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Effect of straining on heat treated 304 austenitic stainless steel

Yogesh G. Joshi; Santosh Jaju; Sourabh Shukla; Pranav Charkha; Atul Dhakne

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In the present investigation, the 304 austenitic stainless steel has been strained up to 0% and 15% reduction in thickness, and analysis has been done with the help of X-ray diffraction (XRD) and microstructure. In 304 austenitic stainless steel (ASS) the microstructure through optical as well as scanning electron microscope 9SEM) has been studied at various thermal aging temperatures with and without strained at 0% and 15%. X-Ray diffraction results show that as stacking fault energy is greater with an increase in straining from 0% to 15%, 304 ASS seems to be deformed more quickly, resulting in a fast conversion to strain induced martensite from austenite. The XRD data also show that a higher percentage of martensite was produced. Microstructure results indicated that due to straining and high temperature heat treatment of 950°C-1000°C, small refined grains of new austenite formed which became the main reason for high strength and ductility. However other side shows that at a common temperature of 850°C-900°C, according to a microstructural study, the martensitic areas are an ideal source for increasing sensitization.

Topics

Crystallographic defects, **Alloys**, **Mechanical properties**, **Scanning electron microscopy**, **X-ray diffraction**

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Thermal Science and Engineering Progress
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Performance investigation of vapor compression refrigeration system using novel amine treated graphene quantum dots based nanosuspension

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Highlights

- This work focuses on a detailed experimental study of amine-treated graphene quantum dots (AGQD) based polyalkylene glycol (PAG) lubricant oil in a vapor compression refrigeration (VCR) system.
- Critical thermophysical properties of AGQD-PAG based nanosuspension are studied such as thermal conductivity, specific heat, density and viscosity using both mathematical models and experimental investigations.
- This AGQD-PAG based nanosuspension is further utilized in VCR cycle to analyze the effect on the coefficient of performance (COP), power

consumption, mass flow rate, compressor discharge pressure, vapor quality, evaporator pressure, pressure drop and pull-down time.

- The study has established that AGQD-PAG based nanosuspension improves all the above mentioned refrigeration properties.

Abstract

In this work, the performance parameters of the vapor compression refrigeration system are investigated using novel amine treated graphene quantum dots-(AGQD) based nanosuspension. The experimentation is carried out in two phases. In the first phase, the synthesis of AGQD based nanosuspension along with the evaluation of thermophysical properties such as thermal conductivity, specific heat, density and viscosity is carried out. The AGQD nanosuspension is synthesized by mixing it in polyalkylene glycol (PAG) refrigeration oil with a concentration of 100 ppm, 200 ppm, and 500 ppm. The experimental result showed that the use of AGQD nanoparticles significantly enhances the thermal conductivity of the PAG lubricant oil with corresponding decrease in specific heat along with minimal enhancement in density and viscosity. The results are also validated with the corresponding mathematical models. In the second phase of the experimentation, the performance parameters of vapor compression refrigeration system are investigated by incorporating synthesized nanosuspension. The experiment is carried out using varying masses of 160 g, 180 g, and 200 g of R134a refrigerant. Each mass of refrigerant is investigated with all three different AGQD-PAG based nanosuspension in the refrigeration system. The performance parameters such as COP, power consumption, mass flow rate, compressor discharge pressure, vapor quality, evaporator pressure, pressure drop and pull down time of vapor compression refrigeration system are experimentally investigated and validated with mathematical models. The highest COP of 2.76 along with 27.36% of lower power consumption is noted by using 200 g of R134 refrigerant with 500 ppm of AGQD-PAG based nanosuspension.

Introduction

The use of nanomaterial to improve the thermal system has been studied by researchers for the last two decades. The overall objective to incorporate any nanomaterial in the system is to obtain sustainable efficiency of the system. Among all the thermal system sectors, the refrigeration sector consumes much electrical energy. As per the current report of IIR, the refrigeration sector consumed 17% of worldwide electricity[1]. The report also estimated that nearly 3 billion different units of refrigeration system are in use and the global sales of these units are about 300 million USD. At the current rate of consumption, it is estimated that by 2050 almost 5 billion units will be in operation[1]. Such high consumption of different refrigeration systems have caused a significant impact on the environment. According to the IIR report of 2017, almost 7.8% of the total greenhouse gas emission is due to power requirements of the refrigeration sector[1].

To reduce the impact of such huge consumption, researchers have modified the refrigeration system from time to time. Developments such as the use of dual evaporator techniques[2], cascade refrigeration [3], use of microchannel heat exchanger [4], use of magnetic field [5] and the use of nanofluid [6] have already been experimented. Among all the developments, the use of nanomaterial is found to enhance the efficiency of the different types of the refrigeration system. The nanomaterial is utilized in different refrigeration systems such as vapor compression refrigeration [7], [8], vapor absorption refrigeration[9], ejector refrigeration [10], solar-powered refrigeration [11], cascade refrigeration [12] etc., and have shown better COP enhancement compared to the conventional system. Among all such types of refrigeration system, vapor compression refrigeration system is largely utilized worldwide. This being the reason why most of the nanomaterials have been tested in vapor compression refrigeration systems.

In a vapor compression refrigeration system, the nanomaterial has been incorporated by converting it into nanosuspension. In most cases, the base fluid utilized for the nanosuspension is the compressor lubricant oil of the refrigeration system. The convective heat transfer gain in lubricant oil by the use of nanomaterial improves the heat extraction rate of an evaporator, which tends to increase the overall COP of the system [13], [14]. As a result, many nanomaterials have been utilized in order to enhance the efficiency of a refrigeration system. The nanomaterial such as Al_2O_3 [15], [16], CuO [17], [18], ZnO [19],TiO_2 [20], [21], SiO_2 [22], [14], gold [23], diamond [24], CNT [25], graphene [26] have already been tested for vapor compression refrigeration system, which have improved the efficiency of the refrigeration system. The only limitation of these nanoparticles is that they are dispersed in the colloidal form. Since it is not bonded with base fluid, it is prone to agglomerate within the base fluid. If such lubricant oil can disperse or mix with better nanomaterial which is more stable compared to the mentioned nanomaterials, significant enhancement in COP of the refrigeration system can be achieved. Over the last decade, graphene quantum dots (GQD) based nanosuspensions are being utilized to improve the stability of conventional heat transfer fluid. The graphene quantum dots are zero-dimensional mono or plural layer of graphene smaller than 100nm. The researchers are experimenting with quantum dots-based nanofluids to enhance the heat transfer rate of conventional fluids and systems.

Amiri et al. [27] utilized the functionalized graphene quantum dots (FGQD) dispersed with the transformer oil to improve the thermal conductivity and heat transfer rate. The amine-treated graphene quantum dots (AGQD) was synthesized using covalent functionalization. The average diameter of dots was 1–17 nm. The nanosuspension formed with transformer oil and FGQD was found to provide enhanced thermal conductivity and no significant enhancement in viscosity. The experimentation shows more colloidal superiority and stability in the resulting oil compared to the conventional lubrication oil. Amiri et al. [28] also investigated the rheological and thermophysical properties of water-based GQD. The experimentation results showed that even with a low concentration of GQD, the thermal conductivity of water was increased. Also, there is no significant enhancement in viscosity which provided it with more colloidal stability. Such novel techniques demonstrated that GQD is more stable in the colloidal form in oil or water compared to traditional metal oxide nanomaterials. Amiri et al.[29] further utilized AGQD to enhance thermal conductivity of two-phased thermosyphons.

In another study, Ettefaghi et al. [30] synthesized the biocompatible GQD based heat transfer nanofluids for radiator coolant using hydrothermal method. The nanofluids were synthesized in four different concentrations of 100 ppm, 200 ppm, 500 ppm, and 1000 ppm. The heat transfer properties such as thermal conductivity and convective heat transfer coefficient were investigated. Both properties showed significant improvement even at a very low concentration of GQD.

Elaheh et al. [31] investigated the transport properties of dispersed GQD in glycerol and distilled water-based nanofluids. Transport properties such as thermal conductivity, rheological properties, and electrical conductivity were analyzed. The GQD was synthesized in different mass fractions using glycerol and distilled water. The experimental results showed significant improvement in thermal conductivity and electrical conductivity with only a 2% weight fraction of GQD. Further a reduction in the viscosity by 49% in glycerol was observed while achieving a gain in thermal conductivity. This makes GQD more stable compared to conventional nanomaterials.

Sedaghat et al. [32] experimentally investigated the thermophysical properties of water, ethylene glycol, and water-ethylene glycol solution by dispersing GQD in it. The experimental investigation showed that using 0.5 wt% of GQD enhanced the thermal conductivity of water, ethylene glycol, and water-ethylene glycol solution by nearly 53%, 18%, and 21% respectively. Likewise in similar literatures, many researchers have demonstrated that the utilization of GQD enhances the thermophysical and rheological properties of conventional fluids [33], [34], [35], [36], [37], [38].

As the utilization of one-dimensional nanomaterial or metal oxide-based nanomaterial is found to have lower stability with the conventional fluid, hence the choice of the utilization of GQD is the answer to enhance the colloidal stability. To the authors' knowledge, the utilization of these GQD in refrigeration lubricant oil is not reported. Moreover, there is no published literature showing the utilization of functionalized amine graphene quantum dots to improve the efficiency of the vapor compression refrigeration system. In the current research, the covalently functionalized amine-treated graphene quantum dots-based nanosuspension lubricant is used for the first time in the vapor compression refrigeration system. Using AGQD in the VCR system, this research focuses on the improvement in the thermophysical properties of refrigeration lubricant oil. Further, an investigation on the performance parameters of the VCR system such as COP, power consumption, mass flow rate, compressor discharge pressure, vapor quality, evaporator pressure, pressure drop and pull-down time is also carried out.

Section snippets

Synthesis of PAG – AGQD nanosuspension

Several literatures show the synthesis of graphene quantum dots by different methods. The most commonly used are chemical vapor deposition [39], [40], graphene oxide reduction [41], [42], silicon carbide epitaxial growth [43], [44], micromechanical stripping [45], [46], etc. In the current research work, amine treated graphene quantum dots is synthesized in two phase. In the first phase GQD is synthesized using nitric acid method and further treated with ammonia solution to form amine treated …

Experimental system

The vapor compression refrigeration experimental system is designed according to Indian standard of IS 1476 energy efficiency bureau[47]. The system is calibrated through Datacone

Technologies to reduce any type of error in the experimentation. The system is able to work within the maximum evaporator temperature limit of −5 °C to the maximum condenser temperature limit of 60°C (Fig. 6 and Fig. 7). The controlled conditioned environment is provided for the experimentation using split air …

Experimental procedure and investigation

The experiments with different concentrations of PAG-AGQD were carried out in two phases. In the first phase of the experimentation, the thermophysical properties of the PAG-AGQD were determined. Thermal conductivity, specific heat, density and viscosity were investigated to determine the thermophysical properties of AGQD-PAG based nanosuspension. The details of the instruments used to evaluate thermophysical properties are stated in Table 2. In the second phase of the experimentation, the …

Thermal conductivity and specific heat of AGQD – PAG-based nanosuspension

The thermal conductivity of synthesized AGQD – PAG based nanosuspension has shown better enhancement as compared to the conventional PAG lubrication oil. The pattern of gain in thermal conductivity is obtained by the Hamilton model as well as with physical experimentation. The results from the Hamilton model and experimentation show the impact of quantum dots concentration on thermal conductivity. As the quantum dots concentration in the nanofluid (AGQD – PAG based nanosuspension) increases, …

Conclusion

The performance investigation of vapor compression refrigeration using amine-treated graphene quantum dots based nanosuspension (AGQD-PAG) has been done experimentally. At the same time results concerning COP, pressure drop, vapor quality, mass flow rate and refrigerant-oil mixture properties are also validated with mathematical model. The thermophysical properties of AGQD-PAG nanosuspension such as thermal conductivity, viscosity, specific heat and density are evaluated. The effect of …

Future scope

The current study establishes that the utilization of nanosuspension in the refrigeration system provides improved performance parameters. The quantum dots are zero-dimensional and smaller as compared to the one and two-dimensional nanomaterials. Hence the colloidal suspension formed by it is more stable. The following can be the scope of this research work:

- Different types of quantum dots-based nanosuspensions can be investigated to improve the performance of lubricant oil and such nano …

…

CRediT authorship contribution statement

Yogesh G. Joshi: Conceptualization, Methodology, Software, Data curation, Writing – original draft. **Dinesh R. Zanwar:** Supervision. **Sandeep S. Joshi:** Visualization, Investigation. **Vinit Gupta:** Validation, Writing – review & editing. …

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. …

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Performance of a computerized refrigeration cycle test rig for varying concentrations of (CuO-Al<inf>2</inf>O<inf>3</inf>/MO) hybrid nano-lubricants and R600a refrigerant charges: an energetic and exergetic approach

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Experimental investigation for thermophysical properties of reduced Graphene-Based nanosuspension for refrigeration lubricant

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Abstract

In the last two decades, many attempts have been made to conserve the energy of thermal systems using nanotechnology. Among them, the refrigeration sector is such a thermal system that utilized much of the world's energy. In this paper, a nanofluid based lubrication oil used in the compressor of the refrigeration system which is prepared with graphene nanoparticles. The thermophysical properties of this nanofluid were investigated by measuring thermal conductivity and viscosity. The objective of this experiment is to increase the convective heat transfer capacity of the lubricating oil. For this two lubrication oils have been used, polyester oil and mineral oil. Using both oils, nanofluids of three different concentrations have been prepared and tested. Both the theoretical model and experimental observation were done to conduct the test. The test concluded that the reduced graphene nanoparticle increases the thermal conductivity of the oil, but also increases the viscosity. The highest thermal conductivity of 2.65 W/mkwas observed from mineral oil with reduced graphene nanoparticle based nanosuspension of 0.1 wt% compared to the conventional lubrication oil. Also, a gain in viscosity of 37.2% measured at 80 °C was observed. Experiments have concluded that despite of gain in viscosity, nanosuspension was stable and not agglomerated. It is concluded that optimal graphene nanoparticle concentration can be used to enhance the thermophysical properties of mineral oil and polyester oil.

Citations (6) References (51)

... As a result, many nanomaterials have been utilized in order to enhance the efficiency of a refrigeration system. The nanomaterial such as Al 2 O 3 [15,16], CuO [17,18], ZnO [19],TiO 2 [20,21], SiO 2 [14,22], gold [23], diamond [24], CNT [25], graphene [26] have already been tested for vapor compression refrigeration system, which have improved the efficiency of the refrigeration system. The only limitation of these nanoparticles is that they are dispersed in the colloidal form. ...
... The gain of thermal conductivity is accounted to the availability of more surface area in the lubrication oil. The colloidal form of AGQD nanoparticle in the PAG oil provides extra room for the transfer of heat, which as a result improves the thermal conductivity of the lubrication oil [26, 38,48]. Along with it, as the nanoparticle concentration of quantum dots increases the specific heat of nanosuspension is found to decrease. ...

Performance investigation of vapor compression refrigeration system using novel amine treated graphene quantum dots based nanosuspension

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... Recent developments in vapor compression refrigeration systems have focused on several key areas to improve efficiency, reduce environmental impact, and enhance overall performance. The development such as advanced compressor technology [5], use of nanosuspension [6][7][8][9] [10] [11][12], use of magnetic field [13], dual evaporator method [14], integrated renewable energy systems [15,16] etc. However, the utilization of natural refrigerant are much easier compared to the such methods. ...

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In the past few decades, multi-walled carbon nanotubes (MWCNT) have been used to increase the efficiency of thermal systems. Many nanofluids were synthesized using MWCNT, using which the thermophysical properties of normal fluid have enhanced. Out of these fluids, polyester oil (POE) and mineral oil (MO) are the oils that are used in the refrigeration sector. In this paper, MWCNT has been used to ... [Show full abstract]

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This study highlights the utilization of nano-particle fluids as the refrigerants in the conventional vapour compression based thermal systems due to their super improvement in thermo-physical properties together with heat transfer capacity to enhance performance of the system described by its COP and reliability of refrigeration system. Further, demanding situations of performance enhancement of ... [Show full abstract]

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Abstract. This study aims to understand the role of machining parameters in turning Haynes 25 alloy. In this work, experiments as per Taguchi L9 orthogonal array are performed considering cutting speed, feed rate and depth of cut as input parameters. Here the objective is to generate the cutting parameters to achieve minimum tool wear and surface roughness. Surface roughness affects the component's performance and integrity, and tool wear play is a key response to achieve the required finish. The methodical parameters are cutting speeds as 500, 1000, and 1500 rpm; depth of cuts as 0.6, 1.2, and 1.8 mm; with feed rates as 0.05, 0.1 and 0.15 mm/rev respectively. The tool wear and surface roughness are statistically investigated using S/N ratio followed by regression analysis. The results indicate that with cutting speed of 500 rpm and feed rate of 1.2 mm/rev with depth of cut as 1.2 mm, the tool wear and surface roughness are minimum, resulting in optimum conditions.

Keywords: Haynes 25, Taguchi Method, Turning, Superalloy

1. Introduction

In machining, it is essential to achieve the desired surface quality with minimum tool wear for optimal component performance and reliability. Surface roughness affects the functional attributes like friction, wear, and fatigue resistance. As a result, comprehending the contributing factors to surface roughness and adopting efficient techniques for optimization is of utmost importance [1,2]. Haynes 25 is a cobalt based superalloy known for its strength and high corrosion resistance and can withstand at high temperature environments. This alloy possesses variety of applications in aerospace and power sectors. The aerospace and gas turbine industries primarily rely on materials that necessitates to work in critical conditions ensuring seamless integration.

Currently a limited literature is available on the study of roughness and tool wear in machining Haynes 25 alloy. However, the work reports ideal range for cutting speed, feed rate, and depth of cut for machining Haynes 25. Andhare et al. [3] explored the effect of cutting parameters on surface roughness in machining with cryogenic-treated inserts and MQL (minimum quantity lubrication) techniques. These methods proved to optimize machining performance and improve tool durability. Further, finite element simulation with response surface methodology have shown significant results in turning Haynes 25 [4,5]. Other methods, like use of cermet tools [6] and nano lubricants [7–9] have reported promising results in improving tool wear and surface roughness. In the present experimentation, the effect of cutting parameters on surface quality and tool wear in turning Haynes 25 alloy has been attempted. The L9 Taguchi method of experimentation is used to relate scientifically the cutting parameters on tool wear (TW) and surface roughness (SR).

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2. Experimental Details

The setup consists of a CNC lathe (MTAB) on which turning experiments are conducted, in Fig. 1. The workpiece, Haynes 25 is cylindrical rod of 30 mm dia. Experiments are carried with tungsten carbide inserted cutting tools for varying parameters as per the design of experiments, mentioned in Table 1. These parameters are primarily responsible for tool wear and surface roughness. These parameters also significantly influence the cutting zone with heat generation, tool wear rate, and surface finish. Based on initial trials, the range of parameters are chosen ensuring stability while machining Haynes 25 alloy.

Table 1: Range of parameters

Parameter	Values/Range
Cutting Speed (RPM)	500, 1000, 1500
Feed Rate (mm/rev)	0.05, 0.10, 0.15
Depth of Cut (mm)	0.6, 1.2, 1.8

Each of the input parameters combination are repeated, and experimental runs were randomized to improve the reliability. This strategy removes uncontrolled elements and ensures consistency in results. A surface roughness tester (Mitutoyo SJ-410) is used to measure the machined surface's roughness, Fig.2, whereas an optical microscope is used for measuring the tool wear. The measurements against the experiments are summarized in Table 2.

Figure 1. Experimental Setup

Figure 2. Surface roughness measurement

Table 2: Experiments and the corresponding responses

Run No.	Cutting Speed	Feed Rate	Depth of Cut	Surface Roughness	Tool Wear
1	500	0.05	0.6	0.5390	42.63
2	500	0.1	1.2	0.4090	43.39
3	500	0.15	1.8	1.3260	60.71
4	1000	0.05	0.6	0.4780	37.66
5	1000	0.1	1.2	0.3980	30.40
6	1000	0.15	1.8	1.3950	51.69
7	1500	0.05	0.6	2.0100	38.01
8	1500	0.1	1.2	0.6210	38.25
9	1500	0.15	1.8	1.1320	72.75

Further, signal-to-noise ratio (SN) plots through Taguchi method are evaluated in conjunction with experimental results to determine the ideal parameters. To ascertain the nature of connection between the machining parameters, SR and TW regression analysis is carried [10,11]. The average response values of the variables (TW and SR) for each level in the form of SN ratio plots are obtained. In machining, since the requirement is less tool wear with good surface finish, the condition of "smaller/lower the better" is employed as given in Eqn. 1; where y_i stands for the experimental value of the i^{th} test and n is the number of replications.

$$(SNR)_{LB} = -10 \log\left[\frac{1}{n}\sum_{i=1}^{n}(y_1^2)\right] \quad (1)$$

3. Influence of machining parameters on TW and SR

The role and influence of machining parameters on surface roughness is plotted in Fig. 3 considering the main effects plot of the SN ratios. The plot shows that optimum parameters to be cutting speed as 1500 rpm, feed rate of 0.15 mm/rev and depth of cut is 1.8 mm with probability at 95 % confidence level. Further, with the same L9 Taguchi approach, tool wear when plotted, the optimum conditions were found to be cutting speed as of 500 rpm, feed rate of 0.15 mm/rev and dept of cut of 1.2 mm with the same 95% confidence level, in Fig. 4. However, while considering both surface roughness and tool wear for combined minimum, the optimal parameters are cutting speed of 500 rpm, depth of cut of 1.2 mm, and feed rate as 0.15 mm/rev respectively as shown in Fig. 5.

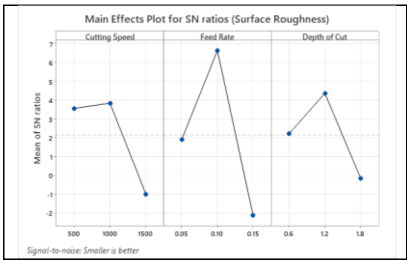

Figure 3. SN plot for SR

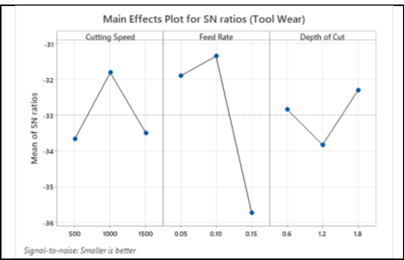

Figure 4. SN plot for TW

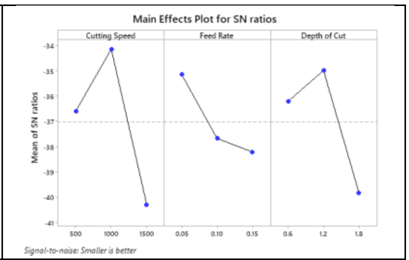

Figure 5. SN plot for combined responses

In machining, the increased cutting speed increases the surface roughness [12–14], as evident from the experiments. For the same feed rate and depth of cut, when cutting speed increases from 500 to 1500, surface roughness is increasing. However, the tool wear tends to increase with feed rate [15–18]. The findings were further supported by regression analysis, which resulted into predictive models to establish relationship between surface roughness and tool wear as a function of machining parameters, as given in Eq. 2 and Eq. 3 respectively.

Surface Roughness = -0.242 + 0.000496 Cutting Speed + 2.75 Feed Rate + 0.328 Depth of Cut (2)

Tool Wear = 24.3 + 0.00076 Cutting Speed + 222.8 Feed Rate - 0.96 Depth of Cut (3)

Probability maps were created to verify the regression model that links cutting parameters to the measured surface roughness and tool wear. The plot illustrates the level of agreement with the expected as mentioned in the above relations and actual responses. The optimal conditions are cutting speed of 500 rpm, depth of cut as 1.2 mm, and feed rate of 0.15 mm/rev plotted in Figs. 6 & 7.

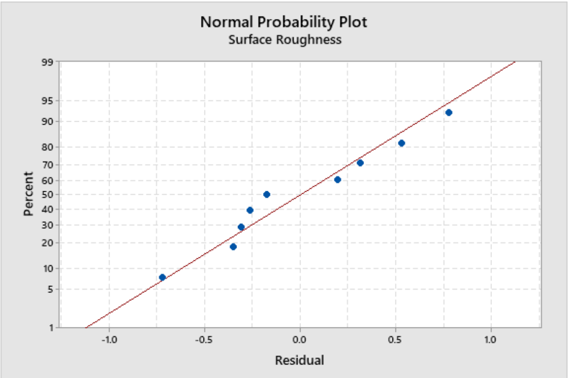

Figure 6 Probability plot for SR

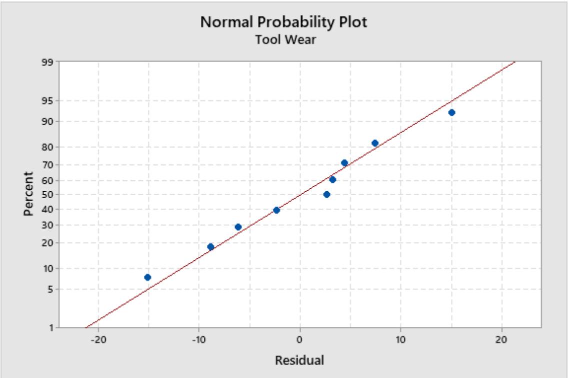

Figure 7 Probability plot for TW

4. Tool wear mechanism

The surface roughness is majorly affected by tool wear [19], during experiments, a fixed volume of chips is collected for observation and analysis. The findings show notch wear as visible in Fig. 8, 9. Such type of wear has been observed in mostly Ni and Co based superalloys [20–22]. However, the cause of such tool wear is found to be very uncommon and it indicates adhesive wear mechanism [23], which is due to high cutting temperatures at tool-chip interface, leads to weldability of work material with the tool.

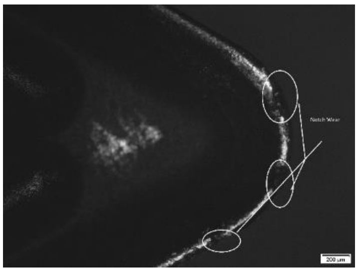

Figure 8 Tool wear in 03

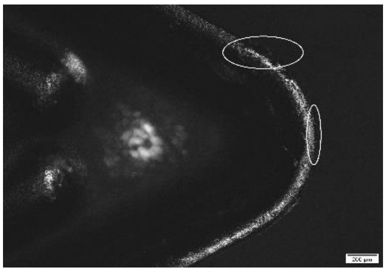

Figure 9 Tool wear in 06

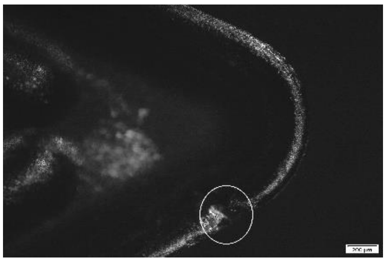

Figure 10 Tool wear in 09

5. Conclusion

The objective of the present study is to comprehend how cutting parameters affect tool wear, and surface roughness in turning Haynes 25. The optimal conditions for obtaining minimum surface roughness and tool wear are found to be, 500 rpm; 0.15 mm/rev and 1.2 mm. A linear trait is observed between 500 to 1000 rpm, and beyond 1000 rpm there is no indicative of surface roughness, which needs further investigations on a larger set of experiments. Cutting speed has a notable effect on surface roughness, while feed rate affects both surface roughness and tool wear. High feed rates tend to increase surface roughness and tool wear too with similar effects from depth of cut also. The active tool wear mechanism is observed to be adhesive in nature which is results in tool notch wear damage in cutting tools.

Acknowledgments

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Modelling and Study of Dynamics and Control of a Two-Link Serial Manipulator

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(INCOME 2023)

Vinit S. Gupta & Yogesh G. Joshi

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Abstract

A manipulator design is mainly dictated by kinematic and dynamic analysis so far as mechanism design is concerned. This work mainly focuses on dynamic analysis and implementation of proportional–integral–derivative (PID) controller for a two-link serial manipulator. Through this work, we intend to study the dynamic equations to evaluate the joint forces/torques, carry out their parametric analysis and study the impact on joint torques, displacement, velocity and acceleration. Implementation of a PID controller is also carried out by establishing controller equations. An attempt is made to validate the controller model for step input signal. This work presents in a very simple manner the entire formulation of dynamic equations and controller equations and is therefore critical to the mechanical design of serial manipulators for practical industrial applications. This work paves way to better understanding in implementation of dynamic and control algorithms on different manipulators mainly serial manipulators.

Abbreviations

\({m}_{1}\): Mass of link 1

\({L}_{1}\): Length of link 1

\({x}_{1},{y}_{1}\): Position coordinate for end of link 1

q_{1}: Angular displacement of link 1

m_{2}: Mass of link 2

L_{2}: Length of link 2

x_{2}, y_{2}: Position vector of link 2

q_{2}: Angular displacement of link 2

r_{1}: Radius of link 1

r_{2}: Radius of link 2

v_{1}: Linear velocity function of link 1

v_{2}: Linear velocity function of link 2

I_{1}: Inertia of link 1

I_{2}: Inertia of link 2

L: Euler–Lagrangian function

g: Gravitational acceleration

τ_{1}: Torque at link 1

τ_{2}: Torque at link 2

e: Error in signal

\({K}_{P}\): Proportional gain

\({K}_{I}\): Integral gain

\({K}_{D}\): Derivative gain

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Taguchi based approach for multiparameter optimization in Turning Haynes 25

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Abstract

This study aims to understand the role of machining parameters in turning Haynes 25 alloy. In this work, experiments as per Taguchi L9 orthogonal array are performed considering cutting speed, feed rate and depth of cut as input parameters. Here the objective is to generate the cutting parameters to achieve minimum tool wear and surface roughness. Surface roughness affects the component's performance and integrity, and tool wear play is a key response to achieve the required finish. The methodical parameters are cutting speeds as 500, 1000, and 1500 rpm; depth of cuts as 0.6, 1.2, and 1.8 mm; with feed rates as 0.05, 0.1 and 0.15 mm/rev respectively. The tool wear and surface roughness are statistically investigated using S/N ratio followed by regression analysis. The results indicate that with cutting speed of 500 rpm and feed rate of 1.2 mm/rev with depth of cut as 1.2 mm, the tool wear and surface roughness are minimum, resulting in optimum conditions.

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Wire EDM is an eco-friendly, non-traditional machining process with no contact between the workpiece and the wire electrode and has a widespread usage in the field of medical industry, automobile industry, etc. The purpose of this present work is to optimize various wire EDM input parameters for machining of INVAR 36. The Taguchi technique was used to carry out the optimization. The control ... [Show full abstract]

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January 2012 · Australian Journal of Mechanical Engineering

R. Thirumalai · J. S. Senthilkumaar · P. Selvarani · [...] · KM Senthilkumaar

This paper describes the development of response models such as surface roughness and flank wear for machining Inconel 718. Several experiments are conducted by varying the cutting speed, feed, and depth of cut as machining parameters based on the design of experiments. The surface roughness and flank wear are measured as responses against these parameters. Response optimisation has been ... [Show full abstract]

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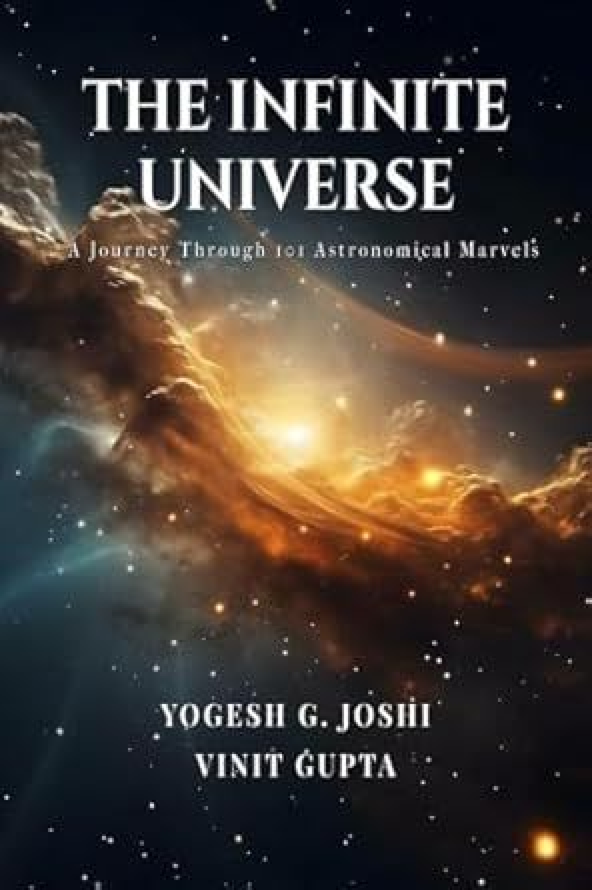
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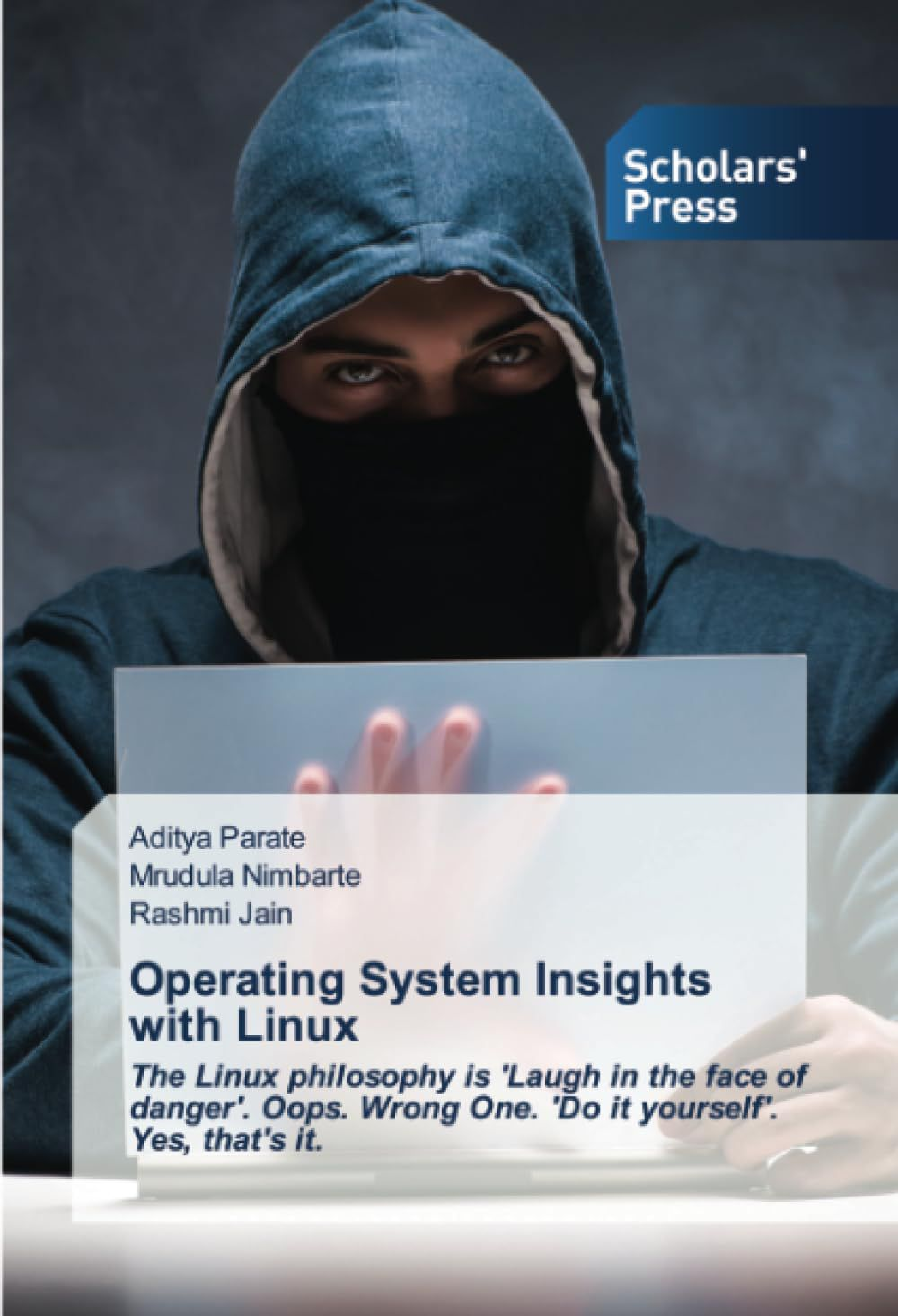

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