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Effect of Cutting Depth and Feed Speed to Surface Roughness in Lathe Process of Screw Conveyor Shaft (Case Study: PT. RAPP)

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ABSTRACT

The metalworking process is one of the most important things in manufacturing of machine components, such as lathe process. Therefore, it is required continuously innovation to improve production quality. There are several ways to do this, for example by choosing the right type of tool, depth of cut, and spindle speed. In turning process for the production of goods is very important to produce a precision product in accordance to desiring of size and roughness. The turning speed of a lathe has a type of spindle rotation rate that is used according to production requirements, which uses a rotational speed that can be changed the rate of rotation of the machine, in order to determine the level of surface roughness in the turning process. One is affected the optimal conditions of the turning speed and feeding rate. In this paper, the variations of different rotational speed levels of low speed, medium speed and high speed according to variations of feeding rate in order to know the difference in roughness results for the screw conveyor shaft operation. The roughness was measured on the surface turning process using a reference of surface roughness stand comparator (ISO2632 / I-1975). The result of test revealed the greater speed of feed rate, the greater value of roughness. Reversely, the smaller speed of feed rate affected the lower roughness value.

KEY WORDS: *Feed rate, Lathe machine, Turning operation, Roughness surface.*

1.0 INTRODUCTION

One of the pulp and paper industry companies in Indonesia is PT. Riau Andalan Pulp and Paper (PT. RAPP). PT. RAPP is one of the largest integrated pulp and paper mills in the world, with an area of 1750 hectares and an area of Industrial Plantation Forest (HTI) of PT. RAPP reaches approximately 476,000 hectares (ha) [1]. The production capacity of pulp produced reaches 2.8 million tons per year and the production capacity of paper produced reaches 850,000 tons per year due to increased production [1]. PT. RAPP has workshop department to serve repairment and maintenance. In addition, the workshop is able to produce several components by manufacturing process, such as producing the screws conveyor shaft.

The quality of products produced by the machining process is always associated with the accuracy of geometry dimensions and tolerances including the value of surface roughness. Therefore, surface roughness becomes one of the standards of product accuracy and quality.

Shaft is one of product that should have a low surface roughness. The shaft functions as a machine element that transfers power from the prime movers. Due to large dynamic loads, the shaft must have a low surface roughness in order to reduce wear on the shaft. The case study occurred at PT RAPP indicates the surface roughness value on the shaft of 3.2 µm. However, the problem often occurs on the shaft that is losses on the surface due to rough surfaces. Therefore, there is uneven mechanical loading on the shaft surface.

The surface roughness is an irregular configuration and surface characteristic deviations in the form of rough, which can be seen on the surface profile. This occurs due to several factors such as: cutting parameters, tools geometry, the work piece dimensions, defects in work piece material and chip formation flow [2]. The quality of a product can be influenced by the surface roughness of the work piece.

Some researchers have studied the effect of machining processes on work surface roughness [3-11]. The cutting speed and feed rate of a turning process operation may affected by the

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size of the work piece diameter and the number of revolutions per minute [4,5,8]. Furthermore, the greater diameter of work piece rotation, then longer of ratio of the chips formed, the cutting speed may be even greater [9,10].

This study aims to determine the effect of changes in feed speed in the turning process on the surface roughness of work piece to manufacture screws conveyor shaft in PT. RAPP workshop. The surface roughness is very influential on the performance of the shaft of screw conveyor, which affects the quality and price of the item. The results of this study are expected to provide standard to machine operators those changes in feed speed, having an affect on surface roughness of screw conveyor shaft in turning process.

2.0 METHODOLOGY

In this research is an experimental method with the feeding speed and depth of cut as an independent variable, the surface roughness of the test object as the dependent variable. The diameter of the test object was as a controlled variable. A lathe machine type of 10 M Lathe Machine was used in this research. The tool used the HSS (High Speed Steel). The surface roughness stand comparator was used for surface tester. The material to be tested is a screw conveyor shaft. The lathe machine, tool, surface tester, the material object and finishing process of the object can be seen in figures 1-5, respectively.

There are several stages in machining process of screw conveyor shaft, which including notifications from the user, workmanship of the product and finishing. The stages carried out in accordance to SOP (Standard Operating Procedure) of workshop. The user/customer sends a notification that has been signed by the user to the planner and QA Supervisor. Then, the user submits technical drawings according to the standard in the workshop. The planner submits documents to the supervisor, then ordering to employment details to the lathe operator to do the machining process. The machining process for the screw conveyor shaft consists of several steps, the process of installing a shaft conveyor on a 10 M lathe chuck using a crane. The center point setting on the conveyor shaft, spindle speed, feeding rate and deep of cut setting. The feeding rate on screw conveyor shaft was done with different feeding and consumption variations.

There were 5 variations in the size of the desired diameter by user, namely: ϕ155 mm, ϕ140 mm, ϕ130 mm, ϕ90 mm and ϕ60 mm. The following sequence of the feeding process applied on the screw conveyor shaft on turning process i.e. a speed of 20 rpm and feeding rate of 0.3 mm/Rev and deep of feeding of 8 mm.

- Perform flat turning for ϕ155 mm with a length of 575 mm (265 + 223 + 95 + 208 + 234 mm).
- The next step is a flat turning for ϕ140 mm with a length of 420 mm (223 + 95 + 208 + 234 mm).
- After completion of pulverization for ϕ140 mm, it will be made flat turning to a diameter of 130 mm, turning is carried out along 280 mm (95 + 208 + 234 mm).
- Continuation of turning for ϕ90 mm, flat turning was done along 160 mm (208 + 234 mm).
- And finally the turning was flat for ϕ60 mm along 234 mm.

In the turning process of ϕ60 mm, variations in spindle speed (rpm), feeding speed (mm/Rev) and depth of cut (mm) are performed. The following is result of the experiment data can be seen in table 1

Figure 1: 10 M Lathe Machine

Figure 2: The HSS (High Speed Steel) Tool

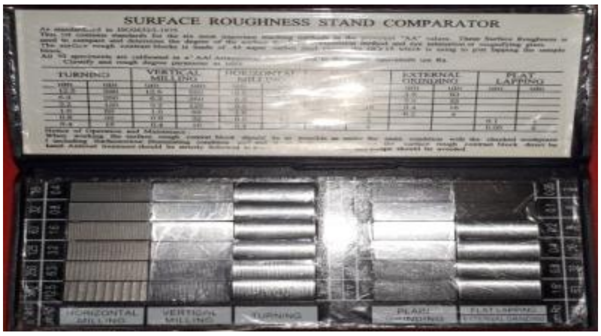

Figure 3: The roughness samples

Figure 4: The screw conveyor shaft

Figure 5: Finishing process

Tabel 1: Experiment Data

Step	Spindle Speed (rpm)	Feeding Speed (mm/Rev)	Depth of Cut (mm)
1	20	0.3	6
2	20	0.3	8
3	20	0.3	6
4	20	0.2	6
5	20	0.1	0.5

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The turning was done in stages till reached diameter target. an every stages of feed process were measured on the shaft with a micrometer. The finishing stage of turning process on screw conveyor shaft is depicted figure 5.

3.0 RESULT AND DISCUSSION

The results of surface roughness testing on turning screw conveyor shafts on spindle speed of 20 rpm, rotational speed variations of feeding and depth of cut material feeding; and surface roughness measurement using the "Surface Roughness Stand Comparator" as standardized in ISO2632 / I-1975 can be seen in table 2.

Table 2: The experimental data results

Experiment	Spesification	Raughness Value (µm)
1	Feeding 0.3 mm/Rev, Cutting Depth 6 mm	12.3/N10
2	Feeding 0.3 mm/Rev, Cutting Depth 8 mm	12.3/N10
3	Feeding 0.3 mm/Rev, Cutting Depth 4 mm	12.3/N10
4	Feeding 0.2 mm/Rev, Cutting Depth 6 mm	6.3/N9
5	Feeding 0.1 mm/Rev, Cutting Depth 0.5 mm	3.2/N8

In Table 2 can be seen the differences of surface roughness values for each variation of machining specifications. The roughness values on the screw conveyor shaft were performed on 5 experimental samples at a diameter of 100 mm.

In experiment 1 carried out with 6 mm of feeding, feed rate of 0.3 mm/Rev and spindle speed of 20 rpm. It was revealed a roughness value of 12.5 µm. The roughness contour is displayed in figure 6. The second experiment result for 8 mm dept of cut, feed rate of 0.3 mm/Rev and spindle speed of 20 rpm received a roughness value of 12.5 µm. The roughness contour is displayed in figure 7. The third experiment was the result for 6 mm dept of cut, feed rate of 0.3 mm/Rev and spindle speed of 20 rpm received a roughness value of 12.5 µm. The roughness contour is displayed in figure 8. The fourth experiment was the result for 4 mm dept of cut, feed rate of 0.2 mm/Rev and spindle speed of 20 rpm received a roughness value of 6.3 µm. The roughness contour is displayed in figure 9. The fifth experiment was the result for 0.5 mm dept of cut, feed rate of 0.1 mm/Rev and spindle speed of 20 rpm received a roughness value of 3.2µm. The roughness contour is displayed in figure 10.

Figure 6: he roughness contour result from experiment 1

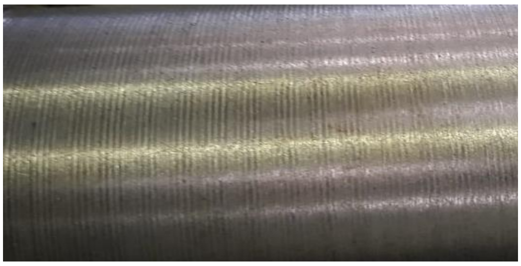

Figure 7: The roughness contour result from experiment 2

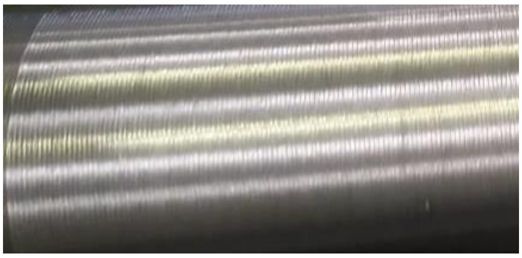

Figure 8: The roughness contour result from experiment 3

Figure 9: The roughness contour result from experiment 4

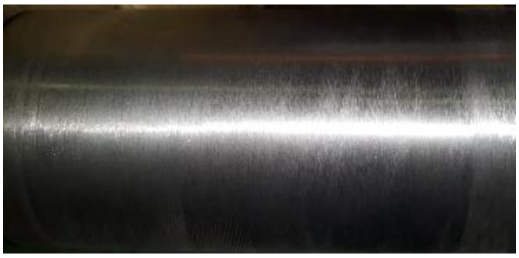

Figure 10: The roughness contour result from experiment 5

The lathe process by using variations of feeding speed is able to obtain a low roughness value. The feeding speed in the lathe process is one of parameter that could affect to the surface of roughness. The difference of cutting speed results in different roughness as well. The best surface roughness resulted at the 0.1 mm/Rev feed speed with surface roughness value of 3.2/N8. This indicating that due to the lower feeding speed given resulted the better the surface roughness of the work piece. The lower feed rate was given the better of the roughness of the work piece, thus potentially resulting low value of roughness. Whilst, the higher value of roughness on experiments to 1, 2 and 3 due to the higher of feed rate were given.

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The lowest roughness value (Ra) in this study is in the 5th experiment with a feeding speed of 0.1 mm/Rev and cutting depth of 0.5 mm, Whilst, the highest roughness value in experiments 1, 2 and 3 with feeding speed of 3 mm/Rev and cutting depth of 6 mm, 8 mm and 6 mm, respectively. The surface roughness value is influenced by the feeding speed (mm/Rev) and cutting depth, while other parameters that influence such as spindle speed (rpm) and tool angle are assumed to be the same. The roughness value on the screw conveyor shaft was classified using the ISO2632/I-1975 standard in micron meter units (µm).

4.0 CONCLUSIONS

The feed rate (mm/Rev) and depth of cut (mm) can effect to surface roughness value on the turning process of screw conveyor shaft. It can be concluded that the lower of feeding rates (mm/Rev) used, the lower of the roughness values produced. The higher feed rates (mm/Rev) used then the higher of the surface roughness value produced. The surface roughness values have the significant differences on feed rate of 0.3 mm/Rev, 0.2 mm/Rev and 0.1 mm/Rev in this paper. Based on the data of roughness value (Ra) result, the lower feed rate (mm/ Rev) and the lower depth of cut (mm), which affected lower roughness values. This was proved by the result for most lowest of the roughness value of 3.2 µm for using feed rate of 0.1 mm/Rev and depth of feed of 0.5 mm. Based on the experiments conducted, it is better to pay attention to use properly the coolant for turning operation on the screw conveyor shaft. Because, one affects to the roughness value on the shaft and reduce vibration. For further research, it can conduct to investigate the surface roughness' values for variation of the tool, which using the variations in cutting depth and cutting speed on the turning process of screw conveyor shaft.

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