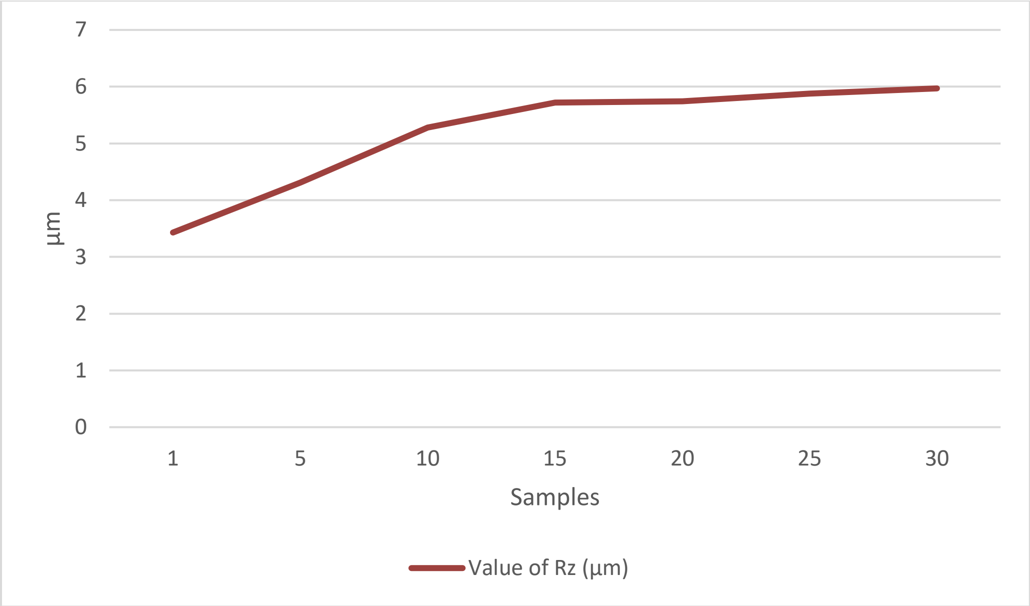

Figure 10. The Rz results of emulsion coolant operation curve.

Table 16 show the results of the mean roughness value (Ra) for turning operation using a synthetic oil coolant.

Table 16. The Ra results of Oil Coolant operation.

Sample Number	1	5	10	15	20	25	30
Value of Ra (µm)	0.73	0.89	0.99	1.06	1.12	1.15	1.17

The results start from 0.73 µm with sample number 1 and end with value 1.17 µm as shown in figure 11.

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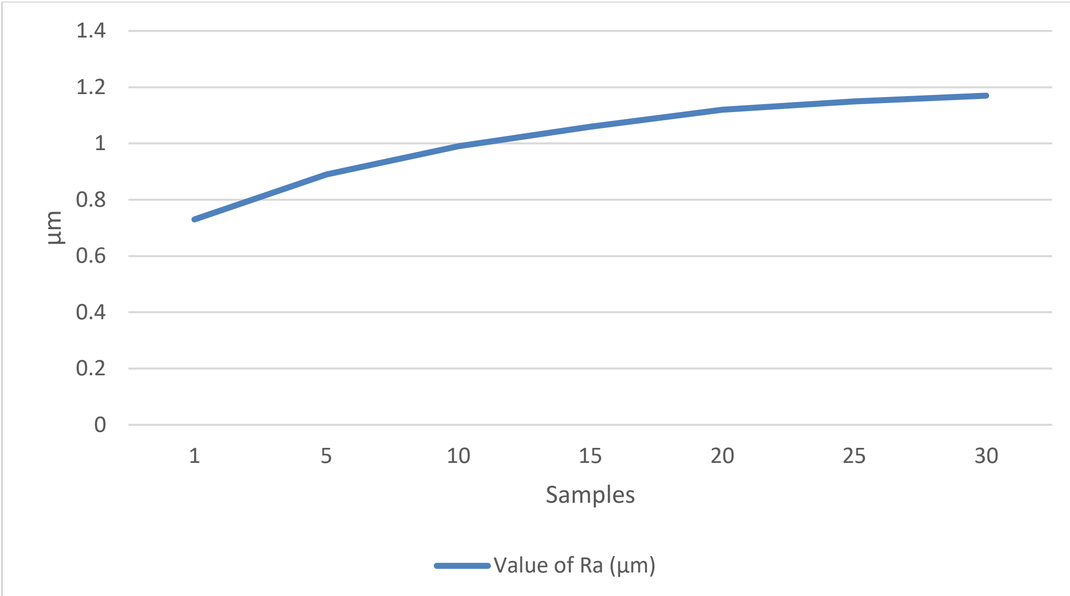

Figure 11. The Ra results of oil coolant operation curve.

The maximum peak to valley height (Rt) results of the tested samples shows in table 17.

Table 17. The Rt results of Oil Coolant operation.

Sample Number	1	5	10	15	20	25	30
Value of Rt (µm)	4.29	5.06	5.75	5.9	6.05	6.25	6.74

The results start from 4.29 µm with sample number 1 and end with value 6.74 µm as shown in figure 12.

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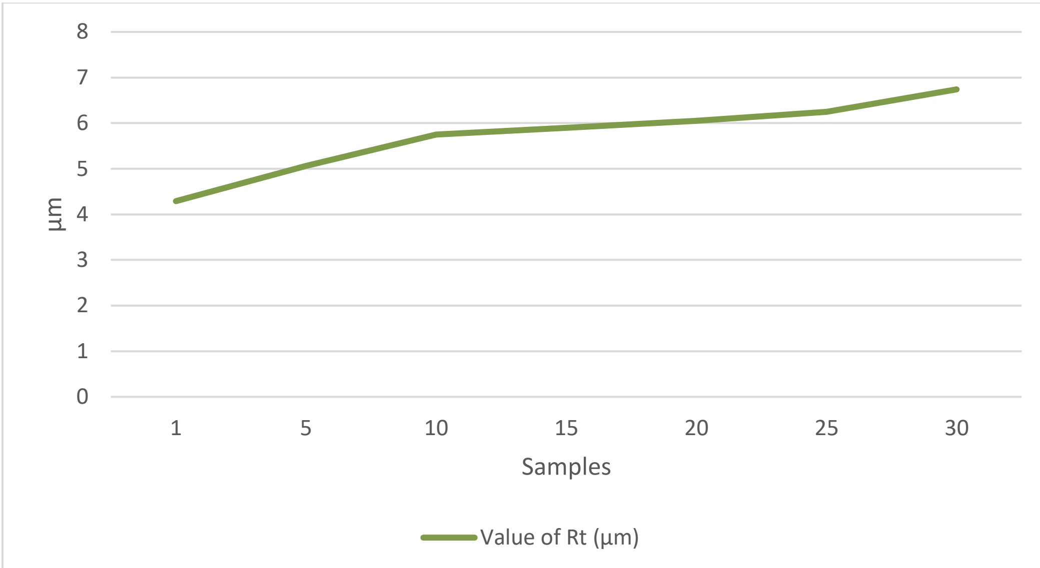

Figure 12. The Rt results of oil coolant operation curve.

The roughness depth (Rz) results of the tested samples show in table 18.

Table 18. The Rz results of Oil Coolant operation.

Sample Number	1	5	10	15	20	25	30
Value of Rz (µm)	4.11	4.59	4.94	5.1	5.32	5.7	5.77

The results start from 4.11 µm with sample number 1 and end with value 5.77 µm as shown in figure 13.

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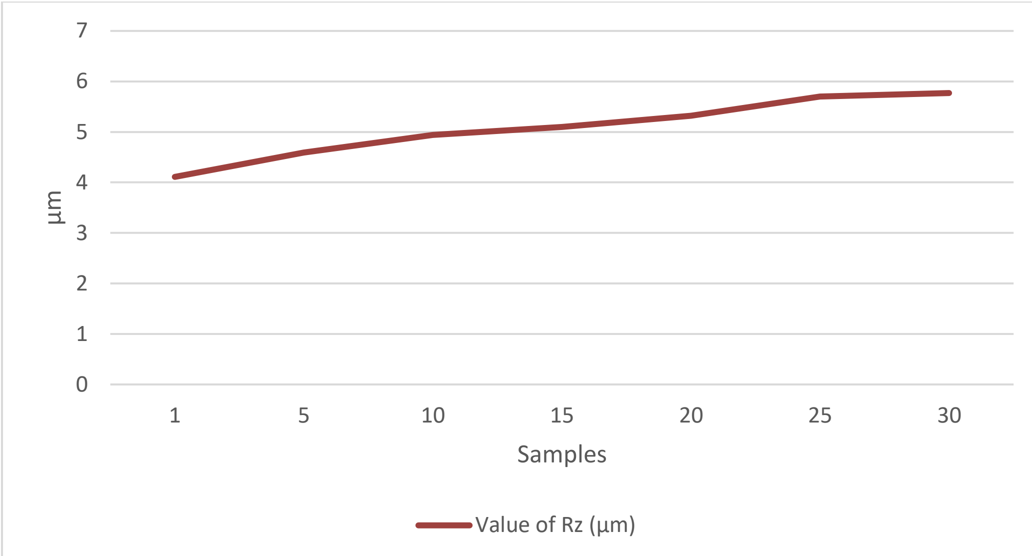

Figure 13. The Rz results of oil coolant operation curve.

DISCUSSION AND CONCLUSION

By comparing the outcomes of the three-type operation's mean roughness value (Ra), maximum peak to valley height (Rt), and roughness depth (Rz), we can discuss the effects of various types of coolant on surface roughness.

- In accordance with the findings displayed in tables 10, 13, and 16, the mean roughness value (Ra) for the emulsion operation ranged from 0.43 µm for sample number 1 to 1.14 µm for sample number 30. The number of (Ra) in a dry operation starts at 0.59 µm, which is considerably rougher than an emulsion operation, and rises to 1.19 µm with sample number 30, which is the roughest end operation. The (Ra) result for sample number 1 in oil operation is 0.73 µm, which is the rougher beginning of all operations, and ends with sample number 30 at 1.17 µm. The three processes are compared in the Ra test result in Figure 14.

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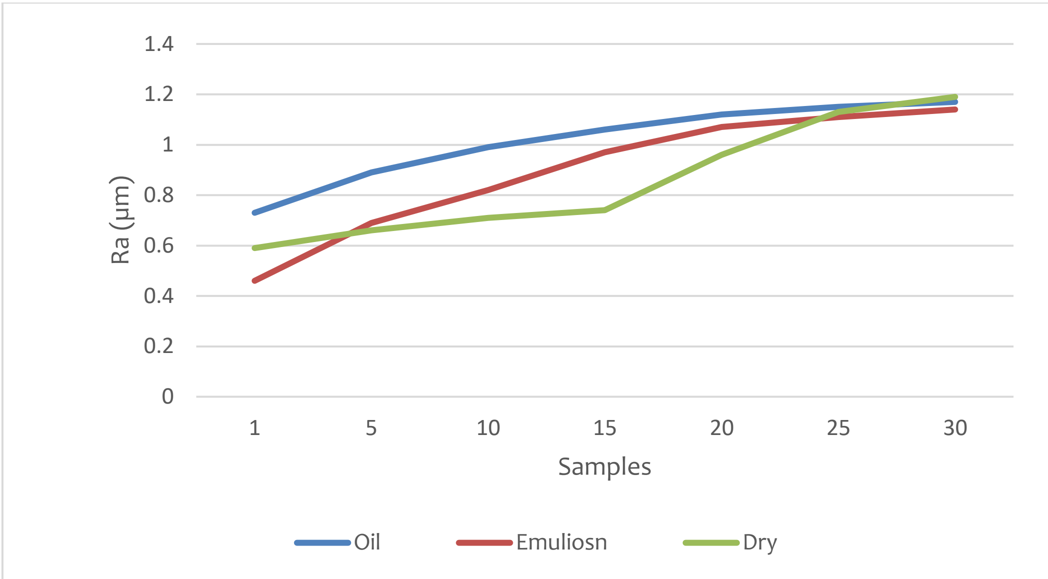

Figure 14. The comparison of the three operations in mean roughness value (Ra) test result.

- Based on the findings in tables 11, 14, and 17, The maximum peak to valley height (Rt) roughness test with operation emulsion ranges from as low as 3.92 µm with sample number 1 to as high as 6.90 µm with sample number 30. When using a dry operation, the number of (Rt) started at a much lower level than when using an emulsion, 3.83 µm, and climbed to 6.93 µm with sample number 30. The outcome of (Rt) for sample number 1 in oil operation is 4.29 µm, which is greater than all other operations' starting points, and ends with 6.74 µm, which is lower than sample number 30's ending point. Figure 15 compares the three operations along with the results of the Ra test.

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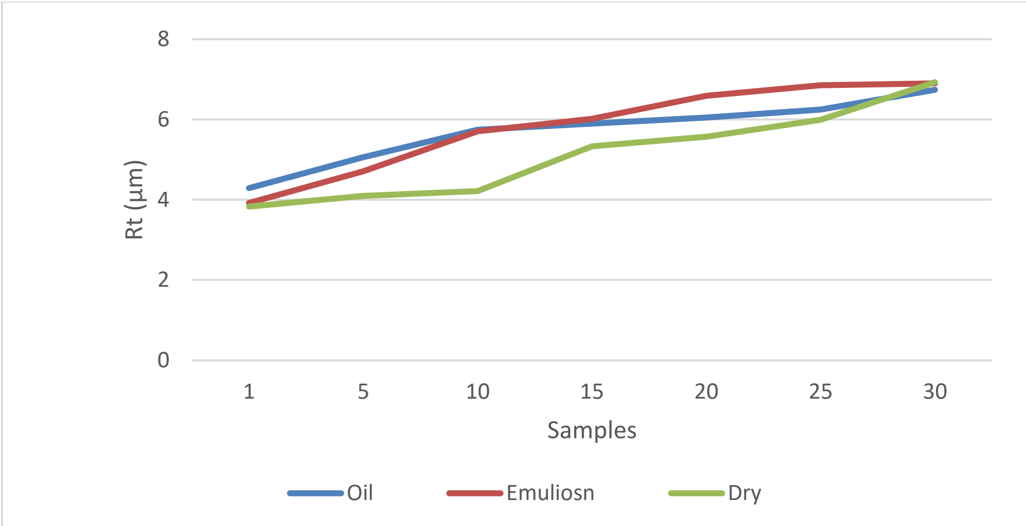

Figure 15. The comparison of the three operations in maximum peak to valley height (Rt) test result.

- The Rz results for roughness depth are displayed in tables 12, 15, and 18 the most of any other operation type is found in the roughness depth with emulsion coolant turning operation. Lower is preferable in this exam. Dry turning of the three operations, has the medium depth of roughness. Operation with oil results in the lowest level of roughening. Figure 16 compares the three operations in terms of roughness depth (Rz).

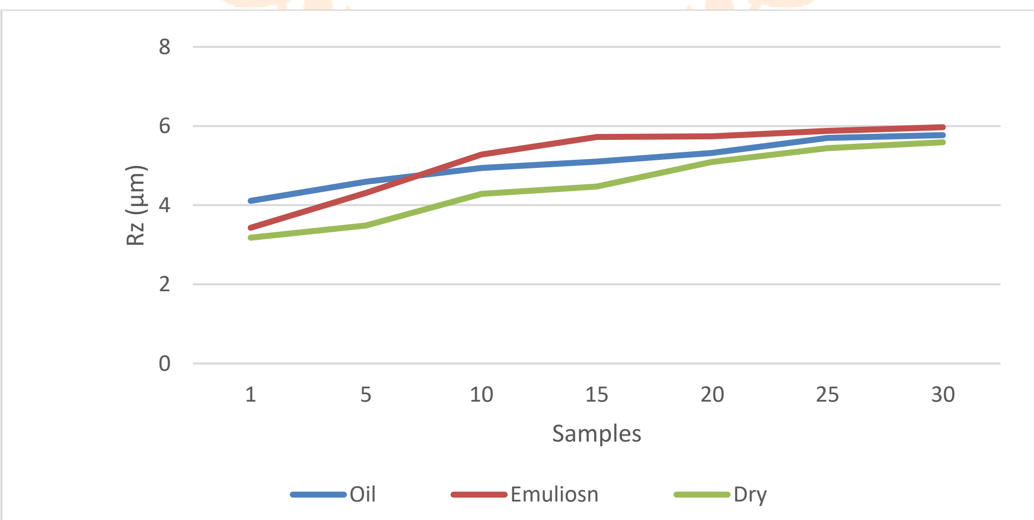

Figure 16. The comparison of the three operations in Rz test result.

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Based on the foregoing, it can be concluded that the results of this study in following,

- Through this experiment, the direct impact of various coolants on surface finishing was ascertained.
- The results showed that emulsion operations are the ideal coolant to use when it comes to surface roughness (Ra).
- Operation with oil coolant gave the best result of maximum peak to valley Height (Rt).
- The best result of roughness depth (Rz) is dry operation which is the lowest roughness depth result of all operations.

REFERENCES

1. Junior, J. K. K., Schueller, J. K., Pinto, F. D. A. C., & Villibor, G. P. (2020). Monitoring of Flank Wear and Damage on Turning Cutting Tools By Image Processing. The Journal of Engineering and Exact Sciences, 6(2), 0098-0106.
2. Liew, P. J., Shaaroni, A., Sidik, N. A. C., & Yan, J. (2017). An overview of the current status of cutting fluids and cooling techniques of turning hard steel. International Journal of Heat and Mass Transfer, 114, 380-394.
3. Maurya, R. K., Niranjan, M. S., Maurya, N. K., & Dwivedi, S. P. (2021). Development of a system to control flow of coolant in turning operation. Journal of Mechanical Engineering (IMechE), 17(1), 17-31.
4. Devaraj, S., Malkapuram, R., & Singaravel, B. (2021). Performance analysis of micro-textured cutting insert design parameters on machining of Al-MMC in turning process. International Journal of Lightweight Materials and Manufacture, 4(2), 210217.
5. Özbek, O., & Saruhan, H. (2020). The effect of vibration and cutting zone temperature on surface roughness and tool wear in eco-friendly MQL turning of AISI D2. Journal of Materials Research and Technology, 9(3), 2762-2772.
6. Li, Z., Zhao, C., Lu, Z., & Liu, F. (2019). Thermal Performances Prediction Analysis of High Speed Feed Shaft Bearings Under Actual Working Condition. IEEE Access, 7, 168011-168019.
7. Fatima, A., & Mativenga, P. T. (2017). On the comparative cutting performance of nature-inspired structured cutting tool in dry cutting of AISI/SAE 4140. Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture, 231(11), 1941-1948.
8. Ejeiji, T., Adedayo, S. M., Bello, O. W., & Abdulkareem, S. (2018, September). Effect of machining variables and coolant application on HSS tool temperature during turning on a CNC lathe. In IOP Conference Series: Materials Science and Engineering (Vol. 413, No. 1, p. 012004). IOP Publishing.
9. Naje, J. M., Jasim, H. B., & Alfatlawy, F. A. (2021). Study the effect of metal cutting fluids in operating machines on operator health and the environment. Periodicals of Engineering and Natural Sciences (PEN), 9(2), 649-656.
10. Islam, S., & Motaleb, I. A. (2019, October). Investigation of the Dynamics of Liquid Cooling of 3D ICs. In 2019 8th International Symposium on Next-Generation Electronics (ISNE) (pp. 1-3). IEEE.
11. Kaynak, Y., Gharibi, A., Yılmaz, U., Köklü, U., & Aslantaş, K. (2018). A comparison of flood cooling, minimum quantity lubrication and high-pressure coolant on machining and surface integrity of titanium Ti-5553 alloy. Journal of Manufacturing Processes, 34, 503-512.
12. Dong, Jianwei & Pei, Weichi & Ji, Hongchao & Long, Haiyang & Fu, Xiaobin & Duan, Hailong. (2020). Fatigue crack propagation experiment

and numerical simulation of 42CrMo steel. Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science. 234. 095440622091045. 10.1177/0954406220910458.

13. Chen, Yuanyuan & Qi, Huiping & Li, Yongtang & Hua, Lin. (2021). Establishment of Thermal Ductile Fracture Criterion for As-Cast 42CrMo Steel and Its Application in Hot Ring Rolling Process. Advances in Materials Science and Engineering. 2021. 10.1155/2021/9120018.
14. Alsoufi, Mohammad & Suker, Dhia & Alsabban, Abdulaziz & Azam, Sufyan. (2016). Experimental Study of Surface Roughness and Micro-Hardness Obtained by Cutting Carbon Steel with Abrasive WaterJet and Laser Beam Technologies. American Journal of Mechanical Engineering. 4. 173-181. 10.12691/ajme-4-5-2.
15. Suker, Dhia & Alsoufi, Mohammad & Alhusaini, Majdi & Azam, Sufyan. (2016). Studying the Effect of Cutting Conditions in Turning Process on Surface Roughness for Different Materials. World Journal of Research and Review (WJRR). 2. 16-21.
16. Alsoufi, Mohammad & Suker, Dhia. (2018). Experimental Investigation of Wire-EDM Process Parameters for Surface Roughness in the Machining of Carbon Steel 1017 and Aluminum Alloy 6060. American Journal of Mechanical Engineering. 6. 132-147. 10.12691/ajme-6-3-6