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IMPROVING THE ACCURACY OF PROCESSING SCREW SURFACES OF PARTS ON CNC MACHINES, BASED ON THE CALCULATION OF GEOMETRIC ERRORS

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ABSTRACT
The article is devoted to improving the geometric accuracy of processing screw surfaces of parts by calculating the expected processing errors and making corrections to the control program. Mathematical models of the error in the shape of the longitudinal section of the part due to elastic deformations and wear of the cutting tool in the process of turning the screw surface are determined. Based on the obtained model of elastic deformations, a correction is introduced into the control program for processing the part, aimed at compensating for the geometric error of the shape.
KEYWORDS: *Geometric accuracy, helical surface, elastic deformations, errors, correction.*

1. INTRODUCTION

Working in automatic or semi-automatic mode, the CNC machine must first ensure the accuracy of manufactured parts, which depends on the total error. The total error, in turn, consists of a number of factors:

- Machine accuracy;
- Accuracy of the control system;
- Errors in the installation of the work piece;
- Errors in adjusting tools to size;
- Errors in setting up the machine size;
- Tool manufacturing errors;
- Dimensional wear of the cutting tool;
- Rigidity of the AIDS system.

Under the accuracy of the machine is understood, first of all, its geometric accuracy, i.e. accuracy in the unloaded state. There are four classes of precision machines: H (normal), P (high), B (high), and (especially high). While checking machines for compliance with the standards of accuracy reveal the precision of geometric forms and regulations basic surfaces, precision of movement along the guide rails, the positioning accuracy of axes of rotation, precision machined surfaces, the roughness of machined surfaces [1-4].

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The accuracy of CNC machines is further characterized by the following specific manifestations: the accuracy of linear positioning of working bodies, the size of the dead zone, i.e. the lag when changing the direction of movement, the accuracy of the return, the stability of the output to a given point, the accuracy in the circular interpolation mode, the stability of the tool position after automatic change.

It should be noted that for CNC machines, the stability of the output of working bodies at a given point is often more important than the accuracy of the machine itself. In order to maintain the accuracy of the machine for a long time of operation, the geometric accuracy standards in the manufacture of the machine are tightened by 40% in comparison with the normative ones, thereby reserving the reserve for wear.

The accuracy of the control system is primarily associated with the operation in interpolation mode – a mode in which the system is controlled simultaneously by several axes. Deviations related to the operation of the interpolator do not exceed the price of the sample. For modern machines with the price of single pulses of 0.001-0.002 mm, the error is insignificant, but it is manifested in the form of deviations of micro geometry, i.e. roughness [5-8].

Errors that do not depend on the operation of the interpolator, but appear in the interpolation mode, can be very significant. Their cause is a systematic error in the transmission of movement by the feed drives. These errors occur in the kinematic chain of the feed drive motor-gearbox-lead screw-sensor. When moving along the same axis, such errors appear as uneven movement of the working bodies and practically do not affect the result of processing. However, when moving along several axes, uneven movement even on one axis leads to processing errors in the form of undulation of the treated surface.

2. MATERIALS AND METHODS

The geometric accuracy of the shape of critical parts has a significant impact on the performance of machines, so special attention is paid to reducing machining errors. Due to the appearance of multifunctional metal-cutting equipment equipped with modern numerical control systems, new opportunities are opening up to further improve the accuracy of processed surfaces, which consists in controlling accuracy by transforming control programs for processing specific parts. To implement these features, it is necessary to have strict mathematical models that link errors to the dominant factors of the process [9-12].

The analysis of surface errors on longitudinal turning machines has shown that most of the processed work pieces are characterized by small dimensions, so it is necessary, first of all, to make corrections to the control program, which allows compensate for errors caused by elastic deformations of the technological system. Mechanical treatment of screw surfaces is considered on the example of the "Worm" part of the gearbox of the electric motor of the wiper drive of passenger cars. The part belongs to the class of shafts, made of 40X steel, the accuracy of the screw surface (outer diameter Ø9,8 mm) corresponds to the 8th quality, the parameter is 1.25 microns.

When machining the surfaces of the "Worm" part on CNC lathes, geometric shape errors occur in the longitudinal section of the part. The work piece is fixed cantilever, so with a diameter of Ø9.8 mm, the dominant influence on the error of the longitudinal section shape is elastic deformation of the work piece. Maximum elastic deformation under the action of cutting force

$$y_{max} = \frac{P_y \cdot l^3}{3E \cdot I}, \quad (1)$$

Where, P_y - is the radial component of the cutting force;

l - Is the length of the console;

E - Elastic modulus of the part material "Worm";

$I = \frac{\pi d^4}{64}$ - Moment of inertia of the work piece cross section;

d - the diameter of the work piece.

Radial component of the cutting force

$$P_y = 10 C_p t^x py S^y py V^n py K_{Py}, \quad (2)$$

where, $C_p x_{py} y_{py} n_{py}$ - is a constant coefficient for cutting conditions and degree indicators at the cutting depth t, feed rate S and cutting speed v; K_{Py} - is a correction coefficient for the radial component of the cutting force.

To identify the radial component of the cutting force when cutting the screw surface, the specific value of the radial component of the cutting force is derived [13]. This circumstance allowed us to proceed to the calculation of determining the radial component of the cutting force at the i-th pass [14-15].

$$Py_{уд.} = \frac{Py}{f}, \quad (3)$$

where $f = t_i \cdot s$ - is the area of the cross-section of the section, mm^2.

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Since the P_y - force depends on the value of f in different ways (Fig. 1), the specific force of the Ruud. is a variable.

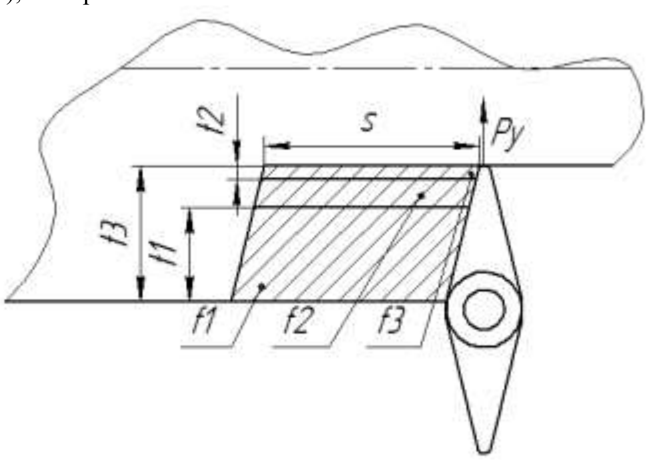

Fig. 1. P_y dependence on the cutting depth t, mm and feed speed s, mm/rev.

$$P_{yi} = \frac{10C_p t^x py S^y py V^n py K_{Py}}{t_i \cdot S} \cdot S_k \qquad (4)$$

Where, S_k is the total chip contact area:

$$S_k = S_1 - S_2, \qquad (5)$$

Where, S_1 is the area of the plate located in the part; S_2 is the area of the plate located in the part on the previous pass. Under the action of the cutting force according to the model (1, 4), elastic deformations occurring at each pass are obtained

$$y_{max.i.b.B.} = \frac{21,33(10C_p t^x py S^y py V^n py K_{Py})\cdot S_k \cdot l^3}{\pi dinp.^4 E \cdot t_i \cdot S}, \qquad (6)$$

Where d_{inp} – the reduced diameter of the work piece. By controlling the movement of the cutting tool, elastic deformations can be reduced: changing elastic deformations and errors by changing the working area of the cutting tool. Formula (7) relates the elastic deformations of the work piece with the elements of cutting force, the diameter of the work piece, the type of material, which allowed us to calculate the geometric error in the cross section of the work piece, which was determined by the formula:

$$\Delta = y_{max.i.b.B.} = \frac{21,33(10C_p t^x py S^y py V^n py K_{Py})\cdot S_k \cdot l^3}{\pi dinp.^4 E \cdot t_i \cdot S} \qquad (7)$$

Where, Δ is the error in the shape of the longitudinal section of the processed part, the maximum value of which is equal to the elastic deformation of the cross section of the work piece that is most distant from its sealing. According to model (7), geometric errors were calculated for data describing the process of turning the helical surface of the part "Worm" and graphs of dependencies $f(t)$ (Fig. 2) and $f(l)$ (Fig. 3) for $C_p = 243$, $v = 68$ m/min, $x_{Py} = 0,9$; $Y_{Py} = 0,1$; $n_{Py} = -0,3$ $K_{Py} = 0,97$; $E = 2,1 \cdot 105 MPa$ were constructed.

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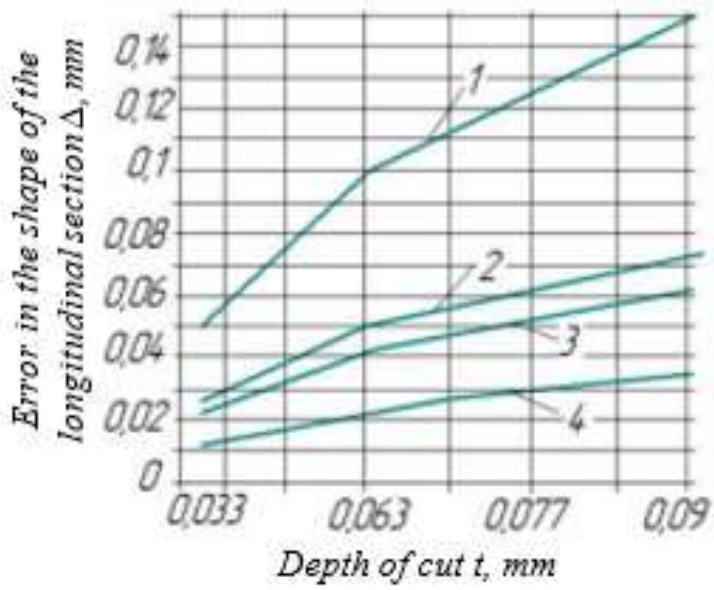

Fig. 2. Influence of the cutting depth on the accuracy of processing the screw surface

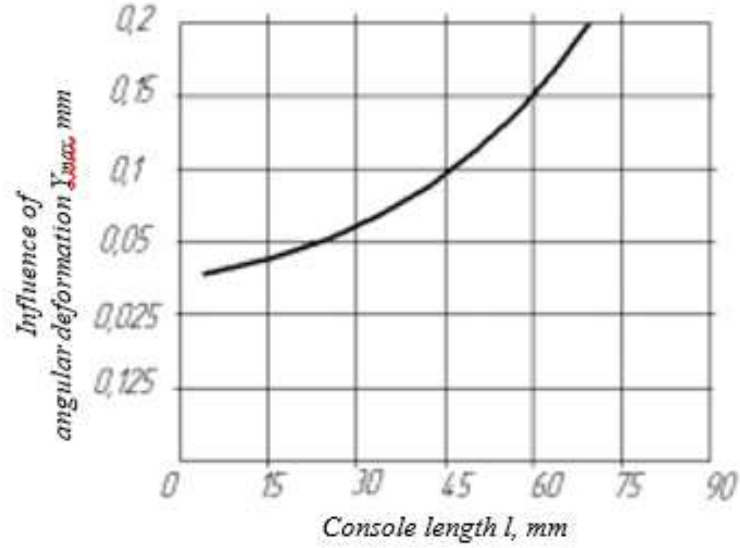

Fig. 3. Influence of the console length on the amount of elastic deformation of the work piece

3. RESULTS AND DISCUSSION

Analysis of the obtained data showed that as the cutting depth t and the length of the console increase, the geometric error increases, which is explained by an increase in the cutting force and elastic deformations of the work piece. Along the length of the console l, the amount of elastic deformation reaches the maximum value in the cross-section that is farthest from the fixing point. Taking into account the error values in the console length function (table. 1) the coordinates of the reference points of the equidistant movement of the cutting tool are determined. The elastic line of the work piece axis is approximated by a circle of a certain radius and the values of the coordinates of its center.

Table 1
Calculated values of geometric errors

Console length, l, *mm*	№ draft passage				№ finishing pas		
	1	2	3	4	1	2	3
	Error of the joint action of elastic deformations and stiffness of the technological system taking into account the approximation						
60	0,12747	0,18253	0,23858	0,29613	0,0681	0,06999	0,07247
50	0,11417	0,16343	0,21348	0,26473	0,0609	0,06259	0,06477
40	0,10087	0,14433	0,18838	0,23333	0,0537	0,05519	0,05707
30	0,08757	0,12523	0,16328	0,20193	0,0465	0,04779	0,04937
20	0,07427	0,10613	0,13818	0,17053	0,0393	0,04039	0,04167
10	0,06097	0,08703	0,11308	0,13913	0,0321	0,03299	0,03397
0	0,04767	0,06793	0,08798	0,10773	0,0249	0,02559	0,02627

4. CONCLUSION

To reduce the error in the shape of the "Worm" part processed on the Hanwha xD 20h longitudinal turning machine, a linear interpolation function is introduced into the control program, which compensates for machining errors caused by elastic deformations of the work piece. As a result, a significant increase in the accuracy of the shape of the processed parts is provided.

REFERENCES

1. *Bobomatov A. Kh. (2017). Creation of an effective design and improvement on a scientific basis of calculation methods for a cotton cleaner - raw from small waste. (Tashkent, Uzbekistan) p. 126.*
2. *Rajabov O. I. (2019). The influence of the mode of movement of the pieces cotton when interacting with a cotton grid. International Journal of Advanced Research in Science, Engineering and Technology.* ***6(3)*** *8455-61.*
3. *Djurayev A., Mavlyanov A., Daliyev Sh. and Rajabov O. (2017). Development and determination of parameters for composite pin cylinder of a seed-cotton cleaner. Digest of scientific and technical achievements in the realm of cotton industry of the Republic of Uzbekistan. pp. 230-34*
4. *Urinov N., Saidova M., Abrorov A. and Kalandarov N. (2020). Technology of ionic-plasmic nitriding of teeths of disc saw of the knot of saw cylinder. IOP Conference Series: Materials Science and Engineering.* ***734(1)*** *012073*
5. *Djuraev A. and Rajabov O. I. (2019). Experimental study of the interaction of multifaceted and cylindrical spiky cylinder in cotton cleaner from small waste. International Journal of Advanced Research in Science, Engineering and Technology.* ***6(3)*** *8376-81*
6. *Djuraev A. and Rajabov O. I. (2019). The influence of the mode of movement of volatiles when interacting with a cotton net Journal Turin Polytechnic University in Tashkent.* ***№1*** *pp.30-35*
7. *Khojiev M. T., Juraev A. D., Murodov O. D. and Rakhimov A. K. (2019). Development of design and substantiation of the parameters of the separator for fibrous materials. International Journal of Recent Technology and Engineering.* ***8(2)*** *5806-11*
8. *Djurayev A. and Rajabov O. (2019). Substantiation of the main parameters of the cylinder with multifaceted spiked of the cotton cleaner from small waste International scientific and practical conference Innovative ideas of modern youth in science and education (USA) p 149-51*
9. *Anvar J. and Ozod R. (2019). Analysis of the Interaction of Fibrous Material with a Multifaceted Grid of the Cleaner. International Journal of Recent Technology and Engineering* ***8(1)*** *2661-66*
10. *Rajabov O., Fazliddin K., and Salimov Sh. (2020). Substantiation of Parameters of the Fibrous Material Cleaning Zone International Journal of Engineering and Advanced Technology* ***9(3)*** *1052-57*
11. *Carlos B. A., Derek P. W., Sidney E. H., Edward M. B., and Marvis N. G. 2011 Charting the Collision Between a Seed Coat Fragment and Newly Designed Lint Cleaner Grid Bars Journal of Cotton Science* ***15*** *33-42*
12. *Mavlyanov A.P. (2018). Improving the designs of the working bodies of cotton feeders and methods for calculating the main parameters (Tashkent, Uzbekistan) p. 120.*
13. *Rajabov O.I. (2019). The influence of the mode of movement of the pieces cotton when interacting with a cotton grid. International Journal of Advanced Research in Science, Engineering and Technology (India). Vol. 6, Issue 3, March 2019. P. 8455-8381*
14. *B. Gaybulloev, N. Ergasheva, O. Rajabov. (2020).The Structure of the Embroidery Machine and Dynamic Analysis of the Needle Mechanism. International Journal of Advanced Research in Science, Engineering and Technology (India). Vol. 7, Issue 1 , January 2020. P. 8376-8381*
15. *O. Rajabov, Z.Shodiyev. (2020). Technological Load from the Cleaned Cotton – Raw. International Journal of Advanced Research in Science, Engineering and Technology (India). Vol. 6, Issue 10 , October 2019. P. 11396-11399*