INVESTIGATION OF CUTTING PARAMETERS IN MILLING OF DIN 1.2379 AND SLEIPNER MATERIALS

by

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In today's machining conditions, the goal is to produce the most suitable quality with the lowest cost. In order to minimize the problems of mouth spillage, especially those used in cutting molds, we have studied Sleipner material as an alternative material and examined the machinability parameters between DIN 1.2379 material used in the application. In this study, with the aid of a force gauge, the forces generated on the material during machining, the surface roughness values after machining with the help of surface roughness device and the temperature values of the materials during machining were measured with the temperature gauge. A total of twelve experiments were carried out for each material at three different chip depths at constant cutting speed and four different progressions for each chip depth. These experiments have been understood from the data that Sleipner material has shown a more stable structure and better results than DIN 1.2379. Thus, the negative manufacturing conditions that may occur during mold production and during mold operation are minimized. In this case, it is necessary to take into consideration the number of the parks produced in the mold and the frequency of mold usage in the material selection of the cutting steel of the cutting molds.

Key words: Sleipner material, DIN 1.2379, cutting parameter, frequency, cutting steel, cutting mold

Introduction

The researchers, continues for reducing the time and the cost required for manufacturing. Automated production and minimal processing are one of the most important goals of modern manufacturing [1]. To achieve this goal, it is highly prioritized to develop techniques to minimize the needs for intermediate processes in production [2, 3]. The technology is currently available to researchers and engineers in the manufacturing process. The control system developed with the combination of existing technologies reduces both production time and cost. One of the minor processes is the controlling the surface quality of the produced part. Determining the surface quality of each part is both costly and a time consuming job. Therefore, it is possible to reduce the time and cost allocated to quality control by improving prediction models and systems.

According to the World Machine-Tool Output & Consumption Survey, the global machine tool consumption in 2014 was $75.3 billion. Based on this report, the machine tool purchasing trends evidently show that the strongest manufacturing countries invest more on the latest machine tool technology. This is due to the fact that machine tools have a hand in
manufacturing of every products in a wide range of industries such as biomedical engineering, nanotechnology, aerospace, automotive, home appliances, and so forth.

On computer numerical control (CNC) machines, the correct sizing and surface quality can be achieved by the correct selection of machining parameters [1]. The machining parameters are parameters such as cutting, feed, spindle speeds, depth of cut [3]. The selection of these parameters is usually made either according to the experience of the operator, the manual of the machine or the tool catalogues [4]. Nevertheless, it is difficult to determine the feed and cutting speeds that can provide the surface roughness and tolerance values specified in the manufacturing drawings [5].

The tribological properties of machined part surfaces are primarily affected by the surface shape [6]. Surface roughness is an important factor not only in traditional tribology fields such as wear, friction, and lubrication, but also in sealing, hydrodynamics, electricity and heat transfer [7, 8]. The most important factor in the industry is surface roughness. Surface treatments are affected by many variables. Reduced surface roughness depends on factors such as reduced depth of cut, proper feed and use of appropriate cutting speeds, increased coolant flow, cutting tool tip radius and large rake angle values.

Ozel et al. [9] emphasized what kind of results can be encountered in the working conditions of tempered AISI 1060 and AISI 4140 steels which are frequently used in practice and in the workings on the change of surface roughness as a result of random selection of machining parameters. In their work, low surface roughness values have been found to be achieved when using high radius cutting tools for both steels.

Their pilot tests with aluminum alloy samples showed that the surface roughness of the work piece, the micro hardness of the work piece, the permanent surface stresses and the dislocation densities changed depending on the tool tip radius. The surfaces treated with the blunt tool were found to be stiffer than those machined with a sharp tool.

In this study, one of the most important criteria in determining the surface quality in machining is the roughness value on the surface of the produced part. In the research, modern production is one of the most important targets of production, while also minimizing cost, increasing automation and minimizing processing for optimal efficiency [10]. To achieve this goal, it is highly prioritized to develop techniques to minimize the needs for intermediate processes in production. Technology therefore, leads researchers and engineers in the production process [11]. The control system developed with the combination of existing technologies reduces both production time and cost. One of the minor processes is the controlling the surface quality of the produced part. Controlling the surface quality of each part is both costly and a time consuming job. Therefore, it is possible to reduce the time and cost allocated to quality control by improving estimation models and systems.

Ebner et al. [11] measured the acoustic sound at high cutting speeds in the milling machine. Mishra et al. [12] attempted to estimate the CNC milling tool wear from the sound changes measured by the sensors in their work. Heng et al. [15] concluded that. It has been shown that the cutting tool changes the sound pressure under various cutting conditions and gives effective results. Mannan et al. [14] studied the relationship between surface quality and the analysis of the noise produced when the cutting tool during chip removal resulting from tool wear.

The aim of this study is to determine the advantages and disadvantages of each other by examining the cutting parameters of DIN 1.2379 and Sleipner materials used in cutting steels cut in sheet metal moulds.
Materials and methods

Working machines, appliances, and tools used in experimental work

Existing CNC machines have less heat rise and vibration than high speed CNC machines. Therefore, there is no need to be mechanically different according to the other machines. The difference in diameter and step determines the axial thrust and the progression in the desired advance values of the machine table through the rotational speed, the torque and the power of the axis motor and all of them.

The CNC machine used in experimental set-up is a milling machine which is a series of O-M series with FANUC control which can perform three axis linear and circular interpolation and it can perform ISO format programming in metric and imperial units. In this study, DIN 1.2379 and Sleipner steel has been chosen as it is widely used, fig. 1.

In production, quality control and maintenance processes, temperature is an important parameter that must be checked. By keeping the temperature under control, it is possible to improve product quality, increase production and avoid sudden stops in unexpected times. Which in turn makes it possible for enterprises to operate in the most favorable conditions. Especially in places where access is not possible, it is possible to measure the temperatures of the objects in motion without contact, fig. 2. The main features that are effective in non-contact temperature measurements are. The environmental conditions of the part are lens and optical system, IR detector, indicator and output.

Advantages of non-contact temperature measurement device include: increased production, reduced maintenance costs, developing quality, removing sudden stops, preventing energy losses.

Infrared thermometers. Since the temperature does not come into contact with the measured object, other production losses are considerably reduced. Infrared thermometers used in isolation-lines also play an important role in reducing energy losses. The device used in this study is Omega’s OS532 infrared touch-type thermometer. They have many advantages over other types of thermometers.

Surface roughness measurement tool. Instruments measuring surface roughness with a penetrating tip measure or control surface roughness at the appropriate lengths and circumferences. In these tools, the drill bit penetrates into the recesses and protrusions which are moved over the surface. This movement is converted into electric current in a magnetic coil or crystal. This electric current is also magnified in the respective units and displayed with the help of a pointer or digitally, and if desired, the printer can be plotted in paper strips as a tip graphic. The cradle attached to the head of this device’s arm-shaped piece supports both the arm and the yoke during movement in certain directions. The movement of the probe tip looks better in the perspective view of the profile measurement geometry.
Team information used in experiment. The R218 obtained from experiment SECO carriers. The 20-2525. 3-22. 218. 20-125ER-ME07 F25M code insert insert used with 060A milling cutter is used. The R218. 20-2525. 3-22. The 060A code gives the mill scale, coupling type, kg values, maximum speed and torque values, fig. 3.

Experimental results and evaluation

The 1.2379 and Sleipner materials and SECO brand 218.20 copy milling set. The constant cutting speed of the milling tool is 130 m per minute. The materials were processed at three different chip depths (2.5 mm, 5 mm, and 7.5 mm) and the materials: \( f_x \), forces, surface roughness, and temperatures were investigated. It was measured according to the ideal cutting conditions of SECO brand tool tips, fig. 4.

In the experimental set-up. A force gauge is attached to the table of the CNC Milling Bench. The Sleipner and DIN 1.2379 materials prepared in the appropriate size are connected to the table of the force gauge with the order. At constant cutting speed at three different chip depths and feed values. A total of 30 experiments were performed. In these experiments, the vibrations generated in the \( x \)-, \( y \)-, and \( z \)-directions at the end of the cutting tool were detected by the force gauge while the force values in the \( f_x \), \( f_y \), and \( f_z \) directions were taken graphically by the force gauge. When machining is carried out, four rows of tracks are observed at each chip depth and in progress.

During the experiment. The 3 or 4 surface roughness values for each cutting direc-
tion were measured and averaged. At the beginning and middle of the experiment, the tempera-
ture was measured with a temperature gauge. As a result of the experiment. The 2\textsuperscript{nd} and 4\textsuperscript{TH} path data are used.

According to the determined experimental conditions and calculations. The obtained
values are given in tab. 1.

Table 1. Substrate roughness and temperature values at varying chip
depths and in progress at Sleipner and DIN 1.2379 materials

<table>
<thead>
<tr>
<th>Material</th>
<th>No.</th>
<th>(a_p)</th>
<th>(V_c)</th>
<th>(N)</th>
<th>(f_x)</th>
<th>(v_f)</th>
<th>Surface roughness [Ra]</th>
<th>Temperature 1</th>
<th>Temperature 2</th>
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<td>2.5</td>
<td>130</td>
<td>275.869</td>
<td>0.05</td>
<td>1.18</td>
<td>0.99</td>
<td>1.7</td>
<td>1.3</td>
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<td></td>
<td>2</td>
<td>2.5</td>
<td>130</td>
<td>275.869</td>
<td>0.075</td>
<td>0.86</td>
<td>1.27</td>
<td>1.4</td>
<td>1.1</td>
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<td>275.869</td>
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<td>1.37</td>
<td>1.95</td>
<td>2.8</td>
<td>2.3</td>
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<td>6</td>
<td>5</td>
<td>130</td>
<td>2069.014</td>
<td>0.05</td>
<td>206.901</td>
<td>1.11</td>
<td>2.98</td>
<td>1.6</td>
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<tr>
<td></td>
<td>7</td>
<td>5</td>
<td>130</td>
<td>2069.014</td>
<td>0.075</td>
<td>310.352</td>
<td>1.65</td>
<td>1.5</td>
<td>1.6</td>
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<tr>
<td></td>
<td>8</td>
<td>5</td>
<td>130</td>
<td>2069.014</td>
<td>0.10</td>
<td>413.803</td>
<td>3.96</td>
<td>4.94</td>
<td>4.4</td>
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<td>11</td>
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<td>180.598</td>
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<td>3.72</td>
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<td>7.5</td>
<td>130</td>
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<td>270.898</td>
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<tr>
<td>Sleipner</td>
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<td>275.869</td>
<td>0.05</td>
<td>275.869</td>
<td>1.79</td>
<td>2.34</td>
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<td>413.803</td>
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<td>180.598</td>
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<td>2.92</td>
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Changing chamber depth, \(f_x\), force value, surface
roughness, and temperature experiment

The 130 m per minute fixed cutting speed, 2.5 mm. in chip depth, and three different
feed quantities (0.050, 0.075, and 0.100) were applied. Looking at the cutting forces, 1.2379
material was found to be more difficult than Sleipner material, fig. 5(a). Surface roughness
value at 1.2379 was higher than Sleipner material, fig. 5(b). The temperature value has changed
as the amount of progression increases. Sleipner material was slightly warmer than material
1.2379, fig. 5(c).
The 130 m per minute, at constant cutting speed, 5 mm in depth of cut, and three different feed rates (0.050, 0.075, and 0.100) were applied. When the shear forces were examined, it was seen that 1.2379 material had more difficulty compared to Sleipner material, fig. 6(a). Surface roughness value in 1.2379 material was higher than Sleipner material, fig. 6(b). The temperature value changed as the amount of feed increased. Sleipner material warmed less than material 1.2379, fig. 6(c).

Considering the $f_c$ cutting force taken from the four different feeds (0.050, 0.075, and 0.100) made at a fixed cutting speed of 130 m per minute at 7.5 mm depth, the 1.2379 material is at 2.5 and 5 mm machining depth. It has been observed that it has more difficulty. Accordingly, the surface roughness value has increased more. Sleipner material was roughened more and 1.2379 showed a more stable structure, figs. 7(a) and 7(b). The temperature value increased with increasing progress. Sleipner material is less heated than 1.2379, fig. 7(c).

**Conclusions**

In this study, as a result of examining the cutting parameters between DIN 1.2379 and patented Sleipner materials in the cold work tool steel class. High abrasion resistance, high tempering resistance, high compressive strength, high dimensional stability in heat treatment, and high hardenability properties of the materials, as a result of the differences in the alloying
Figure 6. Cutting speed 5 mm at 130 m per minute, cutting depth; (a) average $f_x$ value, (b) average surface roughness, and (c) average temperature.

Figure 7. Cutting speed 7.5 mm at 130 m per minute, cutting depth; (a) average $f_x$ value, (b) average surface roughness, and (c) average temperature.
elements of the materials, their superiority to each other was observed. In order to observe the differences between materials, on the CNC milling machine, with the copy milling, constant cutting speed, changing depth of cut and feed per tooth are determined by considering the tool catalogue information and shown in tab. 1, the force $f_x$ coming to the material in the $x$-direction, the surface roughness value measured as a result of the machining and the temperature values measured during processing were obtained as a result of the experiment. During the experiment, the $f_x$, Ra, and °C values found for the feed per tooth of 0.050, 0.075, 0.100, and 0.125 mm at cutting depths of 2.5 mm, 5 mm, and 7.5 mm and each cutting depth were compared with the graphs for the two materials. As a result of this. Looking at fig. 6 for 2.5 mm depth of cut, it was seen that 1.2379 material had more difficulties during processing. Accordingly, the surface roughness value is higher than the Sleipner material. The temperature value increased with increasing progress. Sleipner material is less heated than 1.2379. Looking at fig. 7 for 5 mm depth of cut, it is seen that 1.2379 material is forced more than 2.5 mm machining depth. Accordingly, the surface roughness value has increased more. At 0.100 and 0.125 mm feed, it was roughened 1.2379 more and Sleipner showed a more stable structure. The temperature value increased with increasing progress. Sleipner material is less heated than 1.2379. Looking at fig. 8 for 7.5 mm depth of cut, it is seen that 1.2379 material is more difficult than 2.5 mm and 5 mm machining depth. Accordingly, the surface roughness value has increased more. Sleipner material is roughened more and 1.2379 showed a more stable structure. The temperature value increased with increasing progress. Sleipner material is less heated than 1.2379. As a result, Sleipner material, which is shown as an alternative material in order to minimize the spout problems in cutting dies, has a more stable structure than DIN 1.2379 material. Considering the unit prices of the materials, the quality of the mold and the number of sheet materials to be printed in the mould, Sleipner can be accepted as an alternative and it has been observed that better results are obtained.

References


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