Study on the Impact of Honing Machine Reciprocating Reversing Acceleration upon Reticulate Pattern Trajectory

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Abstract—Based on the discussion of the influence factors and status quo of Honing reticulate pattern processing technology, the paper makes simulation analysis of the reciprocating reversing acceleration of honing machine, in order to uncover the impact of acceleration changes upon the main Honing process parameters and the quality of reticulate pattern, thus offer the theatrical basis for the improvement of honing machine's reversing acceleration.

Keywords-Honing process; Reciprocating reversing acceleration; Reticulate pattern

I. INTRODUCTION

Internal Honing is a special form in internal grinding process, the precision surface was processed by honing processing with three party related principles. Honing processing is widely used in final processing of cylinder in engine and the surface in cylinder. Flat table honing is more advanced honing process than common honing. At present, flat table honing is widely used in processing of cylinder in engine and the surface in cylinder. proved by the experiment, compared with cylinder liner of common Cylinder, liner of flat reticulate pattern is shortened 1/3 to 1/2 with run-in period, increased by 10% to 20% in life and 5% with torque, reduced by 50%-83% with oil consumption and is able to avoid cylinder scraping phenomenon in working[1].

At present, most of the honing processing have three stages that crude honing, half precision honing and precision honing. In order to appear in the opposite direction for graphite layers, boring cutter grape in rough machining, honing head levorotatory in crude honing, honing head dextral in half precision honing and precision honing. The main purpose of the crude honing is fast remove most honing surplus, fixed fine boring process of produce shape error and ensure durability of processing operations platform cushion evenly and accurate. Half precision honing and precision honing stage is the guarantee product size accuracy, precision and surface shape platform including evaluation parameters of key process stability[2].But, some manufacturer is put forward and test a fabrication process, this process greatly improves the quality of flat reticulate pattern. Honing divided four stages with the first time crude honing, another crude honing, first time precision honing and another precision honing. The first time crude honing purpose makes a machining allowance to amount to the size, another crude honing will reach users size and pull out reticulate; first time precision honing work out platform, and keep the shape and size of the precision, Second is the guarantee of the top of the surface and micro finish durability.

The paper discusses the current situation of processing technology of the platform honing and main parameters to influence the track of honing, analysis in the influence of reciprocating acceleration in honing process, render the honing reticulate track by using numerical analysis method. Through its analytical, thus offer the theatrical basis for the improvement of honing machine's reversing acceleration.

II. HONING PROCESS PARAMETERS ON THE EFFECT OF RETICULATE TRAJECTORY

The quality of honing is very important standard for evaluation of honing machine. It is known that in making the machining process, honing formation of reticulate pattern is due to the head of rotation and honing reciprocating two coordinates of cross movement. Because, In the process of making three party related principles (three pieces of flat the principle of mutual research). Therefore, it can not guarantee the influence of each action research transfer without any kind of campaign. The workpiece will produce the error of roundness, when single only reciprocating motion. The workpiece will produce the error of taper, drum or drum type, and not transfer influence of the top and bottom workpiece surfaces. Therefore, it is can get important guarantee of high reticulate pattern quality as long as simultaneous effect of honing reciprocating speed and rotational speed[3~6].

$$V = \sqrt[2]{V_f^2 + V_w^2}$$

$$\tan\frac{\theta}{2} = \frac{V_f}{V_w} = \frac{2 \cdot L \cdot S}{\pi \cdot D \cdot n} \qquad (1)$$

L—stroke length（mm）

Formula 1 shows that reticulate pattern angle is proportional to honing speed reciprocating, and is inversely proportional to the rotation speed. Honing reciprocating speed depends on honing acceleration, rotation speed of honing not only influence the cutting speed and reticulate pattern Angle, but also decide to reticulate pattern direction of honing commutation. The cylinder of diameter **D**=100mm, length **L**=200mm and angle **θ**=55˚.Different simulation track depends on different rotation speed of V_w = 46 m/min (146 r/min), V_w = 57 m/min (181r/min), V_w= 69m/min (219r/min),when honing reciprocating acceleration is constant. The simulation tracks of oil-stone in MATLAB at different area shows in figure 1.
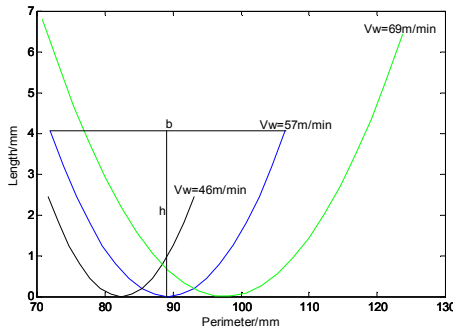

Fig.1 The oil-stone trajectory of different rotating speed in reversing area

The figure 1 shows the greater honing rotation speed, the greater the **b** between slow starting point between the end point, the greater reversing distance **h** in reversing area of the corresponding track, when honing certain reciprocating acceleration. On the contrary, the smaller the honing rotation speed，the smaller **b** of the width of the corresponding trajectory, the smaller **h** of the distance. This is because in the under of certain angle requirement, the greater honing rotation speed, the bigger honing reciprocating speed, the longer the time of reversing acceleration (slow). To sum up, rotation speed of honing main axis have a great influence on the quality of track, as honing have a certain reciprocating acceleration.

The study for the track of different rotating speed are showed in Literature[7]. Early primary it is good honing effect for spindle speed reciprocating V_f = 15.5 m/min, rotation speed V_w = 36.47m/min, V = 39.62 m/min, θ = 45˚ and with 4r/s experiment, parameters is V_f= 12.8 m/min (240/cent),V_w=39.15 m/min (290/cent); V = 41.19 m/min; θ =36˚.The result is ratio of honing speed and reciprocating speed 270/290 = 0.931; 290/240 =1.2083, when θ = 45˚and θ = 36˚. Both results are unlimited circulating decimal. Such results Make reticulate pattern no repeat, but the later can not do without omissions in determined of honing allowance , cutting speed, honing time.

From the above that, the best honing rotation speed is an

S—reciprocating times（times/min）

n—spindle speed（r/min）

D—diameter（mm）

θ—reticulate pattern angle

important significance to ensure the quality of anilox honing in honing certain reciprocating acceleration.

III. THE INFLUENCE OF REVERSING ACCELERATION FOR PARAMETERS

The higher cutting speed, the higher the cutting efficiency for cutting processing in feeding certain. Honing speed is synthesized by honing speed reciprocating trip and linear rota tion, the two relations of that such as formula (1) as shown.

The requirement of honing angle θ is certain, no matter the work piece. Rotating linear speed of honing can be regarded as the same,(the variation of linear speed is caused by diameter trace change can be ignored in speed constant), cutting speed is influenced by acceleration of honing reciprocating reversing through the reciprocating speed V_f to reflect honing.

In a reversing reciprocating trip, the change process speed reciprocating trip as follows:

$$0 \xrightarrow{a} V_f \xrightarrow{-a} 0 \xrightarrow{a} V_f \xrightarrow{-a} 0$$

The time that the zero speed of starting reach to setting of honing reciprocating speed or setting of honing reciprocating speed reach to zero speed of starting is short(long), the time of uniform reciprocating trip high(low), the average speed reciprocating trip small (large), and the low efficiency of honing in a reciprocating trip, when the reversing add (minus) speed is small (large) and vice versa. The cylinder is diameter of **D**=100mm, length of **L**=200mm, requesting aniox angle θ=55˚,1acceleration **a**=2.5 × 10^{4}mm/s^2 honing reciprocating speed V_f=30m/min, rotating speed of V_w by formula(1) to determine. The simulation track of single oil-stone in MATLAB shows in figure 2.

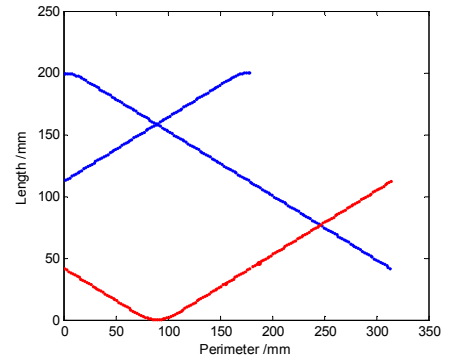Fig.2 The single trajectory of oilstone

The figure 2 shows oil-stone will accelerate (deceleration)in the exchange, the influence of the speed and the reciprocating track will be changed by acceleration of **a**,

stability of anilox angle can not be guaranteed in processing process, which affect the quality of the chemical. The bigger acceleration (deceleration) the shorter the time the speed up to the required uniform time (in the chart the curve segment part are short). This helps to maintain the stability of the angle and expand range of rules reticulate pattern. On the contrary, the smaller acceleration (deceleration) the longer the time the speed up to the required uniform time (in the chart the curve segment part are short)，the greater the range of irregular, the lower quality of reticulate pattern. So, acceleration of appropriate reversing was chose in order to quality of honing reticulate pattern has a great improvement.

IV. THE REVERSING ACCELERATION TO INFLUENCE OF RETICULATE PATTERN QUALITY

Honing machines work quality was reflected by the change of reversing acceleration, especially for influence of honing efficiency in the work. Hypothesis: honing head of five oil-stone, the width of the oil-stone was neglected, five were taken root of the corresponding the same longitudinal oil-stone on which affects the five single points. The cylinder of D=100mm in diameter, L=200mm in length and θ=55°, recipro-cating speed V_f=30m/min, rotating speed of V_w by formula(1) to determine. When the different reversing acceleration are $a = g$ (1 g = 10 m/s^2), a= 2.5 g, $a = 3$ g, $a = 4$ g. The track of the cylinder wall oil-stone are charted through the MATLAB.
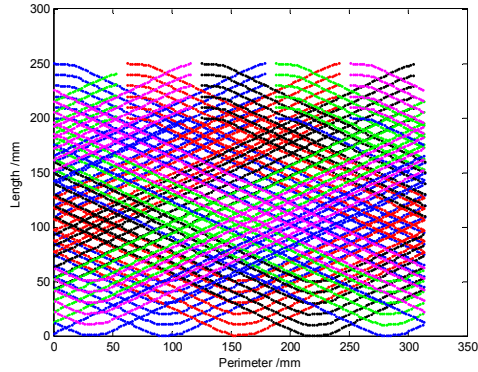

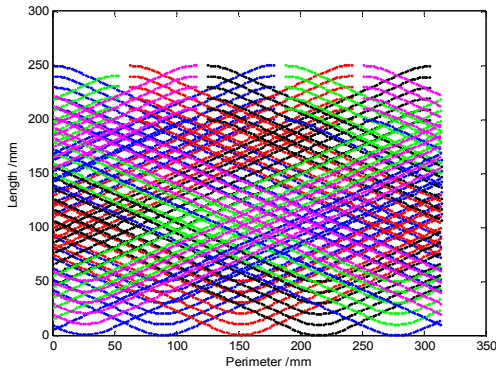Fig.3 Reticulate pattern trajectory of a=g
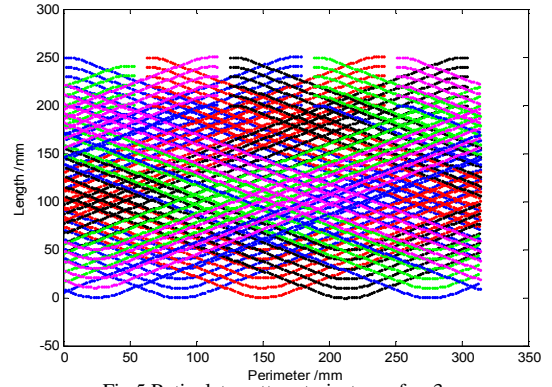

Fig.4 Reticulate pattern trajectory of a=2.5g

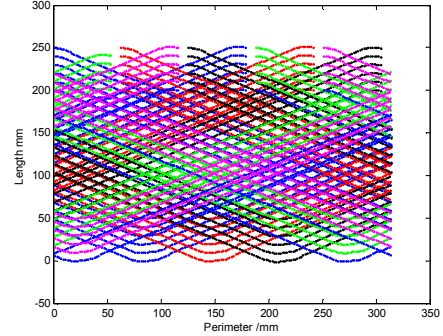
Fig.5 Reticulate pattern trajectory of a=3g

Fig.6 Reticulate pattern trajectory of a=4g

It can draw the trajectory equation of honing reciprocating reversing accelerate (deceleration) through the analysis of the anilox track computation:

$$y = \frac{ax^2}{2V_w^2} \qquad (2)$$

x- horizontal displacement(mm)

It is know that the reciprocating reversing honing track is two paragraphs curve from the above trajectory equation, according to the track of the calculation equation curve arc curvature radius of curvature.

$$k = \frac{aV_w^4\sqrt{V_w^4 + a^2V_w^2t^2}}{(1 + a^2 + V_w^2t^2)}$$

$$R = \frac{(V_w^4 + a^2V_w^2t^2)^{\frac{3}{2}}}{aV_w^4} \qquad (3)$$

From the formula 3 know: the influence of two major factors honing rotational speed and reciprocating acceleration. The increased curvature radius, the genty curve arc, when the increase of rotation speed with acceleration unchanged. It is show the simulation result of figure 4 is correct from another. The increased curvature radius, the genty curve arc, when the increase of acceleration with rotation speed unchanged. But, in fact, the time of exchange acceleration (deceleration) is short, when the increases of reciprocating reversing acceleration and unchanged of acceleration and rotation speed. So, this make curvature radius reduced and curve arc steeper. Figure 7 for diameter D=100mm, length L=200mm and angle θ=55°honin

rotating speed V_w=57m/min(181r/min), different reciprocating reversing track of single grain oil-stone depend on different acceleration of a=2g, a=2.5g, a=3g and a=4g.

Figure 7 shows: the bigger honing acceleration, the smaller the width b of slow starting point and accelerate the end point which the corresponding track in reversing area, when honing certain rotation speed with honing the reciprocating; on the contrary, the smaller acceleration, the bigger the corresponding width b and distance h. This is because in the chemical require Angle, the bigger the acceleration, the smaller the time of the reversing acceleration (deceleration).Therefore, honing reciprocating speed have very big effect for quality of reciprocating track in honing rotation speed certain conditions.
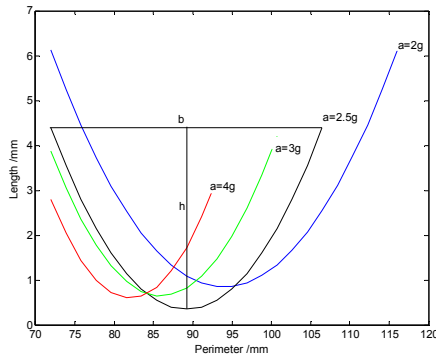

Fig.7 The single oil-stone trajectory of different acceleration in reversing area

To sum up, the ratio of honing reciprocating speed and rotating speed is 0.3640~0.7002 the best reticulate pattern angle can be got. But the best reticulate pattern angle hardly can be got in the area of acceleration with honing reciprocating reversing. Therefore, the bigger honing acceleration, the smaller the area of accelerate regional (deceleration), the greater the valid area on the base of ensure net quality; the bigger curvature radius of curve, the steeper curve arc. So the arc of acceleration (deceleration) area is more short, which improve the reticulate pattern quality of accelerating (deceleration)area. Honing acceleration not only affects the quality of reticulate pattern, but also has huge effect the work efficiency. The acceleration is helpful to improve the work efficiency, however, large acceleration need both starting well of the machine and high requirements of whole machine tools.

V. CONCLUSION

This paper mainly studies honing process parameters and the quality of honing reticulate pattern, they are effected by honing reciprocating acceleration. It can draw two conclusions through the above analysis.

(1) If reciprocating reversing acceleration a of honing machine increases, its maxim reciprocating acceleration also increased, and the rang of rotational speed widened as well, such providing guarantee for choosing the optimal honing process parameters.

(2) As reciprocating reversing acceleration increases, the uniform reciprocating areas increase, and the reciprocating reversing areas decrease. The arc transition zone formed when reversed reduces, and honing quality improves.

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