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ARTICLE

R&L Kinematics of Crank Models in Motor Housing Punch Process

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ABSTRACT

With regards to the assembly line of cost control of Dechang(HK) company, the motor housing's cost control of process will be necessarily respected. Because the supply quantity is big in a machine the price of motor housing is small, so that the cost control of automatic production line is significant with modeling. It is found that the control of equipment includes in shaft and crank linkage for benefit which also needs to be controlled in detail. For the sake of benefits can we fundamentally resolve the main problem of high cost process. .

1. Introduction

Motor housing can be used in assembly line production, because of its thin thickness, can work in the machine line.In the process of stamping, the coil steel plate and the punch press are connected into four working procedures, and three deep drawing operations in a short time to complete the continuous processing of the motor shell.They produce a lot of products in a certain amount of time.Since the production line is an automatic feed punch, it is difficult to control the cost.So we should focus on this cost issue and work for scientific management, networking and digital AI management. Due to excessive machine fatigue, and the processing speed is also fast, we need to carry out timely routine inspection of the machinery and equipment and focus on the hidden faults.This saves the cost of the trip to the manufacturer's personnel for repair due to machine failure and the loss caused by the shutdown of the machine.Because the load and frequency of the machine do not keep up with the loss caused by the fatigue condition under the load of the raw material and the mold, the economic efficiency of the control structure of the crankshaft is an important factor in the automation industry.This paper discusses the crankshaft from the technical point of view of economic benefit. [1~4] the crank is the most critical power mechanism, which turns the rotating motion of the spindle into the linear motion of the ramming motor shell and pushes and presses the thin steel plate.Therefore, the kinematics and dynamics of the crank are studied in order to optimize the crank parameters and save energy and high efficiency.

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2. Model Derivation

2.1 Impact Mode Dynamics of Motor Housing

It is the process of three times of power in motor shell punching, as shown in figure 3.

According to the concept of mechanical power,

because $dP=F_1 d(1/t)$ (1)

Here $\sigma = F/A = \frac{4F}{\pi d_1^2}$ (2)

It has $F = \sigma_1 \pi d_1^2 / 4$ (3)

According to the energy conservation law

$$F = \frac{mv^2}{2l_1} \tag{4}$$

Here $v = \frac{\pi d_0 n}{90}$ (5)

v is crank's doing circulation movement at the diameter of $\rho_z d_0$ [2].

$$\rho_z = \sqrt{\frac{J_z}{m}} \tag{6}$$

$$J_z = 1/2mR^2 \tag{7}$$

Substitute (6) into (7) it gains

$$\rho_z = \frac{R}{\sqrt{2}} \text{ ie } \rho_z = 0.707 \tag{8}$$

Substitute (4) into above equation (5) it has

$$F = \frac{m}{(16200\times l_1)d(3.14\times d_0 n)^2} \tag{9}$$

According to the defining with torque

$$T = Fd_0 \tag{10}$$

& $T = 9.55\times 10^5 P/n$ (11)

replace (11) with equation (10) and gains

$$P = \frac{Fd_0 n}{9.55} \tag{12}$$

Replace (12) with (9) and gains

$$P = \frac{\pi n d_0 \sigma d_1^2}{10.74} \tag{13}$$

Here, v mm/s is the rotation speed of the driving wheel discussed above; N r/min is rotation; P Kw is the power; T is the torque NKm. F_1 is the force exerted by the punch at the first stroke; σ_1 is the impulse pressure. As shown in Table 1, ts is the time of the first punch, m; D_1 is the diameter of the punch hole, which is the same as the diameter of the first punch shell. L_1 is the punching length, which is the same as the first punching shell length mm; T is the thickness. D_0 is the final die diameter.

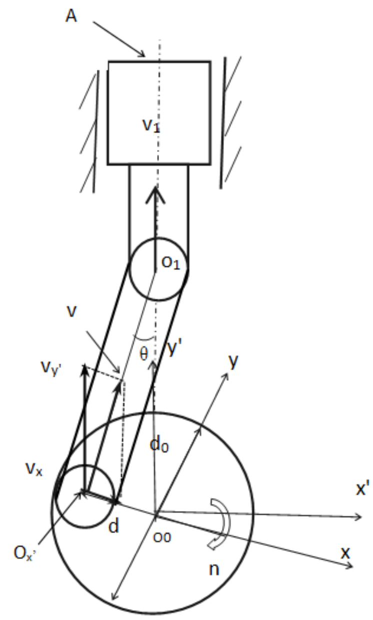

Figure 1. the kinematic of crankshaft linkage in the first motor housing process

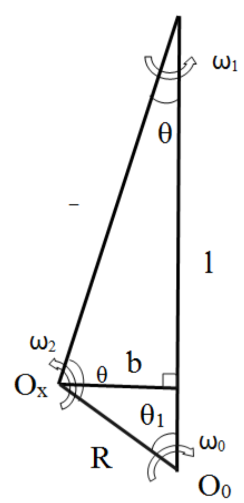

Figure 2. the kinematic of crankshaft linkage

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2.2 Movement Analysis of Crankshaft Connecting Rod Structure

2.2.1 Kinematic Equations

Figure 1 shows the kinematics diagram of crankshaft connecting rod device.The center of the coordinate system x-y is O_0, the crankshaft is the OxO_0 part, and the O_0 circular axis is the drive axis, which rotates n (RPM).Connect the die O_1A through $O_0O1.O_1A$ in the x'-y' coordinate system moves back and forth in a straight line in the y' direction of the orbit, moving at speed v_1.In frame x prime minus y prime, v_1 is equal to v sub y prime.Angle theta is the Angle between the die and the crank. A is the die acceleration; D is the length of the crank, that is, the diameter of the cyclotron; D_0 is the diameter of the drive shaft.As shown in Figure 3, the stamping steel plate mold is O_1A in figure 1.Where a is the first punch, d1 and l1 are the diameter and length of the first punch.B is the second punch, and c is the fourth punch of cutting die.The third and fifth steps are omitted here.The third process is the final product size, which is similar to the second process, so it is omitted in this paper.The fifth step is to remove the shell to the designated point, as shown in the basket below, to facilitate storage and transportation. Assuming that all the forces are the same as F, it is only necessary to analyze the force on the first impact mold. The force analysis process is as follows.

The final member of the connecting rod structure by the crankshaft, namely the section O_0Ox' in the figure, has

$$v_0 = \pi dn \tag{14}$$

According to lever structure principle in Figure 1

$$v_{y'} = \frac{v}{\cos\theta} \tag{15}$$

Due to Figure 2 $v_{y'} = v_1$ (16)

So that $v_1 = \dfrac{v}{\cos\theta}$ (17)

Here θ is included angle between mould and crank, so that

$$v_1 = \frac{v_0}{\cos\theta} \tag{18}$$

Due to the stamping parts with ultimate velocity is zero

$$v_1 + at = 0 \tag{19}$$

$$\& \; dv_1 / dt = -a \tag{20}$$

a is acceleration of stamping parts.

Supposed that stamping time is below

$$t=0.3s \tag{21}$$

(9) take the place of (10) and gain

$$a = \frac{-\pi dn}{t\cos\theta} \tag{22}$$

2.2.2 Equation derivation of the included Angle between connecting rod and center line

Figure 2 is a schematic diagram of crank linkage mechanism, and the parameter can be derived from the following. Set $Ox'O_1 = L$, d = R, b is perpendicular to the L and $O_1O_0 = L$

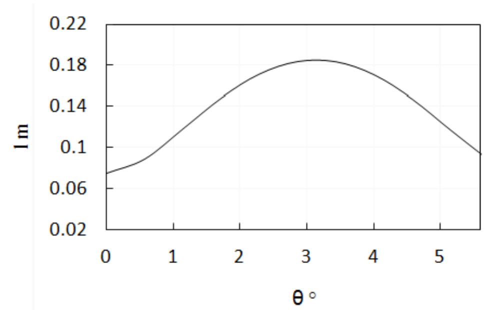
$$l = R\cos\theta_1 + L\cos\theta \tag{23}$$

$$\& \; b = L\sin\theta = R\sin\theta_1 \tag{24}$$

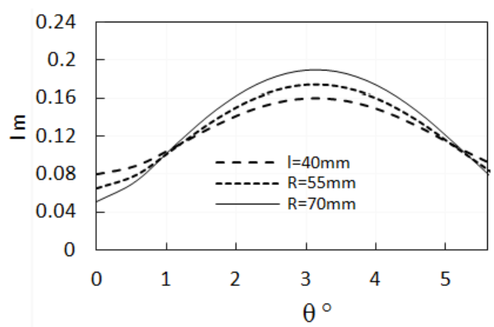
Since law of cosines

$$l^2 = R^2 + L^2 - 2R \quad \cos\theta \tag{25}$$

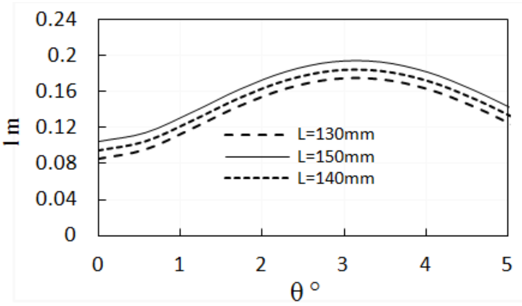
According to above formula supposes that R=40mm, L=120mm and l=R+L-ΔS=160-30= 130 mm. This is the initial Angle of crank drive mould, Δ S for slider here is about equal to 30 mm mold slip effectively.



(a) R=55mm, L=130mm

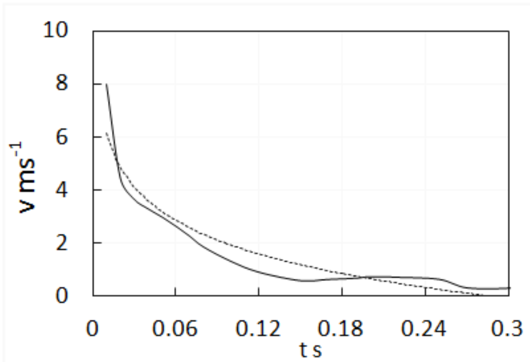


(b) R=40mm,55mm,70mm & L=120mm

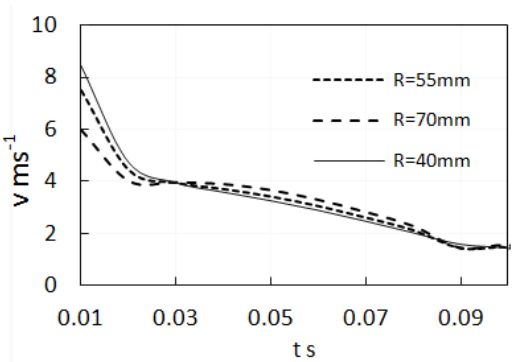


(c) L=130mm,140mm,150mm & R=45mm

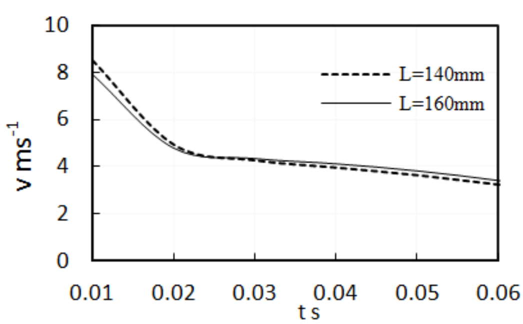
Figure 3. relations of crank length lc and angle in strokes under different R &L



(a) R=40mm, L=120mm

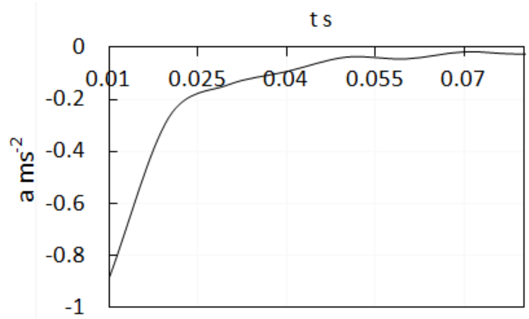


(b) R=40mm, R=55mm, R=70mm &L=130mm

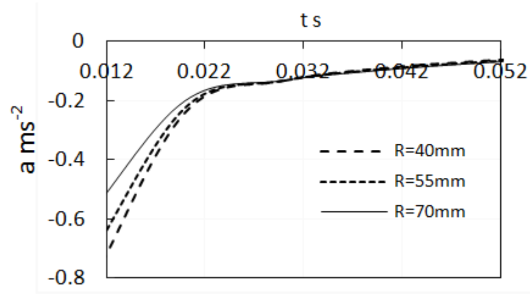


(c) L=140mm,160mm& R=55mm

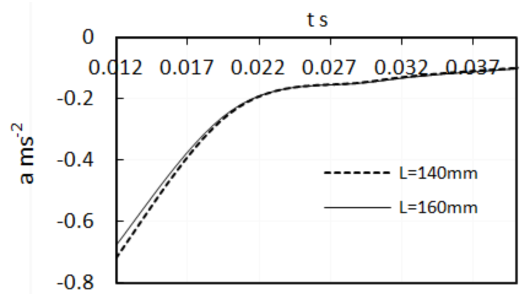
Figure 4. The relations of strokes velocity and time with the parameter R & L



(a) R=40mm, L=120mm



(b) R=40mm, R=55mm, R=70mm &L=130mm



(c) L=140mm,160mm &R=55mm

Figure 5. The relations of strokes acceleration and time with the parameter R & L

Figure 4(a) shows the data under R=45mm and L=130mm.This indicates that the initial speed in the die is up to 500mm/s and the die speed decreases with the increase of time, that is, with the increase of the stamping length.If the stamping time is less than 70m/s in 0.2 seconds, it means that the stamping time is better than 0.3 seconds.FIgure 5(a) shows that the velocity gradually decreases as time increases and finally approaches zero.The change was large before the time was 0.05 seconds, and then moderated. Figure 5(b) curves under R=45mm and L=130mm.It indicates that the distance l between the mold and the center of the drive axis gradually increases with the decrease of Angle from 5.4°, and gradually decreases after 3°.Figure 5 (c) is at L=140mm, and there is no big change in the acceleration of 160mm.At 0.01~0.02s, the curve of 140mm is larger than the absolute value of 160mm, and there is no difference after 0.02s.It indicates

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that the acceleration of the mold changes within the first 0.02s when L changes.

Figure 3(b) shows the L change when the crank radius R changes when L=120mm, which is similar to Figure. 5(a) in a sinusoidal curve.As R gets bigger and l gets bigger, the stroke gets bigger.When R=40mm, l is 0.07m, while when R=70mm, l becomes 0.12m. Figure 3 (c) shows their curves under L=130mm,140mm,150mm & R=45mm.

3. Conclusions

(1) With the increase of time, that is, with the increase of stamping length, the mold speed decreases gradually. Reach below 70m/s in 0.2 seconds.As time goes up, the velocity goes down and it goes to zero.

(2) At 5.4°, the distance l between the mold and the center of the drive axis gradually increases with the decrease of Angle, and after 3°, the l gradually decreases.

(3) When the crank radius R changes, l changes it shows a sinusoidal curve. As R gets bigger and l gets bigger, the stroke gets bigger.

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