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SURFACE ROUGHNESS IN ABRASIVE WATERJET CUTTING

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ABSTRACT
Manufacturing process can be divided into, conventional machining process (CMP) and unconventional machining process (UMP). Differences between these machining processes are: in CMP there must be a physical tool, and in UMP may not be physical tool present. In CMP the waste of material is higher than in UMP. Water jet machining is one example of unconventional machining process. As abrasive waterjet starts to be used in industry, getting high quality surface has become a major requirement. This cutting process has distinct advantages over other unconventional processing technologies. This process is holding several deficiencies, which limits its extensive application. One of the deficiencies is striation marks on cutting surface. Because the major requirement is high quality of the surface, it is necessary to properly select the parameters of this process.This paper analyses the impact of traverse speed on the cutting depth and surface roughness , of aluminium and stainless steel. This analysis leds to the conclusion that, increasing traverse speed leads to reducing the cutting depth. The analyse of impact of traverse speed on surface roughness, leds to the conclusion that by increasing the traverse speed the surface roughness increases in the case of hard metals (stainless steel) and in the case of soft metals (aluminium) decreases.
Keywords: unconventional processing technologies, abrasive water jet machining, cutting depth, surface roughness.

1. INTRODUCTION
Abrasive Water Jet Machining is accepted effective technology for cutting various materials as of its advantages over other unconventional processing technologies such as. no heat is generated in the cutting process, high machining versatility, minimum stresses on the work piece, high flexibility and a small cutting forces, the abrasives after cutting can be reused which allows possible reductions of the cutting cost of the process, machining can be easily automated. The proces has some limitations and drawbacks. It may generate loud noise and a messy working environment, the machining is not applicable for machining too tick pieces, limited number of materials can be cut economically, taper cutting ia also a problem with water jet cutting in very tick materials. As in the case of every machining the quality of AWJC process is significantly affected by the process tuning parameters. There are numerous associated parameters in this technique, among which water pressure, abrasive flow rate, jet traverse rate, standoff distance and diameter of focusing nozzle are of great importance but precisely controllable. The main process quality measures include attainable depth of cut, material removal rate and surface finish .

2. EFFECT OF TRAVERSE SPEED ON OTHER PARAMETERS OF ABRASIVE CUTTING PROCESS

2.1. Effect of traverse speed on depth of cut

Cutting depth is a parameter of the proces of abrasive jet cutting, which depends on the other parameters of the process such as: water pressure, mass flow of abrasive particles, distance between the surface and nozzle, and traverse speed (movement of the nozzle) to be processed in this paper. Studies of two different metals are used to present the impact of traverse speed on the cutting depth of aluminium and stainless steel.

2.1.1 Aluminium

The depth of a cut was measured at different traverse speeds ranging from 1000 to 2000 mm/min. Tests were repeated for two abrasive flow rates of 100 and 150 g/min. The relation between depth of a cut and traverse speed is illustrated in the fig. The figure shows that depth of a cut decreases with the increases of traverse speed. This is because the exposure time of the workpiece unit area to the cutting abrasive jet is reduced. The relation is of a power function form with a high regression rate . This relation is nearly similar irrespective of the considered abrasive flow rate. [1]

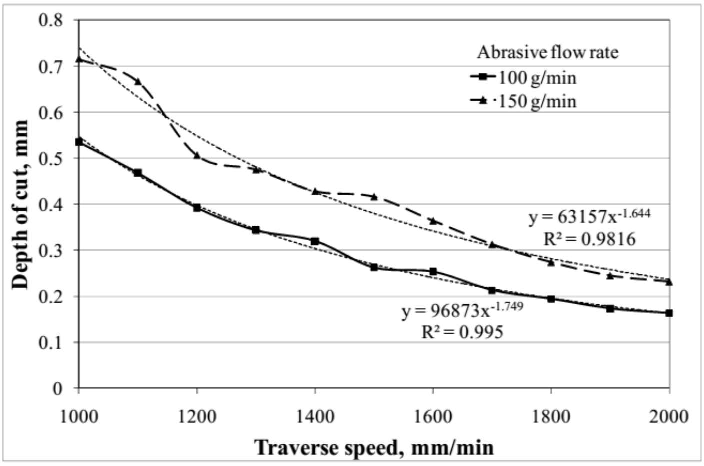

Figure 2. The effect of traverse speed on depth of a cut at different abrasive flow rates (Effect of Process Parameters on Abrasive Water Jet Plain Milling-S. J. Ebeid1, M. R. A. Atia2, M. M. Sayed)[1]

2.1.2 Stainless steel

Results indicate that increase of traverse speed decreases the depth of cut within the operating range selected, by keeping the other parameters considered in this study as constant.With increasing time in which abrasive jet retains its position the cut will be deeper. In this case the stream of abrasive particles will have more time to erode the material resulting in a greather depth of cut . This effect is due to two reasons. First the longer the dwell time the greater the number of impacting abrasive particles hit the material and the greater the micro damage, which starts the erosion process. Secondly, the water from the jet does have a tendency to get into the micro cracks and because of the resulting hydrodynamic pressure, the crack growth results. When the micro cracks grow and connect, the included material will break loose from the parent material and the depth of cut increases.[2]

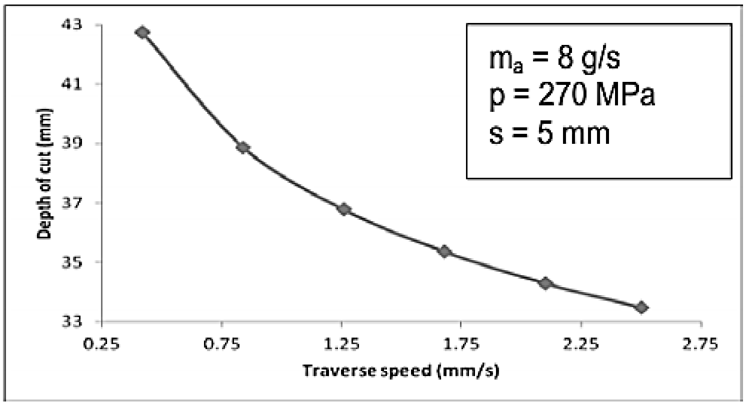

Figure 3. Effect of traverse speed on depth of cut (A Machinability Study of Stainless Steel Using Abrasive Waterjet Cutting Technology-M. Chithirai Pon Selvan and Dr. N. Mohana Sundara Raju) [2]

2.2 Effect of traverse speed on surface roughness

Surface roughness is a parameter of the process of cutting by abrasive waterjet and that as well as cutting depth depends on the other parameters of the process. The quality of the surface is most affected by the depth of cut and traverse speed. The impact of the traverse speed will be presented by the study of two different metals, aluminum and stainless steel.

2.2.1 Aluminium

The surface roughness Ra parameter values were measured at different traverse speeds in the range from 1000 to 2000 mm/min and this test was repeated for two different abrasive flow rates . The test results show that with the increase of traverse speed surface roughness decreases. The relation trend is of a power function with medium regression ratio R^2. [1]

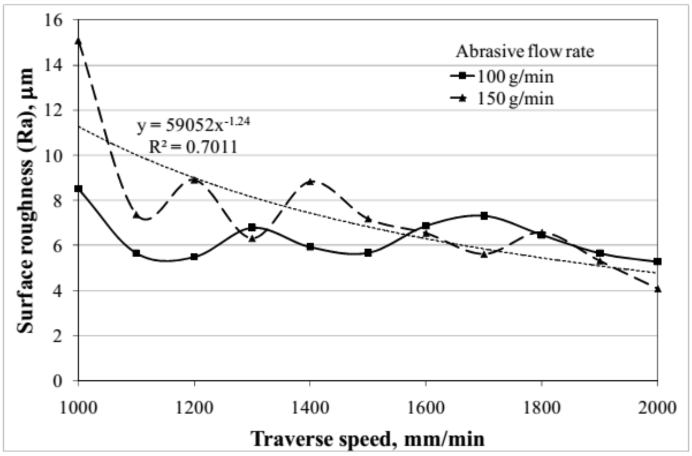

Figure 4. The effect of traverse speed on surface roughnes at different abrasive flow rates (Effect of Process Parameters on Abrasive Water Jet Plain Milling-S. J. Ebeid1, M. R. A. Atia2, M. M. Sayed) [1]

2.2.2 Stainless steel

Due to the reduction of processing costs in practice we have a tendency to increase the traverse speed of the cutting head. Results of increasing the speed are inaccuracies and surface roughness. By increasing the speed of movement of the surface roughness increases. This is due to the fact that the cutting head moves faster, fewer abrasive particles applied to the surface thus a smaller number of cutting edges is available per unit area, resulting in a rough surface.[2]

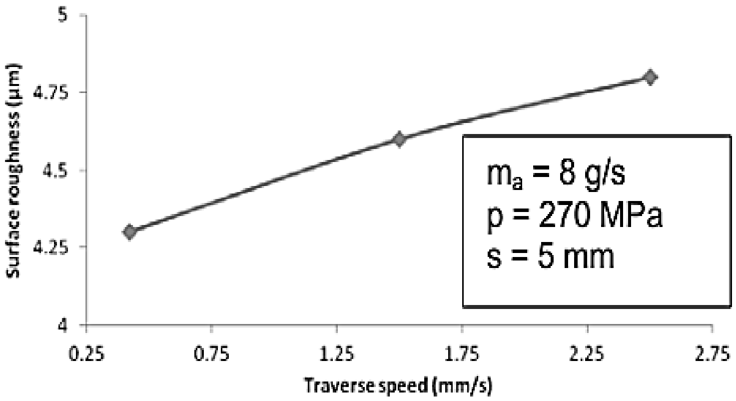

Figure 5. Effect of traverse speed on surface roughness (A Machinability Study of Stainless Steel Using Abrasive Waterjet Cutting Technology-M. Chithirai Pon Selvan and Dr. N. Mohana Sundara Raju) [2]

3. CONCLUSION

Abrasive waterjet machining is a process which has much more advantages than disadvantages. The objective of the paper was to analyse the impact traverse speed on cutting depth. Because cutting depth is a parameter that has an impact on the surface roughness, object of this paper is also the impact of traverse speed on surface roughness.On the basis of the data presented in the analysis it can be seen that with increasing traverse speed is reduced cutting depth, which affects the efficiency of the abrasive water jet cutting and achievemnts of desired effects. This is the case in cutting of stainless steel and aluminium.In the analysis of the impact of traverse speed on surface roughness we can see that by increasing the traverse speed the surface roughness increases ,thats the case in cutting process of stainless steel and cast iron.But in the case of cutting process of aluminium we can see that by increasing of traverse speed surface roughness decreases. This is due to the fact that the steel is typically 2.5 times denser than aluminum [4], and abrasive particles need more time to cut through stainless steel than through aluminium and thats the reason why surface roughness increases by increasing of the traverse speed.

4. REFERENCES

[1] Effects of Process Parameters on Abrasive Water Jet Plain Milling- S.J. Ebeid 1, M.R.A. Atia 2, M.M.Sayed. Design and Production Dept.,Faculty of Engineering, Ain Shams University, Mechanical Engineering Dept., Faculty of Engineering, Arab Academy for Science, Technology and Maritime Transport, Sheraton, Cairo, Egipt,

[2] A Machinability Study of Stainless Steel Using Abrasive Waterjet Cutting Technology-M. Chithirai Pon Selvan and Dr. N. Mohana Sundara Raju, International Conference on Mechanical, Automobile and Robotics Engineering ICMAR, Penang,Malaysia,2012.

[3] A Machinability Study of Mild Steel using Abrasive Water Jet Machining Technology Prof.Kamlesh H.Thakkar*, Prof.Vipul M.Prajapati,Prof.Shreyash A.Thakkar, International Journal of Engineering Research and Application (IJERA), May-June 2013.

[4] http://www.wenzelmetalspinning.com/steel-vs-aluminum.html ,2015.

[5] dr. Brdarević, Unconventional machining processes- Faculty of mechanica engineering, Zenica, Bosnia and Herzegovina, 2012.