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PROCESSING OF A COMPONENT USING A CNC MILLING MACHINE

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Abstract: *CNC (Computer Numerical Control) milling is an advanced technology essential in the manufacturing industry, providing solutions for manufacturing complex parts with a high degree of precision and repeatability. This paper reviews the fundamental processes of CNC milling, starting with CAD design and continuing with CAM programming, machine setup and execution of milling operations. Critical process parameters such as rotational speed, feed and depth of cut that influence product quality and efficiency are discussed. The machined part is made of annealed aluminum alloy Rm ≥ 300 N/mm^2. The machine tool used is Emco 840 CNC milling machine*

Keywords*: CNC milling, cutting velocity, rotation speed, clockwise circle interpolation*

1. INTRODUCTION

CNC milling is a machining process used to make parts of various shapes, sizes and complexities. Milling involves the use of tools called cutters to remove material from the blank to achieve the desired shape [1 ,2 ,3].

2. MECHANICAL TEST OF THE COMPONENT USING A CNC MILLING

The features of the Concept Mill 250 CNC milling machine (see Figure 1) are as follows:

- machine in three working axes, optional 4 and 5 axes,
- the operating interface is Sinumerik,
- the tool shed has 20 slots,
- changing the tools is done using the double gripper device for quick clamping of tools with cone type SK30 DIN 69871,
- axis speed = 0...10000 rpm,
- X-axis rapid advance speed; Y ; Z – 15 m/min,
- X-axis technological advance speed; Y ; Z – 0-10 m/min,
- air-based cooling

Figure 1: CNC Milling machine

To be able to determine the quality of the surface of the external contour [4 , 5, 6], a cylindrical - front cutter Ø20 mm - cutter with removable carbide pads and cylinder - front cutter Ø20 mm - monobloc HSS cutter was used. The material under processing is an aluminum alloy aged $R_m \geq 300$ N/mm^2.

To create the part, the execution drawing was used, after which we created the CAD program.

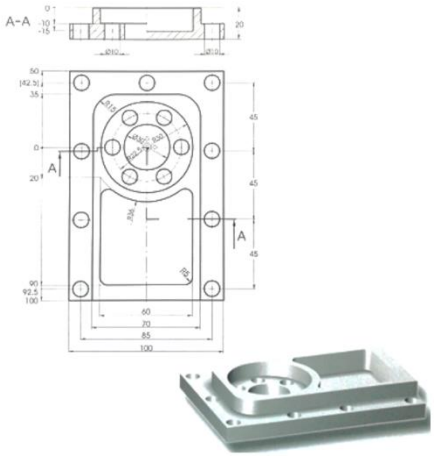

Figure 2: The execution drawing

External contour processing – cylindrical - front milling cutter - Ø20 mm - cutter with removable carbide pads

The parameters of the cutting regime were: v_c = 500mm/min (Figure 2):

- depth of cut of 10mm apmax = 10mm
- cutting speed vc = 500 mm/min
- feed on the cutter ft = 0,23mm
- the number of teeth z = 4 teeth
- speed n = 15.923 rot/min (n= vc *1000/ π*d)
- forward speed vf = 14.649 mm/min (vf = n * ft * z)

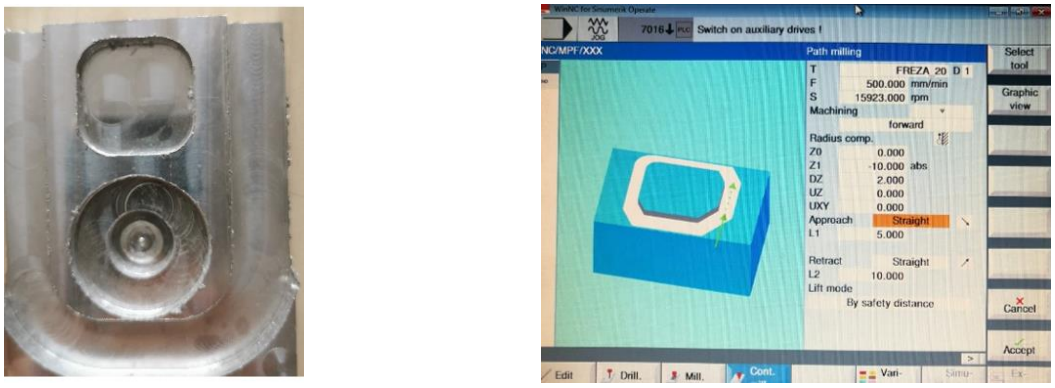

Figure 2: Machining at cutting speed of 500mm/min

The parameters of the cutting regime were: vc = 200mm/min (Figure 3):

- depth of cut of 5mm apmax = 5mm
- cutting speed vc = 200 mm/min
- feed on the cutter ft = 0,20 mm
- the number of teeth z = 4 teeth
- speed n = 3.184 rot/min
- forward speed vf = 2.547 mm/min (vf = n * ft * z)

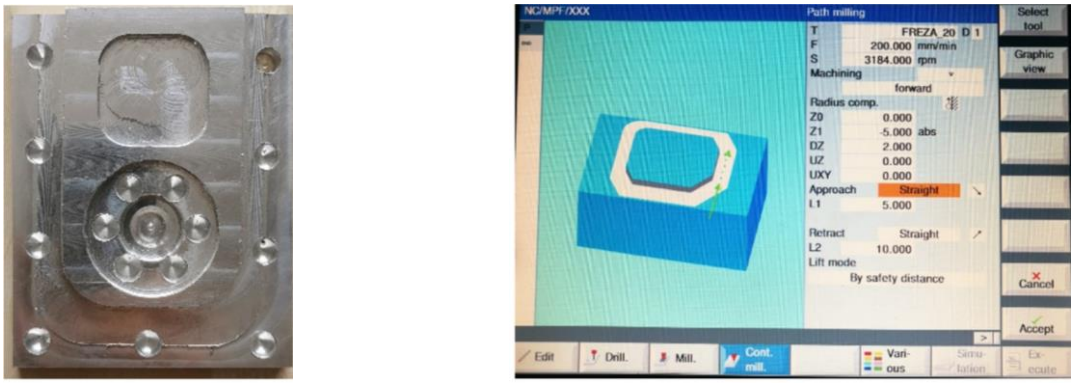

Figure 3: Machining at cutting speed of 500mm/min

The parameters are represented in Table 1.

Table 1. External contour processing – cylindrical - front milling cutter - Ø20 mm - milling cutter with removable carbide inserts

v_c	n	v_f	f_t	a_{pmax}
500	15.923	14.649	0,23	10
200	n = 3.184	2.547	0,20	5

External contour processing – cylindrical - front milling cutter - Ø20 mm – HSS monobloc milling cutter

The parameters of the cutting regime were vc = 150mm/min, (Figure 4):

- depth of cut of 10mm apmax = 0.5 mm
- cutting speed vc = 180 mm/min
- feed on the cutter ft = 0,055 mm

- the number of teeth z = 4 teeth
- speed n = 2.388 rot/min
- forward speed vf = 525 mm/min (vf = n * ft * z)

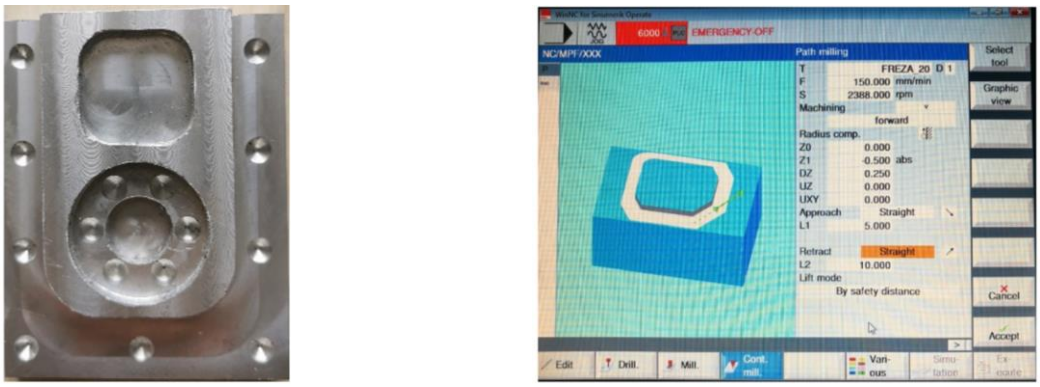

Figure 4: Machining at cutting speed of 150mm/min

The parameters are represented in Table 2.

Table 2. External contour processing – cylindrical - front milling cutter - Ø20 mm - HSS monobloc milling cutter

v_c	n	v_f	f_t	a_{pmax}
190	3025	665	0,055	1
150	2388	525	0,055	0.5

The programming language is sinumerik, see Figure 5. Linear and circular displacements are used to realize the contours. For the contour processing the software needs to define the direction of the cutter's movement in clockwise or trigonometric direction. After this setting the parameters of the trimming regime are set.

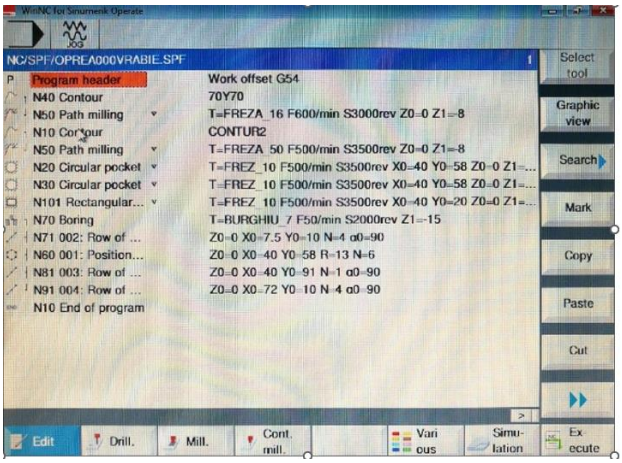

Figure 5: Programming in sinumerik language

3. **CONCLUSIONS**

The CNC milling machine tested does not use coolant during machining. The material being machined is cooled by compressed air only. This leads to

overheating of the tools increasing the friction between the tool and the material, and if the chipping regime is not appropriate the machined surface will also be non-conforming. For the machining to be carried out in accordance with the execution drawing, it is necessary to consider the cooling of the material and the tools when calculating the parameters of the cutting speed.

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