TÍNH TOÁN, THIẾT KẾ HỆ THỐNG ĐIỆN CHO MÁY TIỆN CNC ALECOP

CALCULATION AND DESIGN OF ELECTRICAL SYSTEM FOR ALECOP CNC TURNING

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TÓM TẮT

Công nghệ gia công CNC là xu hướng tất yếu của tất cả các ngành công nghiệp gia công sản xuất trên thế giới. Tại Việt Nam, theo xu hướng, các nhà máy gia công sản xuất đã chuyển sang gia công chính xác trên máy CNC. Tuy nhiên để giảm bớt chi phí đa số các xưởng nhập máy CNC đời cũ đã qua sử dụng. Qua thời gian sử dụng lâu dài các loại máy này hư hỏng và hầu như không còn được sự hỗ trợ phần mềm điều khiển từ hãng sản xuất, cần có giải pháp khắc phục để tránh lãng phí. Ý tưởng thiết kế, lắp đặt hệ thống điện, sử dụng phần mềm MACH3 để điều khiển máy CNC được đề xuất trong bài báo này. Nó giúp tận dụng các máy CNC đã hư hỏng mất hệ điều khiển, tiết kiệm chi phí đầu tư máy mới, bên cạnh đó giảm bớt gánh nặng về xử lý rác thải công nghiệp ở các nước đang phát triển.

Từ khóa: Tiện CNC, mach 3, phục hồi máy CNC, lắp đặt điện máy CNC

ABSTRACT

CNC machining technology is an inevitable trend of all manufacturing processing industries in the world. In Vietnam, following the trend, manufacturing processing factories have switched to precision machining on CNC machines. However, to reduce costs, most factories import used CNC machines. After a long time of use, these machines are damaged and almost no longer have the control software support from the manufacturer, and it is necessary to have solutions to avoid waste. The idea of designing and installing electrical systems, using MACH3 software to control CNC machines is proposed in this paper. It helps to take advantage of damaged CNC machines without the control system, save investment costs for new machines, and reduce the burden of industrial waste treatment in developing countries.

***Keywords**: CNC turning, mach3, CNC machine restoration, CNC machine electrical installation*

1. **Posing problems.**

Derived from the fact that the need to repair and improve CNC machines is increasingly popular. In order to take advantage of damaged old CNC machines and save investment costs, the authors have researched and proposed a solution to convert the Mach3 control system for CNC machines with damaged electrical - control parts.

Currently, in the mechanical workshop of Vinh Long University of Technology and Education, ALECOP mini CNC lathe has had a long time of exploitation leading to machine damage, students lack of internship machines. Through the inspection, the machine is severely damaged in the electrical - control part, and the operating system of the machine cannot be restored. Therefore, the team decided to study, design and install a new electrical-control system of the machine, switch to Mach 3 operating system and restore the mechanical system of the machine. The research with the desire to have more machines for students to practice, study the CNC Turning Internship, CNC Maintenance Internship and applications to practice CNC Maintenance vocational skills for students. In addition, the research results can serve as a premise for the maintenance and improvement of similarly damaged CNC machines.

Figure 1. Alecop CNC turning

2. **Research content and methods.**

The research presented in this paper uses theoretical research methods, calculates and selects suitable components, designs electrical circuits, installs new electrical cabinets and installs control software for Alecop CNC lathes.

2.1. Choosing motors for the CNC turning.

To choose stepper motor and spindle motor for Alecop CNC lathe, we need to analyze the force acting on the tool feed mechanism and the maximum cutting power through the problem with the following cutting conditions:

Longitudinal turning a part D = 50 ± 0,02 mm, length 150mm. Material is carbon steel <0,6%C without hard shell, σ_b = 75KG/mm^2

Cutting depth t = 2 mm

Feed amount S = 0,3 mm/ rev

Tool has the following parameters: T5K10 hard alloy material has a durability of 50 minutes, tool cross section F=12x12mm, $\varphi = 45^0$, $\varphi_1 = 10^0$, $\gamma = -15^0$, $\lambda = 0$

We have the formula to calculate the cutting speed [5]:

$$V = \frac{C_v.K_v}{T^m.t^{Xv}.S^{Yv}} \quad (2\text{-}1)$$

According to the book Mechanical cutting parameters [1]:

$$C_v = 273;\ X_v = 0{,}15;\ Y_v = 0{,}2;\ m = 0{,}2$$
$$K_{mv} = 1;\ K_{nv} = 1;\ K_{uv} = 1;\ K_{\varphi v} = 1;$$
$$K_{\varphi 1v} = 1;\ K_{qv} = 0{,}93;\ K_{ov} = 1$$
$$\text{So } K_v = 0{,}93$$

Substitute the above result into the formula (2-1):

$$V = \frac{273.0{,}93}{50^{0,2}.2^{0,15}.0{,}3^{0,2}} = 133 m/min$$

Number of revolutions:

$$n = \frac{1000.V}{\pi.D} = \frac{1000.133}{3{,}14.50} = 847\ rev/min$$

Tangent force:

$$P_z = C_{pz}.t^{Xpz}.\ S^{Ypz}.\ V^{nz}.K_{pz} \quad (2\text{-}2)$$

According to the book Machining cutting parameters [1]:

$$C_{pz} = 300;\ X_{pz} = 1;\ Y_{pz} = 0{,}75;\ n_z = -0{,}15$$
$$K_{mp} = 1;\ K_{\varphi pz} = 1;\ K_{\gamma pz} = 1{,}25;\ K_{\lambda pz} = 1$$
$$\text{So } K_{pz} = 1{,}25$$

Substitute the above result into the formula (2-2):

$$P_z = 300.\,2^1.\,0{,}3^{0,75}.\,133^{-0,15}.\,1{,}25 = 146 \text{ KG}$$

Radial force:

$$P_y = C_{py}.t^{Xpy}.S^{Ypy}.V^{ny}.K_{py} \quad (2\text{-}3)$$

According to the book Machining cutting parameters [1]:

$$C_{py} = 243;\ X_{py} = 0{,}9;\ Y_{py} = 0{,}6;\ n_y = -0{,}3$$
$$K_{mp} = 1;\ K_{\varphi pz} = 1;\ K_{\gamma pz} = 2;\ K_{\lambda pz} = 1$$
$$\text{So } K_{pz} = 2$$

Substitute the above result into the formula (2-3):

$$P_y = 243.\,2^{0,9}.\,0{,}3^{0,6}.\,133^{-0,3}.\,2 = 101 \text{ KG}$$

Axial force:

$$P_x = C_{px}.t^{Xpx}.S^{Ypx}.V^{nx}.K_{px} \quad (2\text{-}4)$$

According to the book Machining cutting parameters [1]:

$$C_{px} = 339;\ X_{px} = 1;\ Y_{px} = 0{,}5;\ n_x = -0{,}4$$
$$K_{mp} = 1;\ K_{\varphi pz} = 1;\ K_{\gamma pz} = 2;\ K_{\lambda pz} = 1$$
$$\text{So } K_{pz} = 2$$

Substitute the above result into the formula (2-4):

$$P_x = 339.\,2^1.\,0{,}3^{0,5}.\,133^{-0,4}.\,2 = 105 \text{ KG}$$

Cutting capacity:

$$N = \frac{P_z.V}{60.1020} = \frac{146.133}{60.1020} = 0{,}3\ KW$$

X-axis load capacity:

$$N = \frac{P_y.V}{60.1020} = \frac{101.133}{60.1020} = 0{,}22\ KW$$

Z-axis load capacity:

$$N = \frac{P_x.V}{60.1020} = \frac{105.133}{60.1020} = 0{,}23\ KW$$

X and Z axis torque: $T = \frac{P.9{,}55}{n}$ (2.5)

X and Z axis motor revolutions:

$$n_{x,z} = \frac{0{,}3.847}{5} = 50\ rev/min$$

Substitute the above result into the formula (2.5):

$$T_X = \frac{0{,}22.9{,}55}{50} = 0{,}042\ N.m$$

Based on the cutting capacity and torque of the X, Z axis, we proceed to choose the main shaft motor and the X, Z axis motor accordingly.

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2.2. Design electrical circuits for CNC turning.

Select the Mach3 USB CNC control communication circuit, which has the following specifications [7], [6]:

- Low cost, good anti-interference.

- MACH3 USB circuit used with Mach3 software to connect to a computer via USB interface, simple setup.

- The MACH3 USB circuit is capable of controlling 4 or 5 axes using stepper motors (or servos) at the same time through the pul/dir ports X, Y, Z, A, B.

- There are 4 inputs IN1, IN2, IN3, IN4

- There are 4 outputs OUT1, OUT2, OUT3, OUT4

- All inputs and outputs are isolated to ensure absolute safety.

Specifications:

- Communication with computer via USB port

- Power used: 5VDC USB

- Maximum pulse frequency: 100Khz

- Control 4 or 5 axes X, Y, Z, A, B

- Number of inputs: 4 inputs IN1, IN2, IN3, IN4

- Number of outputs: 4 outputs OUT1, OUT2, OUT3, OUT4

The circuit is designed as follows:

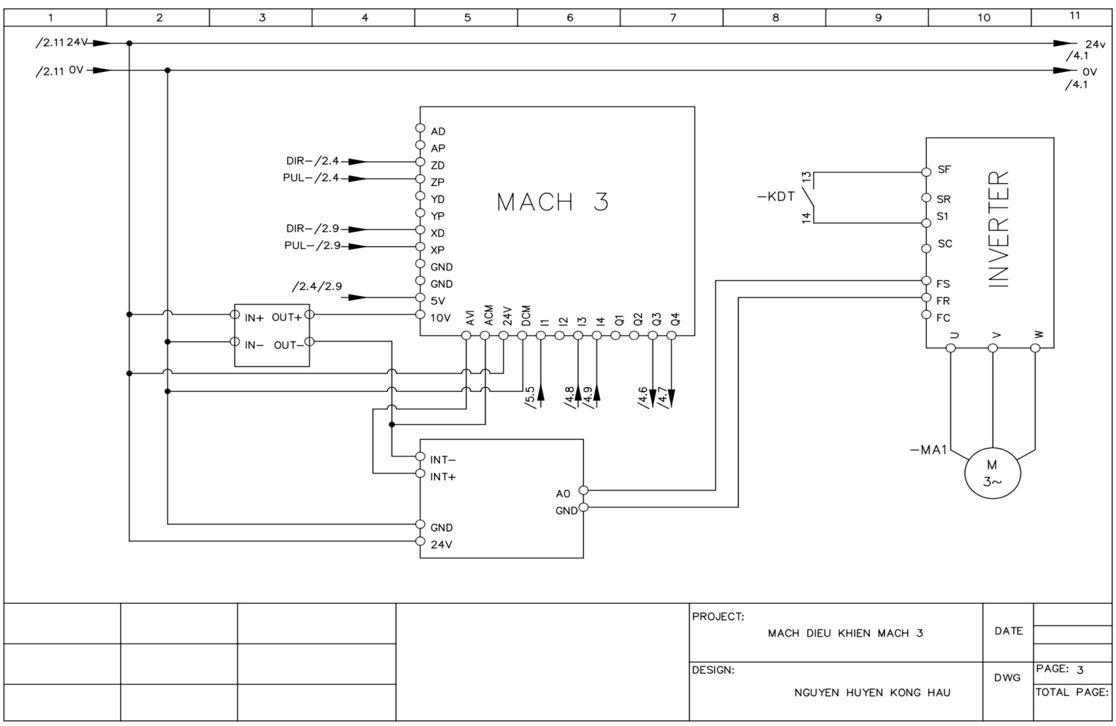

Figure 2. Electrical cabinet diagram

2.3. Results and discussion

From the cutting power and rotational torque of the X and Z axes, we choose the motor as follows:

- Spindle motor: Bizkaia T-65080 engine, capacity 1.5KW

- X-axis motor: Sanyo Denki 103H7126-0440 stepper motor, torque 1.27 N.m

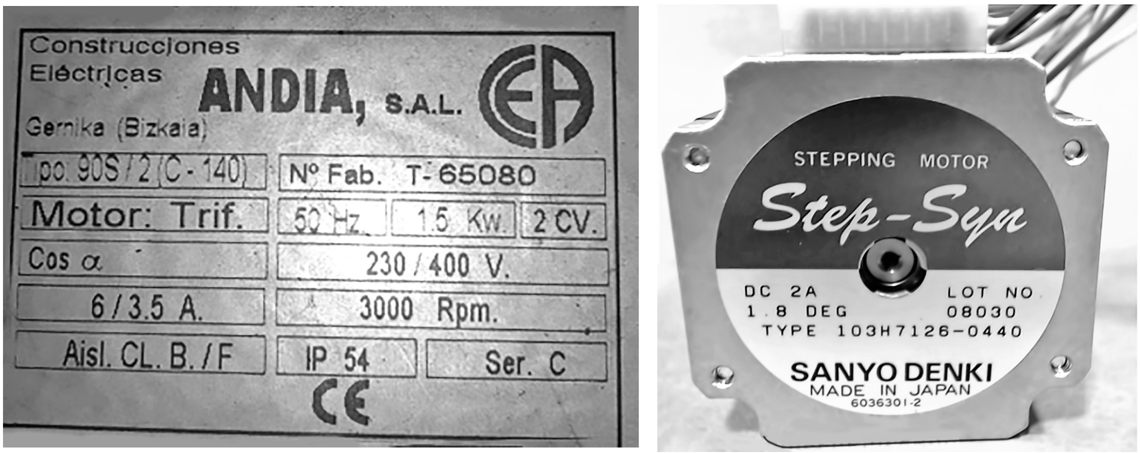

Figure 3. Spindle motor and X, Z axis motor

Proceed to install the electrical cabinet according to the diagram, we get the electrical cabinet as shown in Figure 4.

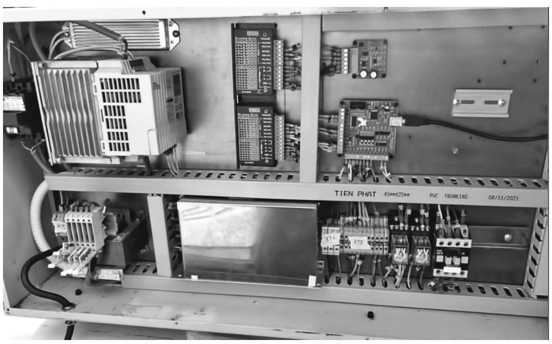

Figure 4. Fully installed electrical cabinet

Experimental products processed on Alecop CNC lathe after switching the control system are shown in Figure 5.

Figure 5. Experimental products on CNC lathe Alecop

3. Conclusion.

Through the calculation results, the authors have selected a suitable motor for the Alecop CNC lathe. Besides, the group has completed the design and installation of electrical cabinets in accordance with the processing requirements according to the original problem. With the selected equipment based on calculation, we have restored the Alecop CNC lathe and processed the experimental product as shown in Figure 5. Specific experimental results will be presented in the next articles.

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