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Machining parameters effect in dry turning of AISI 316L stainless steel using coated carbide tools

Rusdi Nur¹,², MY Noordin¹, S Izman¹ and D Kurniawan¹,³

Abstract
Austenitic stainless steel AISI 316L is used in many applications, including chemical industry, nuclear power plants, and medical devices, because of its high mechanical properties and corrosion resistance. Machinability study on the stainless steel is of interest. Towards sustainable manufacturing, this study also includes the power consumption during machining along with other machining responses of cutting force, surface roughness, and tool life. Turning on the stainless steel was performed using coated carbide tool without using cutting fluid. The turning was performed at various cutting speeds (90, 150, and 210 m/min) and feeds (0.10, 0.16, and 0.22 mm/rev). Response surface methodology was adopted in designing the experiments to quantify the effect of cutting speed and feed on the machining responses. It was found that cutting speed was proportional to power consumption and was inversely proportional to tool life, and showed no significant effect on the cutting force and the surface roughness. Feed was proportional to cutting force, power consumption, and surface roughness and was inversely proportional to tool life. Empirical equations developed from the results for all machining responses were shown to be useful in determining the optimum cutting parameters range.

Keywords
Austenitic stainless steel, cutting force, surface roughness, power consumption, tool life, coated carbide, response surface methodology

Introduction
Sustainable production applies to many engineering fields, including machining processes.¹ In turning, as one of the machining processes, sustainable production can be implemented by taking into account the cutting conditions used in the production process, such as the cutting parameters and cutting fluids, the cutting tool performance, the quality of machined surface, and the power consumed for cutting. An essential indication in sustainable production is the minimization of power consumption.²,³ Considering this, necessary steps to evaluate and minimize the power consumption during the machining process should be evaluated.⁴

Previous investigations have been carried out in the machining processes by varying the cutting conditions and measuring the machining responses. However, power consumption is often neglected, and this holds true in the case of turning process. Very limited research has been performed to investigate aspects of machinability, which also includes power consumption. Some researchers have proposed ways to incorporate power consumption as one of the machining responses to consider when performing machinability study by varying the cutting conditions during turning. These include the work by Ezugwu et al.⁵ that developed an artificial neural network model for analyzing and predicting the cutting parameters when turning of Inconel 718 alloy using coated carbide. Cutting forces, power consumption, surface roughness, and flank and nose wears were the responses measured during the experimental machining.⁵ Bhattacharya et al.⁶ utilized Taguchi techniques for investigating the influence of cutting conditions on surface finish and power consumption when turning of carbon steel using multilayer coated carbide tool. The research results showed that the cutting speed had a significant effect on power consumption and

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surface roughness, whereas the other cutting parameters gave no substantial effect on the responses. The study of Hanafi et al. optimized the machining parameters by applying the Taguchi method and gray relational theory when dry turning Polyetheretherketone reinforced with 30% of carbon fibers using TiN coated tools, with minimizing power consumption and surface roughness as the target. It was concluded that the machining responses on the composite are influenced more by the cutting speed and depth of cut. Also, Bhushan analyzed the cutting parameters when turning 7075 Al alloy 15 wt% SiC composite to determine their effect on tool life and power consumption. It was concluded that both tool life and power consumption are functions of the cutting parameters. Toward sustainability of turning process, this should be investigated, creating the need to conduct study on the machinability in turning process, which also considers power consumption.

The material of interest is AISI 316L stainless steel, which presents high corrosion resistance variance among stainless steels. It contains 25 wt% Ni, which is used to produce an austenitic structure which allows hardening. Considering its properties, this AISI 316L stainless steel is often used for structural components in the chemical industry, nuclear plants, as well as medical devices. From machining point of view, it is considered hard to machine because of its low thermal conductivity, high tensile strength, work-hardening rate, and abrasiveness, leading to high cutting force, high cutting temperature, susceptibility to notch wear, built up edge formation, and poor surface finish. Being of high added value, the products made of this stainless steel will have even better notion when fabricated by considering sustainable manufacturing.

A common practice in machining is the use of cutting fluids. Although overall machinability can be improved by reducing friction or temperature at the cutting region, their use should be minimized whenever possible. Attempts to minimize cutting fluid use have been done to the extreme by performing dry machining, without the use of any cutting fluid. Previous research reported dry machining on various workpiece materials, including stainless steels, with success to some extent. Thus, this study also tries dry machining to turn the stainless steel workpiece.

In line with many of the references mentioned before that performed machinability study using statistical tool, this study uses response surface methodology (RSM) as the design of experiment technique to determine the effect of machining parameters on the machining responses. RSM has predictive capability and is useful when there are conflicting results between machining responses, which require optimization or compromise on the input factors. This is usually the case in machining processes. It is not uncommon for contradictions to occur. For example, higher cutting speed provides finer surface finish but will lead to higher power consumption. Of course, the additional benefit of using this RSM as the design of experiments technique is that it needs fewer experiments for the same number of input factors, compared with one-factor-at-a-time technique.

The cutting parameters, i.e. cutting speed and feed, are varied, and their effect on the machining responses is quantified. The machining responses of interest are cutting force, tool life, surface finish, and power consumption. Those machining responses are combination between the common responses in machinability study (cutting force, tool life, and surface finish) and the machining response in the power consumption. This study proposes the incorporation of power consumption, an important consideration in sustainable manufacturing, as a response in machinability of a workpiece material. To the best of the authors’ knowledge, this study is the first to study the machinability of AISI 316L stainless steel, which is dry turned that also includes power consumption as the machining response along with other responses commonly used in a machinability study.

### Experimental

The turning experiments were performed using a two axis CNC lathe with a capacity of 8.3 kW maximum power and the spindle speed range from 100 to 6000 rpm. An AISI 316L austenitic stainless steel was used for the workpiece material. The composition of AISI 316L is shown in Table 1.

The cutting tool used for the experiment was a tungsten carbide with multilayered, nanotextured TiCN, Al₂O₃, and TiN coating (Mitsubishi). The tool is designated as ISO CNMG 120408, with 80° diamond shape and 0° relief angle. The length of the cutting edge is 12.7 mm with a thickness of 4.76 mm and cutting point radius of 0.8 mm. The cutting conditions were chosen based on the recommendations suggested by the tool’s manufacturer. The cutting speeds were varied at 90, 150, and 210 m/min, the feed was also varied at 0.10, 0.16, and 0.22 mm/rev, whereas the depth of cut was set at a constant 0.4 mm.

<table>
<thead>
<tr>
<th>Grade</th>
<th>C</th>
<th>Mn</th>
<th>Si</th>
<th>P</th>
<th>S</th>
<th>Cr</th>
<th>Mo</th>
<th>Ni</th>
<th>N</th>
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<tr>
<td>316L</td>
<td>Min</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>16.0</td>
<td>2.00</td>
<td>10.0</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Max</td>
<td>0.03</td>
<td>2.0</td>
<td>0.75</td>
<td>0.045</td>
<td>0.03</td>
<td>18.0</td>
<td>3.00</td>
<td>14.0</td>
</tr>
</tbody>
</table>

Note: balance Fe.
The turning process was performed dry (without cutting fluid).

Tool wear progression was measured using digital microscope (Zeiss Stemi 200-C) at every preset cutting time until the tool met one of the tool life criteria. The measurements were done without removing the tool from its holder to minimize error. The tool life criteria were set at maximum flank wear width of 0.1 mm or catastrophic failure. Surface roughness ($Ra$) was measured by a surface profilometer (Accretech Handysurf) at 0.8 mm cut off length and 4 mm sampling length in each measurement. The cutting forces were recorded during the turning process by a force dynamometer (Kistler 9265B) associated with a multi-channel amplifier to transform output signal from the dynamometer into a readable forces in three directions. Power consumption was measured by setting three portable power monitors (Omron ZNCTX21) at the main power, the spindle drive, and axis drive.

The data analysis on the results was done in such a way that the influence of the independent variables (cutting speed and feed) on the dependent variables (cutting force, surface roughness, power consumption, and tool life) can be quantitatively measured. Regression analysis technique was used to develop the mathematical models for the various responses. A three level full factorial design was used with all combinations of the input variables at three levels were specified.

**Results and discussion**

There are a total of 11 runs included in the experimental design and the results are shown in Table 2. Note: $V_c$ is cutting speed, $F$ is feed, $x_1$ is the coded factor of cutting speed, $x_2$ is the coded factor for feed, $F_c$ is main cutting force, $Ra$ is surface roughness, $P_c$ is power consumption, and $T$ is tool life. For each machining response, empirical model was developed according to guidelines for a three level full factorial design with two input factors at three levels each with two repetitions at the center point, which were established and reported elsewhere. Analysis of variance (ANOVA) was calculated on each model to determine the significance of the model itself and its coefficients. Significance level was set at 95% confidence interval ($Prob > F$ to be maximum at 0.05).

**Cutting force**

Results for cutting force at various cutting speeds and feeds show that it fits linear model. The ANOVA for the cutting force data is given in Table 3. Having its $Prob > F$ of much less than 0.01, the linear model is valid. As for the coefficients, only the feed was

<table>
<thead>
<tr>
<th>Std</th>
<th>Vc (m/min)</th>
<th>f (mm/rev)</th>
<th>Coded</th>
<th>$F_c$ (N)</th>
<th>$Ra$ ($\mu$m)</th>
<th>$P_c$ (kW)</th>
<th>T (s)</th>
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<tbody>
<tr>
<td>1</td>
<td>90</td>
<td>0.10</td>
<td>$-1$</td>
<td>140.90</td>
<td>1.19</td>
<td>0.870</td>
<td>4860</td>
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<tr>
<td>2</td>
<td>150</td>
<td>0.10</td>
<td>0</td>
<td>133.33</td>
<td>1.10</td>
<td>1.062</td>
<td>3960</td>
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<tr>
<td>3</td>
<td>210</td>
<td>0.10</td>
<td>$1$</td>
<td>131.67</td>
<td>1.03</td>
<td>1.363</td>
<td>1780</td>
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<tr>
<td>4</td>
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<td>0.16</td>
<td>$-1$</td>
<td>190.51</td>
<td>1.93</td>
<td>0.920</td>
<td>2700</td>
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<td>5</td>
<td>150</td>
<td>0.16</td>
<td>0</td>
<td>185.13</td>
<td>1.44</td>
<td>1.213</td>
<td>1680</td>
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<tr>
<td>6</td>
<td>210</td>
<td>0.16</td>
<td>1</td>
<td>178.67</td>
<td>1.16</td>
<td>1.494</td>
<td>1080</td>
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<tr>
<td>7</td>
<td>90</td>
<td>0.22</td>
<td>$-1$</td>
<td>226.09</td>
<td>2.83</td>
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<tr>
<td>8</td>
<td>150</td>
<td>0.22</td>
<td>0</td>
<td>212.29</td>
<td>2.54</td>
<td>1.238</td>
<td>1463</td>
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<tr>
<td>9</td>
<td>210</td>
<td>0.22</td>
<td>$1$</td>
<td>206.71</td>
<td>2.39</td>
<td>1.598</td>
<td>960</td>
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<tr>
<td>10</td>
<td>150</td>
<td>0.16</td>
<td>0</td>
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<td>1.41</td>
<td>1.256</td>
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<td>11</td>
<td>150</td>
<td>0.16</td>
<td>0</td>
<td>182.25</td>
<td>1.43</td>
<td>1.270</td>
<td>1500</td>
</tr>
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**Table 3. ANOVA for linear model of cutting force.**

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of squares</th>
<th>DF</th>
<th>Mean square</th>
<th>$F$ value</th>
<th>$Prob &gt; F$</th>
</tr>
</thead>
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<tr>
<td>Model</td>
<td>12698.84</td>
<td>1</td>
<td>12698.84</td>
<td>16.81</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>$x_2$</td>
<td>12698.84</td>
<td>1</td>
<td>12698.84</td>
<td>16.81</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Residual</td>
<td>6798.75</td>
<td>9</td>
<td>755.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cor Total</td>
<td>19497.59</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
considered as significant factor. Cutting force was insensitive to the change in cutting speed.

The obtained empirical equation of the cutting force \( (F_c) \) in the form of actual factor is as stated in equation (1),

\[
F_c = 51.38 + 766.75 \times f
\]

where \( F_c \) is the main cutting force and \( f \) is the feed. For convenience, the equation can be displayed as response surface contour as well as three dimensional surface, as depicted in Figure 1.

The effect of feed to the cutting force is related to the size of the uncut chip thickness. Naturally, the higher the feed, the higher the cutting force as well. This is consistent with the fact that \( F_c \) is the main force acting on the rake face of the tool, and it was confirmed by a report on turning the hardened steel. Considering that the size of uncut chip thickness has no relation with cutting speed, the cutting speed’s effect was not significant to cutting force. This is in agreement with previous studies on various workpiece metals.

**Power consumption**

For power consumption, it was quadratic model which suits the data. Initial model was developed, but its ANOVA indicated that \( x_1^2 \) and \( x_1 x_2 \) factors were not significant. To improve the model, these factors were omitted, and a new model with partial sum of square by omitting those two factors was obtained. The ANOVA of the power consumption data is as given in Table 4. The quadratic model as well all its coefficients were now considered significant.

The obtained equation for the power consumption \( (P_c) \) is as presented in equation (2).

\[
P_c = -0.382 + 4.65E - 03 \times V_c + 10.94 \times f - 31.10 \times f^2
\]

where \( P_c \) is the power consumption and \( V_c \) and \( f \) are the cutting speed and feed, respectively. The response surface contour and 3D surface for equation (2) are depicted in Figure 2.

It is known that to obtain higher spindle speed, higher power is needed by the motor to rotate the spindle. When cutting action takes place, the motor consumes even higher power to maintain the set spindle speed. It is interesting to note that previous studies reported that the change in power consumption is contributed not only by the cutting speed but also by other cutting parameters as well. The results displayed significant influence of both cutting speed and feed on the power consumption of the dry turning process. The relation between the input factor and

![Figure 1. Response surface graphs of (a) contours and (b) 3D surface for cutting force.](image)

| Table 4. ANOVA for partial sum of square of the quadratic model of power consumption. |
|---------------------------------------------|----------|----------|----------|----------|----------|
| Source     | Sum of squares | DF | Mean square | \( F \) value | Prob > \( F \) |
| Model       | 0.52       | 3    | 0.17         | 139.49   | <0.01    | Significant |
| \( x_1 \)   | 0.47       | 1    | 0.47         | 374.03   | <0.01    | Significant |
| \( x_2 \)   | 0.02       | 1    | 0.02         | 17.02    | <0.01    | Significant |
| \( x_1^2 \) | 0.03       | 1    | 0.03         | 27.42    | <0.01    | Significant |
| Residual    | 0.01       | 7    | 0.001        |          |          |            |
| Cor total   | 0.53       | 10   |              |          |          |            |
the machining response is proportional, which is as expected, and was reported before for turning of steels and various other workpiece materials.\textsuperscript{1,6,17–20} Although both cutting speed and feed are significant, their effect can be ranked. From Table 4, cutting speed has $F$ value of much higher than feed, and this means cutting speed still dominates the effect. This is in line with report by Bhattacharya et al.,\textsuperscript{6} which concluded that cutting speed was responsible for 77.4\% of the power consumption. Nonetheless, the finding that feed also gives significant effect on power consumption means it should be also be considered when reduction in power consumption in turning AISI 316L is intended.

### Surface roughness

For surface roughness, linear model was suitable, and the ANOVA is given in Table 5. It was found that only the feed is significant to the surface roughness.

The equation of the $Ra$ model is as stated in equation (3) in the form of actual factor.

\begin{equation}
(Ra)^{-1.31} = 1.43 - 5.24 \times f
\end{equation}

where $Ra$ is the surface roughness and $f$ is the feed. The response surface contour and 3D surface for equation (3) are illustrated in Figure 3.

The obtained $Ra$ from the turning at the selected cutting parameters was mostly within finish turning range, which is 0.7–1.5 $\mu$m,\textsuperscript{12,20} especially when the feed was 0.16 or lower. The stainless steel workpiece showed expected behavior that its surface roughness is proportional to feed. Theoretically, surface roughness is a function of nose radius and feed, and hence their proportionality and also why the $Ra$ value was not influenced by the cutting speed. The non-significant effect of cutting speed on the surface roughness suggests that the cutting speeds are within the range of low cutting speed or the material is considered soft.\textsuperscript{11,12,20}

### Tool life

For tool life, the quadratic model was best suited. Backward elimination on the factors $x_1^2$ and $x_1x_2$ of the initial model was done due to their insignificance. The ANOVA for tool life is given in Table 6.

The obtained equation of the tool life ($T$) is presented in equation (4).

\begin{equation}
(T)^{-1.5} = -6.55E - 05 + 1.45E - 07 \times V_c + 6.87E - 04 \times f - 1.83E - 03 \times f^2
\end{equation}

where $T$ is the tool life, and $V_c$ and $f$ are the cutting speed and feed, respectively. The response surface contour and 3D surface for equation (4) are shown in Figure 4.
The tool life was longer at lower cutting speed and lower feed. The trend is as expected, considering both input factors contribute to higher tool wear progression. This is in agreement with previous results, which also reported that the effect of cutting speed is higher than feed’s to the tool life.11,12,20

**Optimization**

Now that empirical models for all machining responses as functions of cutting speed and feed have been obtained, selection of optimum cutting parameters setting can be done. One can set the expected range of each machining response and the range of cutting speed and feed that fit the expectation for all machining response can be determined.4,12,20 As an example, say that arbitrarily, the tool life shall be more than 1808 s (30.1 min), the cutting force should be less than 190 N, the power consumption should be less than 1200 W, and the surface roughness shall be less than 1.48 μm. To achieve those criteria, the range of cutting speed and feed should fall within the gray region of the overlay plot (Figure 5) of all the machining responses.

Another way to use the empirical equations of the machining responses is for determining the optimum

---

**Figure 3.** Response surface graphs of (a) contours and (b) 3D surface for surface roughness.

**Figure 4.** Response surface graphs of (a) contours and (b) 3D surface for tool life.

**Table 6.** ANOVA for partial sum of squares of the quadratic model of tool life.

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cutting parameters when a set of machining response is desired. Figure 6 depicts the graphical optimization of the so-called desirability plot when one wishes to determine the optimum cutting speed and feed which will result in the minimum cutting force, minimum power consumption, minimum surface roughness, and the maximum tool life. For such target, the optimum cutting parameters combination is at feed of 0.19 mm/rev and cutting speed of 125 m/min.

Conclusion

Turning of AISI 316L austenitic stainless steel was performed by using coated carbide tool without cutting fluid. The cutting speed and feed were varied at 90, 150, and 210 m/min and at 0.10, 0.16, and 0.22 mm/rev, respectively. The machining responses evaluated were cutting force, power consumption, surface roughness, and tool life. RSM was used for the design of experiments. It was found that feed was proportional to cutting force, power consumption, and surface roughness and was inversely proportional to tool life. Cutting speed was proportional to power consumption and was inversely proportional to tool life, while being not significant to cutting force and surface roughness. This shows that power consumption, which is an important factor in sustainable manufacturing, can be included in machinability study along with other machining responses. The developed empirical models of the machining responses can be used to determine the optimum cutting parameters range, optimum cutting speed, and feed, which will result in the minimum cutting force, minimum power consumption, minimum surface roughness, and the maximum tool life.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Financial supports from the Ministry of Education, Malaysia and Universiti Teknologi Malaysia through Fundamental Research Grant Scheme No. 4F285 are gratefully acknowledged.

References


**Country**
- United States

**Subject Area and Category**
- Engineering
  - Industrial and Manufacturing Engineering
  - Mechanical Engineering

**Publisher**
- SAGE Publications Inc.

**Publication type**
- Journals

**ISSN**
- 09544089

**Coverage**
- 1989-ongoing

**Scope**
The Journal of Process Mechanical Engineering is a quarterly publication for engineers in industry and academe who are concerned with the process industries. The Journal publishes high-quality papers covering a broad area of mechanical engineering activities associated with the design and operation of process equipment. The impact of design on the overall performance of the industrial enterprise, including efficiency, quality, sustainability and waste management is an important feature of the Journal.

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Machining parameters effect in dry turning of AISI 316L stainless steel using coated carbide tools

Author(s): Nur, R (Nur, Rusdi); Noordin, MY (Noordin, M. Y.); Izman, S (Izman, S.); Kurniawan, D (Kurniawan, D.)

Source: PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PART E JOURNAL OF PROCESS MECHANICAL ENGINEERING
Volume: 231 Issue: 4 Pages: 676-683 DOI: 10.1177/0954408915624861 Published: AUG 2017

Abstract: Austenitic stainless steel AISI 316L is used in many applications, including chemical industry, nuclear power plants, and medical devices, because of its high mechanical properties and corrosion resistance. Machinability study on the stainless steel is of interest. Toward sustainable manufacturing, this study also includes the power consumption during machining along with other machining responses of cutting force, surface roughness, and tool life. Turning on the stainless steel was performed using coated carbide tool without using cutting fluid. The turning was performed at various cutting speeds (90, 150, and 210 m/min) and feeds (0.10, 0.16, and 0.22 mm/rev). Response surface methodology was adopted in designing the experiments to quantify the effect of cutting speed and feed on the machining responses. It was found that cutting speed was proportional to power consumption and was inversely proportional to tool life, and showed no significant effect on the cutting force and the surface roughness. Feed was proportional to cutting force, power consumption, and surface roughness and was inversely proportional to tool life. Empirical equations developed from the results for all machining responses were shown to be useful in determining the optimum cutting parameters range.

Accession Number: WOS:000406532800006

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<td>Kurniawan, Denni</td>
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ISSN: 0954-4089
eISSN: 2041-3009
Machining parameters effect in dry turning of AISI 316L stainless steel using coated carbide tools


DOI: 10.1177/0954408915624861

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Author Keywords
Austenitic stainless steel; coated carbide; cutting force; power consumption; response surface methodology; surface roughness; tool life

Index Keywords
Austenitic stainless steel, Biomedical equipment, Carbide cutting tools, Carbide tools, Chemical industry, Corrosion resistance, Cutting, Cutting fluids, Cutting tools, Electric power utilization, Nuclear fuels, Nuclear power plants, Surface properties, Surface roughness, Turning; AISI316L stainless steel, Austenitic stainless, Coated carbides, Cutting forces, High mechanical properties, Response surface methodology, Sustainable manufacturing, Tool life; Stainless steel

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Publisher: SAGE Publications Ltd

ISSN: 09544089
CODEN: PMEE
Language of Original Document: English
2-s2.0-85026230497
Document Type: Article
Publication Stage: Final
Source: Scopus
Salam

ini paper ketiga yang mendapat respon dari Journal of Process Mechanical Engineering dan saya telah baiki sesuai comment reviewer dan juga telah dihantar ke Dr. Denni untuk dibaiiki kembali sebelum di proofreading.

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To: denni@utm.my

06-Aug-2015

Dear Dr. Kurniawan:

Manuscript ID JPME-15-0067 entitled "Machining Parameters Effect in Dry Turning of AISI 316L Stainless Steel using Coated Carbide Tool" which you submitted to Journal of Process Mechanical Engineering, has been reviewed. The comments of the reviewer(s) are included at the bottom of this letter.

The reviewer(s) have recommended major revisions to your manuscript. Therefore, I invite you to respond to the reviewer(s)' comments and revise your manuscript. May I also draw your attention to the attached Editorial Checklist as the issues should also be addressed when preparing for submission of your amended version.

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Sincerely,
Katrina Newitt,
Associate Editor
The Journal of Process Mechanical Engineering Office

Reviewer(s)' Comments to Author:

Reviewer: 1

Comments to the Author
The authors have studied the effects of various cutting parameters on the power consumption and the surface finish and provided a range of optimised parameters to minimise power consumption as well as achieving a good surface finish and tool life. The submitted paper requires a review by a native English speaker to improve the English level. The literature review is very weak and the novelty of the results is not clear. The discussion section should be improved specifically on the effect of cutting speed on cutting forces and power consumption. The authors should also compare their findings with the published results.

Reviewer: 2

Comments to the Author
This paper investigates the influence of cutting parameters on the machining responses in dry turning AISI 316L stainless steel. I think this paper can be acceptable subject to the following revisions.
1. The title should be “Machining Parameters Effect in Dry Turning of AISI 316L Stainless Steel using Coated Carbide Tool”. But in page 2 of the manuscript, the title is “Power Consumption as Machining Response in Dry Turning of AISI 316L Stainless Steel using Coated Carbide Tool”.
2. In the abstract, “various cutting speeds (0.10, 0.16, and 0.22 mm/rev) and feeds (90, 150, and 210 mm/min)” should be changed to “various cutting speeds (90, 150, and 210 mm/min) and feeds (0.10, 0.16, and 0.22 mm/rev)”. And in the first paragraph of page 4, “The cutting speeds were varied at 0.10, 0.16, and 0.22 mm/rev, the feed was also varied at 90, 150, and 210 mm/min” should be changed to “The cutting speeds were varied at 90, 150, and 210 mm/min, the feed was also varied at 0.10, 0.16, and 0.22 mm/rev”.
3. The English should be improved.

Dari: Denni Kurniawan (denni@utm.my)
Kepada: izman@fkm.utm.my; ar_rusdi_nur@yahoo.com
Tanggal: Minggu, 20 Desember 2015 17.03 GMT+8

Assalam,

Dilampirkan pruf paper yang baru accepted. Silakan disemak, dan kalau ada apa-apa yang perlu diubah/ditambahkan, sila maklumkan, dan nanti akan saya masukkan.

Thank you and best wishes,
Denni

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From: Denni Kurniawan <denni@utm.my>
Date: Sun, Dec 20, 2015 at 4:41 PM
To: Prof Noordin Mohd Yusof <noordin@fkm.utm.my>

assalam Prof,

Beberapa yang saya sudah tukar:
- Corresponding Author nya adalah Prof
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While working on the article, I noticed that the figures 1,3,5,6 are of poor quality. Could you please provide me the better quality figures to be inserted in the article.

It would be great if you could provide me the same by 13th July in order to publish the issue on time.

Please let me know in case of any question. I look forward to hearing from you.

Thank you!

Regards,

Arshiya

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Thank you!

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Thank you and best wishes,
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Have a great day ahead!

Regards,

Arshiya