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ANALYSIS OF THE RESULTING MACHINING FORCES BY USING STANDARD AND WIPER CUTTING TOOLS IN DRY FINISH TURNING OF AISI 420

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Abstract. *The machining processes can be associated with the cutting forces and surface topography. The machining forces can be represented by three orthogonal components (feed force F_f, passive force F_p and main cutting force F_c). The surface topography can be quantified by roughness parameters such as Average Roughness (R_a) and Total Roughness (R_z). In this work, a study of the static and dynamic machining forces and the analysis of R_a and R_z generated on dry finish turning of AISI 420 stainless steel using wiper and standard tools were made. The experiments were realized using a constant cutting speed, two feed rates (f), two depth of cut (a_p) and two tool geometries (wiper and standard). It has been observed that with higher feed rate values the static forces in standard tool were more significant than in wiper tool using the same other cutting parameters. For low feed rates both of them presented the same behavior relating to static cutting forces. As for the dynamic forces, the feed rate was the most influent parameter for both geometries. Furthermore, the surface roughness has direct relationship with cutting forces in the tool. The wiper insert showed better performance for forces and roughness when relating to the conventional insert.*

Keywords: *wiper tool, standard tool, turning, cutting forces*

1. INTRODUCTION

Modern improvements in manufacturing processes drive the development of new technologies and means of production, designed to achieve increased productivity and reduced the costs of production while maintaining the high quality of products. In order to increase productivity in this sense, tool manufacturers are continuously improving their materials, offering new coatings for cutting edges and modifying the cutting inserts geometries (Stachurski *et al.*, 2012).

The dry finish turning of a stainless steel AISI 420 is discussed in this paper. It is a martensitic stainless steel which has a high mechanical strength and good machinability. It is ideal for manufacturing high precision parts as cutlery utensils, surgical and dental instruments, spindles, pumps and valves parts, plastic moulds and glass industry.

According to cutting tool, a new technology for turning inserts in high yield was developed in the 90s. The geometry called wiper was introduced in the market with cutting capacities far superior to what had been used until then.

Initial studies involving wiper tools were based on the fact that the best finish was obtained from the combination of high cutting speeds with low feed rates. Moreover, it was possible to obtain higher cutting tool lifetime with the cutting speed reduction. Grzesik and Wanat (2006) found in the turning of a hardened steel alloy that could have similar results to the wiper tool using standard tool with lower feed rates. Davim and Figueira (2007) also concluded that wiper geometry tools perform better than the conventional tools for improved surface finish. The study conducted by Gaitonde *et al.* (2009) showed better performance of ceramic wiper tool for surface finish and tool life in turning of AISI D2, whereas with standard tool the cutting forces were smaller. In the comparative study on these two different tool geometries, Atefi *et al.* (2012) mentioning that the surface roughness and cutting force values in wiper ceramic inserts are 19.4% and 4.2% respectively lower than these values in standard ceramic inserts in high speed turning of Inconel 718 super alloy. Another recent study mentions the wiper insert more efficient than standard insert regarding the cutting tool life in turning of SAE 4140 (Souza *et al.*, 2013). Finally, hard turning of martensitic stainless steel was performed using wiper coated carbide tool at various cutting speeds and feed rates by Noordin *et al.* (2007). The set parameters combination of low cutting speed and low feed rates produced the longest tool life. Wiper coated carbide tool achieved very fine surface finish, much better than the theoretical values and within the strict range of finish machining criteria.

The research mentioned above generate reflections of why the wiper tool does not occupy a prominent position in the market. Thus, this study aims to bring best practical and theoretical foundation to defend the use of this geometry. Few studies have been conducted to date by performing a comparison of cutting forces on these two types of inserts, which encourages research and development of this paper. For this study was made an analysis of the static and dynamic portions of the three orthogonal components of machining force (feed force F_f, passive force F_p and main cutting force F_c) and the analysis of average (R_a) and total roughness (R_z) generated on dry finish turning of AISI 420 stainless steel using wiper and standard tools.

1.1 Cutting Forces in Turning

A simplification is made to study the cutting forces in a turning process that assesses the application of forces at a certain point, whereas in practice these forces are acting on determined area or surface.

The machining force F is the total force acting upon a cutting edge during the machining. In turning there is a single edge and the components of this force can be set through an orthogonal decomposition which takes into regard the chip formation features. They may vary with tool angles, feed and cutting speed.

The consideration of three components from the decomposition above is common. The three principal forces acting on a cutting tool are shown in Fig. 1. The main cutting force F_c acts downward on the tool tip and thus tends to deflect the toll downward and the workpiece upward. This is usually the largest component, and acts at the direction of cutting velocity. The feed force (or thrust force) F_f acts in the longitudinal direction (feed direction of the tool) and tends to push the tool towards the right and away from the chuck. The passive force (or radial force) F_p acts in the radial direction and tends to push the tool away from the workpiece. This is the smallest of the force components (Diniz *et al.*, 2010; Ferraresi, 1977; Kalpakjian and Schmid, 2010; Machado *et al.*, 2009; Tschätsch, 2009). According to Kalpakjian and Schmid (2010), these forces are important in the design of machine tools, as well as in the deflection of tools and workpieces for precision machining operations. The machine tool and its components must be able to resist such forces without causing significant deflections, vibrations, and chatter in the overall operation. Because of the many factors involved in the cutting processes, forces F_f and F_p are difficult to calculate directy (in contrast to the F_c); they usually are determined experimentally if desired.

The specific cutting pressure (K_s) is the main cutting force (F_c) per sectional area of chip (A_o) as shown in Eq. (1),

$$F_c = K_s \cdot A_o = K_s \cdot a_p \cdot f \tag{1}$$

where K_s is the specific cutting pressure (also called specific cutting force), and A_o is the sectional area of chip (also called cutting area) which can be defined by the product of the depth of cut (a_p) and the feed rate (f).

The depth of cut (a_p) has a direct linear relationship with the cutting forces: doubling up a_p, the cutting forces also doubles. But the feed rate (f) does not yield the same way. In turning process, if f is doubled, K_s decrease, and thus there is no rising and directly linear variation between f and cutting forces (Gaitonde *et al.*, 2009; Machado *et al.*, 2009).

The thickness of cut (h) is the variable that has the most effect on K_s. The greater h, the less K_s. Since this curve is a hyperbola, the biggest influence of h on K_s appears in the range of small and medium chip thickness values. Also, the tool cutting edge angle (κ_r) affects the forces during the cutting process: the greater κ_r, the greater the feed force (F_f) and the less the passive force (F_p). For this reason, as a rule, instable workpieces demand a large κ_r (Tschätsch, 2009).

The static portion of cutting force can be specified as the average of a data sampling force magnitude a certain time interval. However, the dynamic portion of cutting force is associated with a baseline oscillation at the beginning of cut, generally reaching a maximum value at the end of cut (Toh, 2004). Static and dynamic entities of the sampled cutting force were extracted as the mean and oscillatory components respectively (see Fig. 2) and analyzed in time and frequency domains from which features sensitive to tool wear were identified. Time domain established the nature and level of static force magnitude change while frequency analysis demonstrated the dynamic force signatures' response to cutting conditions as well as accrued wear levels (Dimla, 2000). Oraby and Hayhurst (2004) verified the behavior of standard inserts about the dynamic forces generated, and measured experimentally the greater feed rate influence on the oscillation amplitude of this cutting force portion. This response was obtained through a comparative study with a diverse range of cutting parameters.

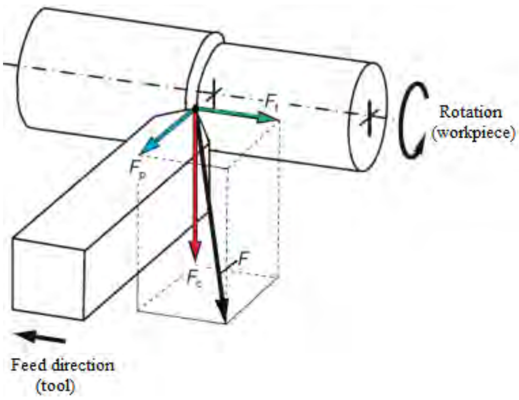

Figure 1. Cutting forces in turning.

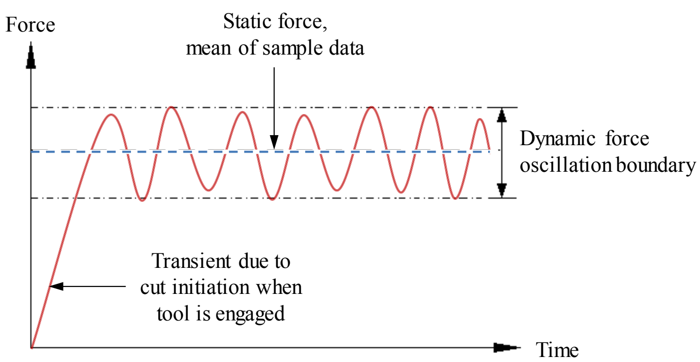

Figure 2. Force amplitude vs. time (fixed cutting conditions) (adapted from Dimla, 2000).

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Information about the history of the cutting forces is very significant because they express points involving the cutting process, the workpiece, the tool and the clamping devices. Thereby provides a strong foundation for understanding the kinematics and dynamics of cutting tools and machining processes. They can also be used to optimize the geometries of cutting tools and test instrument's probabilities of distortion. Moreover, these forces are commonly used in the monitoring of tool life.

1.2 Surface Roughness

The finishing surface study is important in cases where it requires a precision fit between the joined parts and when the dimensional accuracy and shape are not suitable to ensure the functionality of the whole.

The surface roughness is a microscopic topography left by machining and often imperceptible. This evaluation is possible with the use of a specific apparatus called profilometer. In Brazil, the concepts of surface roughness are determined the standard NBR ISO 4287 (ABNT, 2002), adopting the system midline.

The generated roughness in machining is influenced by the process than the machine tool. According to Machado *et al.* (2009) there are some factors that may contribute to generate roughness, such as: grooves generated by the tool nose; burr generation on the workpiece during the cutting operation; bits of the built-up edge in the machined surface; geometric shape of the chip breaker on the tool edge.

The parameters used to evaluate the texture of the machined surface are the average roughness (R_a) and total roughness (R_z), Fig. 3. R_a is the arithmetic average of the absolute values of the surface profile ordinates (*P(x)*) in the evaluation length *L*. The average roughness is the area between the surface profile and its mean line (*LM*), or the integral of the absolute value of the roughness profile height over the evaluation length *L*. R_z is the maximum height of the profile in the evaluation length *L*

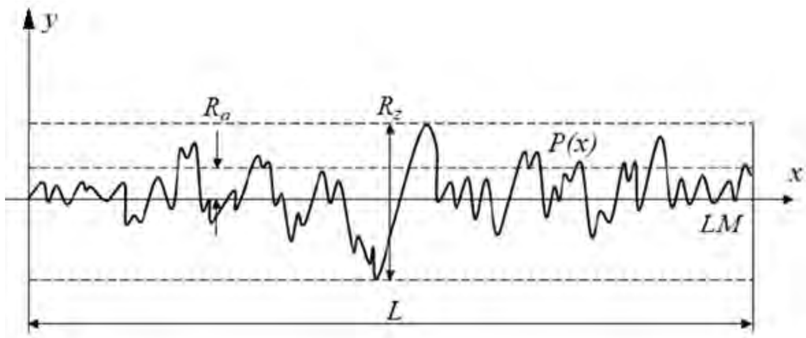

Figure 3. Roughness R_a e R_z on a surface profile *P(x)* of an evaluation length *L* (adapted from Mello *et al.*, 2012)

1.3 Standard and Wiper Tool

The insert geometry determines the working area of the insert as regards component material and cutting data possibilities. Also defines the cutting action and strength of the cutting edge as well as the range of acceptable chip-breaking in terms of depth of cut (a_p) and feed rate (*f*). It is generally dedicated to the component material type as there are wide variations in the form of long-chipping and short-chipping materials, continuous, discontinuous chips, hard and soft materials. There are also various operational demands and geometries that are different depending upon if they are intended for rough, medium or finish-machining and whether the insert has a negative or positive basic shape. Machine power and vibration tendencies also affect the choice of insert geometry as some geometries are more easy-cutting than others (Sandvik, 2012).

The increasing of tool nose radius (r_ε) make it more resistant but increases the vibration due to friction caused by the larger contact area between workpiece and tool. The finish surface depends on a lot of the ratio between feed rate and nose radius. This ratio contributes directly to the workpiece roughness being the lowest possible roughness in turning process (Diniz *et al.*, 2010; Machado *et al.*, 2009; Kalpakjian and Schmid, 2010).

The standard tool (Fig. 4a) had one nose radius (r_ε) which can range from 0.1 to 2.4 mm. Are the most common used, but are being chased by a new technology called wiper tool.

The wiper tool (Fig. 4b) generally has three or more nose radii (reaching up to nine) conferring a different interaction with the workpiece surface and resulting changes in finish surface machined. This increases the contact length of the tool and the effect of feed rates in a positive way. The reduction in cutting times with these tools is around 30% because they can operate at high feed rates generating small roughness and good chip breaking. The nose radius of wiper tool provides a low profile height on the cutting edge of the generated surface which has the smoothing effect of the machined surface (Sandvik, 2012).

Furthermore, the wiper tool has more lifetime than standard tool (Souza *et al.*, 2013).

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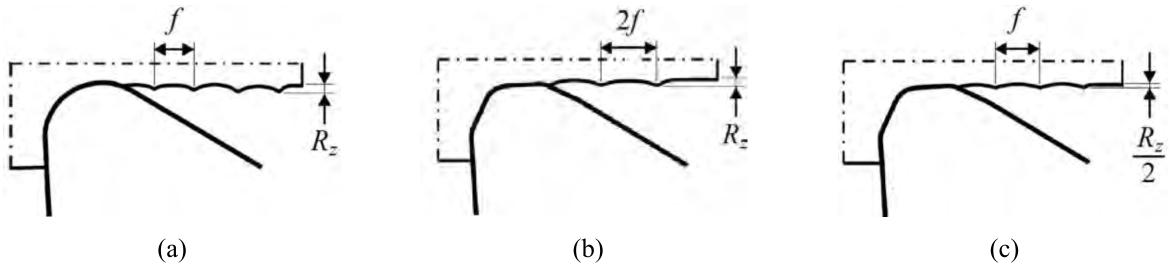


Figure 4. Scheme on surface roughness formation (R_z parameter) during the turning process: (a) standard geometry and (b-c) wiper geometry (Stachurski *et al.*, 2012)

2. METODOLOGY

The experimental procedure consisted of the dry finish turning of martensitic stainless steel AISI 420 using standard and wiper tool. Figure 5 shows the experimental setup.

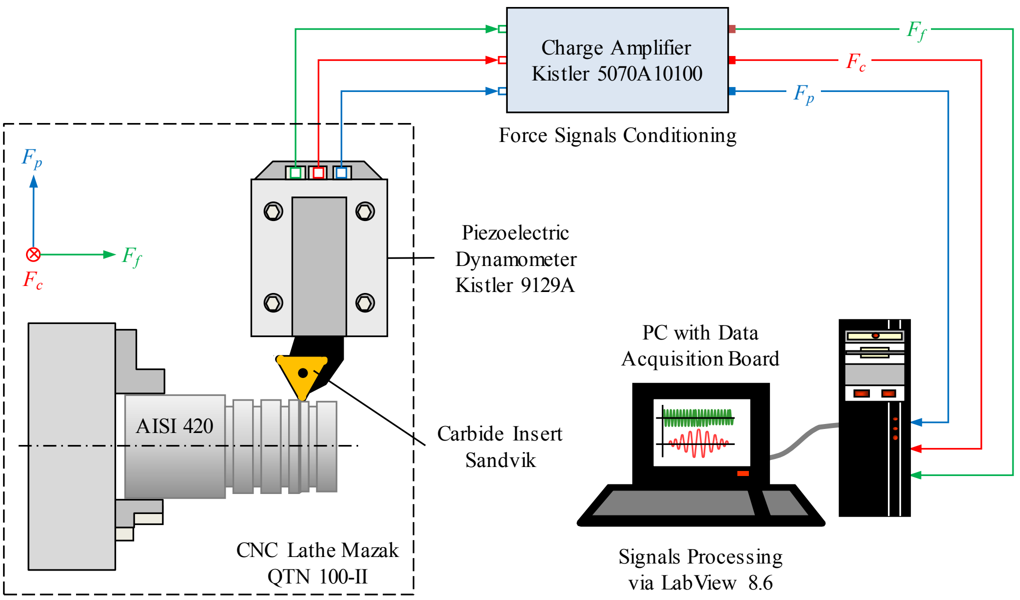
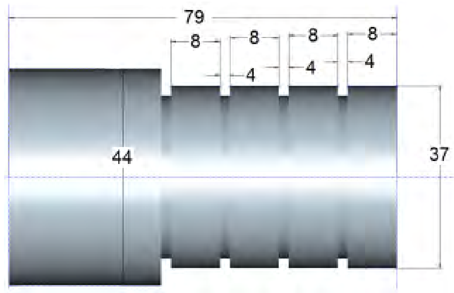


Figure 5. The experimental setup

The external longitudinal turning was made using the CNC lathe Mazak model Quick Turn Nexus 100-II (Fig. 6a). Measurement of cutting force and surface roughness of turned surface was made and the obtained values were properly stored. The workpiece was prepared in order to facilitate and enable better data acquisition. Only one workpiece (Fig. 6b) with four intervals interspersed was used in the trials.

(a) (b)

Figure 6. (a) CNC lathe Mazak QTN 100-II; (b) workpiece used in the experiment

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2.1 Workpiece

Table 1 specifies the chemical composition obtained for the martensitic stainless steel AISI 420 used in the experimental procedures. The metal chemical composition has been performed using a spectrometer Spectrolab model LVFA18B (LAMEF-UFRGS) and hardness measurement of steel was 210 HB.

Table 1. Chemical composition of stainless steel AISI 420 (Rosa *et al.*, 2012)

Element	Fe	Cr	C	Mn	Ni	Si	S	others
Weight [%]	85,80	12,95	0,329	0,326	0,234	0,176	0,0098	0,185

2.2 Cutting Tool

Tool inserts with triangular negative basic format (T-Max P), nose radius r_ε= 0.4 mm and chipbreaker for finishing turning (PF e WF) were used in the experiments (Fig. 7). The Sandvik inserts have coverage type MTCVD (Medium Temperature Chemical Vapor Deposition) of $TiCN/Al_2O_3/TiN$. The toolholder has the tool cutting edge angle $\kappa_r = 93°$.

(a) TNMG 160404-MF (b) TNMX 160404-WF

Figure 7. Tool inserts: (a) standard; (b) wiper.

2.3 Cutting Parameters

For the experimental procedures were choose two types of nose geometries, two values of feed rate (f = 0.1 and 0.2 mm/rev.), two values of depth of cut (a_p = 0.5 and 1.0 mm) and one cutting speed (v_c = 290 m/min), generating $2^3 = 8$ combination of parameters in order to verify the influence of this variation on the resulting cutting force and the surface roughness. These parameters were based on the manufacturer's optimal specifications for both geometries. Table 2 show the cutting parameters used in the eight tests.

Table 2. Cutting parameters used with v_c = 290 m/min

Geometry	**Test**	a_p **[mm]**	f **[mm/rev.]**
Standard 	S1	1.0	0.1
	S2	1.0	0.2
	S3	0.5	0.1
	S4	0.5	0.2
Wiper 	W1	1.0	0.1
	W2	1.0	0.2
	W3	0.5	0.1
	W4	0.5	0.2

2.4 Cutting Force Data Acquisition System

The cutting force measurements were performed for eight different combinations (S1 to S4 and W1 to W4) after the definition of the cutting parameters. The Kistler piezoelectric dynamometer model 9129A which allows the acquisition of the three orthogonal components of machining force (Fig. 8) was used for data acquisition.

The machining force signals obtained in the turning process correspond to feed force (F_f), passive force (F_p) and main cutting force (F_c). The sensitivity and amplification of each axis was adjusted on Kistler charge amplifier model 5070A10100.

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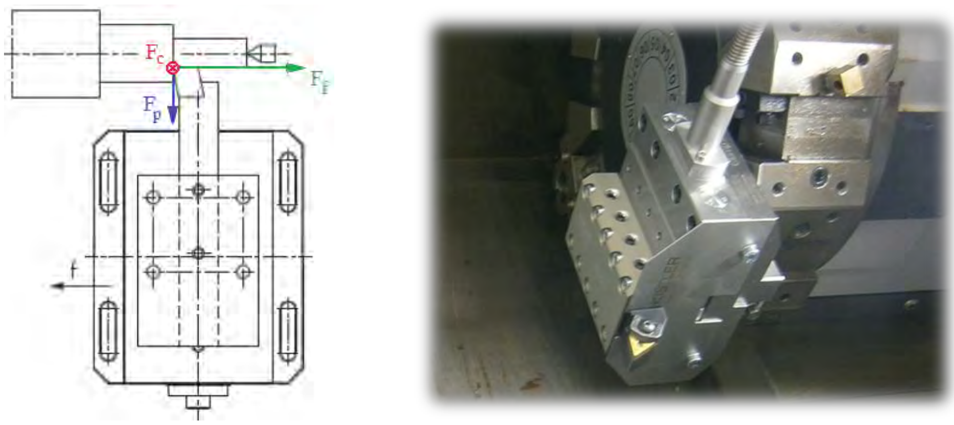

(a) (b)

Figure 8. Kistler stationary dynamometer model 9129A: (a) draw of forces during longitudinal cylindrical turning (adapted from Kistler, 2009); (b) 3-component system installed on Mazak QTN 100-II

The signal processing was performed using the software LabView 8.6. Two different values of feed rate (f) present two different data acquisition time for each parameter combination (Tab. 2). The sampling rate was 2 kS/s during 7 s. The cutting time of the tool (t_c [s]) in each test is presented by Eq. 2:

$$t_c \text{ [s]} = \frac{60 \cdot L_f \cdot \pi \cdot d}{1000 \cdot f \cdot v_c} = \frac{60 \cdot 8 \cdot \pi \cdot 37}{1000 \cdot f \cdot 290} \quad \therefore \quad t_c \cong \frac{1}{5 \cdot f} \qquad (2)$$

Then a cutting time is about 1.0 s (2000 samples) for $f = 0.2$ mm/rev. and 2.0 s (4000 samples) for $f = 0.1$ mm/rev.

2.5 Surface Roughness Data Measuring System

The roughness measurement of the turned surface was made using a portable profilometer Mitutoyo model SJ-201 with resolution of 0.01 µm. In this measurement was used a cut-off (sampling length) of 0.8 mm and an evaluation length (L) of 0.8 × 5 = 4.0 mm. A magnetic base was used to fix the workpiece and to position it to measure the texture in four planes lagged approximately 90° (Fig. 9).

Figure 9. Surface roughness measurement equipment Mitutoyo SJ-201 and workpiece machined

3. RESULTS

The results obtained in turning with standard and wiper tools were evaluated in a comparative way considering the analysis of the machining force components and surface roughness generated in the workpiece.

3.1 Analysis on the Orthogonal Components of Machining Force

Table 3 indicates the orthogonal components (feed force F_f, passive force F_p and main cutting force F_c) measures in turning operations, considering the variations on tool geometry, feed rate and depth of cut. The results correspond to the final average (static force F) for each case and values of expanded uncertainty (dynamic force ± ΔF) with 95% of confidence interval.

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Table 3. Values for measured static (F) and dynamic ($\pm \Delta F$) cutting forces

Test	a_p [mm]	f [mm/rev.]	v_c [mm/min]	F_p [N]	$\pm \Delta F_p$ [N]	F_c [N]	$\pm \Delta F_c$ [N]	F_f [N]	$\pm \Delta F_f$ [N]
S1	1.0	0.1	290	77.2	25.4	275.3	57.9	194.6	36.6
W1	1.0	0.1	290	92.5	16.3	274.5	57.1	187.2	26.0
S2	1.0	0.2	290	121.5	89.7	503.1	181.1	253.1	118.6
W2	1.0	0.2	290	148.3	93.7	474.7	211.3	244.4	111.4
S3	0.5	0.1	290	80.2	13.9	152.8	42.5	102.1	23.0
W3	0.5	0.1	290	83.1	19.6	149.7	52.8	93.0	25.7
S4	0.5	0.2	290	118.9	93.8	249.7	211.7	112.0	111.0
W4	0.5	0.2	290	120.2	40.1	217.9	110.5	102.7	58.0

3.2 The Static Cutting Force Components

The average values of force was extracted from within a certain time range (1500 samples for f = 0.2 mm/rev and 3000 samples for f = 0.1 mm/rev) to estimate the static cutting forces on tool inserts. Figure 10 shows the graph of the static orthogonal components in machining force for the data values of Tab. 3.

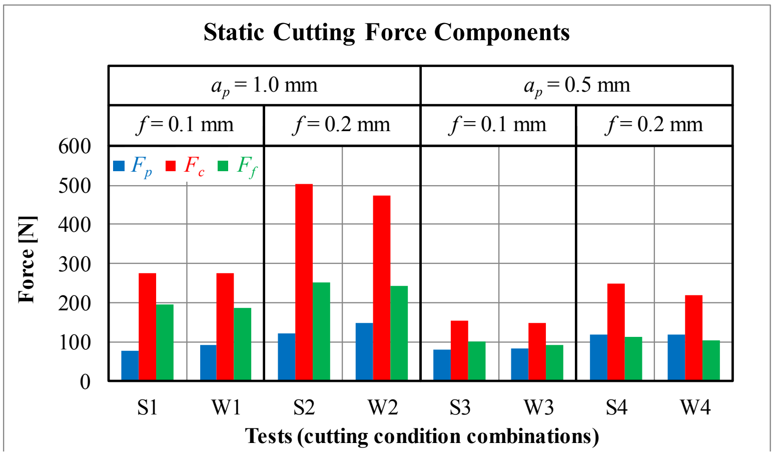

Figure 10. Static cutting forces in turning of AISI 420

The influence of cutting parameters on the forces generated in turning due to change in the sectional area of chip (A_o) is evident. The accepted theory states that to decrease of depth of cut (a_p) is obtained a decrease of main cutting force (F_c) in the same ratio. For an increase of feed rate (f) reflects higher in F_c but not to the same extend because there is a decrease of the specific cutting pressure (K_s). Table 4 shows the percentage of reduction or increase of main cutting force with the variation of depth cut and feed rate.

Table 4. Percentage change in the cutting force with the cutting parameters

Situation	Standard		Wiper	
Decrease a_p	S1 (1.0 mm) to S3 (0.5 mm)	44.5%	W1 (1.0 mm) to W3 (0.5 mm)	45.5%
	S2 (1.0 mm) to S4 (0.5 mm)	50.4%	W2 (1.0 mm) to W4 (0.5 mm)	54.1%
Increase f	S1 (0.1 mm/rev.) to S2 (0.2 mm/rev.)	82.7%	W1 (0.1 mm/rev.) to W2 (0.2 mm/rev.)	72.9%
	S3 (0.1 mm/rev.) to S4 (0.2 mm/rev.)	63.4%	W3 (0.1 mm/rev.) to W4 (0.2 mm/rev.)	45.6%

The higher difference observed in the increase of feed rate f for a_p = 1.0 mm (S1/S2) and a_p = 0.5 mm (S3/S4) (analogously to wiper insert) can be basically described by Ferraresi (1977). For a ratio of $a_p/f < 5$ there is influence on the K_s by end-cutting edge, cutting edge rounding and friction between workpiece and flank face. In this case (Tab. 5), it has been S1 for S2 to a range of 10 to 5 this reason S3 and S4 to a range of 5 to 2.5, reflecting a sharp decrease of K_s.

Table 5. The a_p/f ratio from cutting parameters of Tab. 3.

Test	a_p [mm]	f [mm/rev.]	a_p/f
S1	1.0	0.1	10
W1	1.0	0.1	10
S2	1.0	0.2	5
W2	1.0	0.2	5

Test	a_p [mm]	f [mm/rev.]	a_p/f
S3	0.5	0.1	5
W3	0.5	0.1	5
S4	0.5	0.2	2.5
W4	0.5	0.2	2.5

The nose radius of the wiper inserts enable that the total force becomes more evenly distributed along the surface of reproducing generating lower K_s in the rake face. Equation 1 showed the interaction between the above mentioned variables. Keeping constants a_p and f, K_s is the variable that can be influenced to alterations with the change of tool geometry.

The main cutting force (F_c) and feed force (F_f) produced by the wiper tool were equal or lower than those obtained for conventional tool. This is due to a reduction of K_s by altering the shape of the edge, which facilitates the cutting action. However, the passive force (F_p) was higher. A possible explanation is that the same geometry that facilitates the feed rate and tangential cutting is hindering the radial cutting.

Souza *et al.* (2012) proved experimentally that the wiper tool has a longer tool life in compared to standard tool, what comes according to the cutting forces data acquired. The wiper tool probably will have a longer durability by being less or equal requested in all situations considering the action of the static forces.

3.3 The Dynamic Cutting Force Components

The dynamic cutting forces allow extracting various data about the influence of cutting parameters and influence of tool inserts in this process output variable. Figure 11 shows that the cutting tool vibration is more influenced for the feed rate, presenting in almost all cases an increase of over 100% on the dynamic cutting forces when is doubled up the value of that parameter. This behavior is according to studies cited by Oraby and Hayhurst (2004).

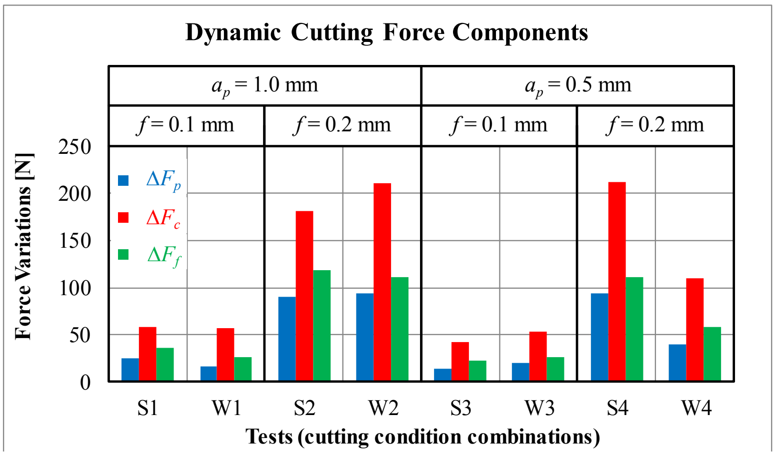

Figure 11. Dynamic cutting forces in turning of AISI 420 (95% of confidence interval).

The comparative study on the dynamic cutting force between standard and wiper tool still in development and does not provide a good database as analysis source. According to Sandvik (2012) the nose radius of wiper insert provides a low profile height in the cutting edge of the generated surface which has a smoothing effect on the turned surface (see Fig. 4). This effect is associated with the contact area flank face/workpiece that is larger and generates higher vibration (a similar effect occurs with increasing the nose radius).

The dynamic cutting force components were strongly influenced by the feed rate of the tool (as with the static forces). The assumption is that the feed rate requires that the workpiece overcome a kind of step to rise in turning. This consideration can prove the current statements that for higher feed rate greater will be the vibration: while both tools with f = 0.1 mm had the similar behavior, for f = 0.2 mm the standard and wiper tool had an increase at least 208% and 307% respectively in the oscillation of the cutting force.

Figure 11 showed that the depth of cut has not a strong influence on the dynamics portions. The result by the comparison between W2 and W4 is a reduction of about 50% in the dynamic force value of W2. By the comparison between S2 to S4 is an increase of nearly 16%. This discrepancy generates oscillations on surface finishing of the workpiece.

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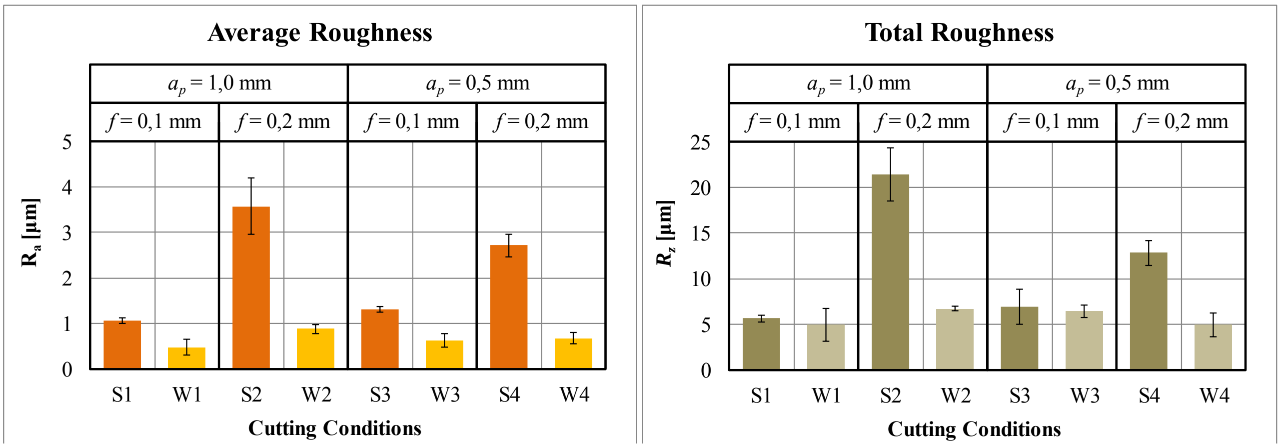
The reason $a_p/f < 5$ cause a reduction of K_s as already mentioned. Given that the situation S4/W4 the ratio $a_p/f = 2.5$ and there are significant differences in standard and wiper geometries (the wiper geometry makes a higher reduction than standard), the dynamic portion of W4 decreases substantially in comparison to W2. The same was not observed for the standard tool from S2 to S4. The situation S4 had a variation of the cutting force 15% higher in comparison to W4, which is the major difference between them observed in dynamic forces. Likewise, still worth observe the similarities in dynamic force behavior between W2 and S4.

3.4 Average and Total Roughness Analysis

Figure 12 shows the roughness measured results (with three repetitions) of machining process.



(a) (b)

Figure 12. Roughness parameters and its expanded uncertainty with 95% of confidence interval: (a) R_a, (b) R_z

The tests were developed with manufacturer's specified parameters for the analyzed tools. Probably these recommendations are for the best use in the process (maximum material removal rate with a tool life of 15 minutes ensuring good quality of machined surface).

The better situation (both R_a and R_z) for standard tool was S1 and for wiper tool was situation W1. Although the static and dynamic portions of forces are not the smallest, the roughness found was the best.

The greater roughness average (situation W2) with wiper tool using $f = 0.2$ mm/rev. and depth of cut $a_p = 1.0$ mm was the worst for this kind of tool and have high quality and outperforms the best roughness R_a found to standard tool.

Note that the main negative cutting parameter for both tools is the feed rate (f). The better behavior of the wiper tool is due to the fact of providing a low profile height of the cutting edge of generated surface. The standard tool does not have the same ability due the different contact interaction between workpiece and tool. The radius of wiper tool difficult the formation of valleys and peaks from the increase of feed rate.

The effect of wiper tool on total roughness (R_z) when the situations W1 and W4 had the bests results (W1 with greater a_p and W4 whit greater f used in this experiment).

The generated surfaces on turning with wiper insert are more qualified than those of the standard insert. There is a direct interaction between cutting forces generated and finishing surface reproduced. The higher effort over the tool, lower the quality of the finishing surface.

Considering the figures 11 and 12 note that there is no significant difference between cutting efforts as there is in roughness. Thus, the acting forces are influenced individually for each tool, but the tool geometry with more nose radius is dominant on quality of finishing surface.

4. CONCLUSIONS

This work presented an analysis of the static and dynamic portions of feed force (F_f), passive force (F_p) and main cutting force (F_c) and the analysis of average (R_a) and total roughness (R_z) generated on dry finish turning of AISI 420 stainless steel using wiper and standard tools and the following conclusions can be drawn:

- The static force components on the standard tool are greater than wiper tool. With an increase of feed rate (f) the main cutting force is higher, clearest on the increase of feed rate for both depth of cut (a_p). The main cutting force (F_c) and feed force (F_f) for wiper tool are the same or smaller than standard tool. The passive force (F_p) for wiper tool was higher. A possible explanation is that the same geometry that facilitates the f and tangential cutting is hindering the radial cutting.

- The consideration of the dynamic force components brought an innovation segment to the paper. The cutting tool vibration is more influenced for feed rate (*f*). The depth of cut (a_p) has not a strong influence on the dynamic force. Nevertheless the wiper tool can be working in more dynamic solicited condition than standard tool in particular situations like low *f* with low a_p.
- Considering the different reproduction capabilities of a better finished surface with each tool the interactive response between cutting forces and surface roughness showed that greater force on the cutting tool generates the less capacity of reproduction of lower roughness. Both geometries had average (R_a) and total (R_z) roughness change with the static orthogonal components of cutting force.
- Allowing for that the costs of both tools are the same it concluded that the use of wiper tool is economically viable, even when used with conditions do not specified by the manufacturer.

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