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The Kinematic Models of Crank with Angle and Time in Motor Housing 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. It is found that the control of equipment includes in increasing crank and linkage length ratio which also needs to be controlled in detail for the stroke stability with kinematic model. The second is the rotation of crank whose increasing cause speed to increase and acceleration to increase as well. The speed attains 0.2m/s at n=50r/m while the acceleration attains 4m/s2 at n=60r/m.

Keywords: Automatic production line; Crank linkage; Linkage length; Motor housing Modeling; Kinematics

Introduction

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 die, 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 [1-6]. 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. Overview in this paper the dislocation, speed and acceleration of crank has been studies. In order to gain the good acceleration and speed the kinematic modelling has been established. With L (length) and R(radius) the curves is drawn to compare with variable parameters and found the intrinsic relation among them.

Modeling

Is a schematic diagram of crank linkage mechanism, and the parameter can be derived from the following. b is perpendicular to the L and O1O0 = L (Figure 1,2).

$$l = R\cos\theta_1 + L\cos\theta \quad \text{------ (1)}$$

$$b = L\sin\theta = R\sin\theta_1 \quad \text{-------- (2)}$$

$$l^2 = R^2 + L^2 - 2RL\cos\theta \quad \text{------- (3)}$$

According to above formula supposes that R=40mm, L=120mm and it has lmax=R+L=160 mm, lmin=L-R=80 mm. This is the crank driving mould, Δ l=lmax-lmin for distance here is about equal to 80 mm mold effectively. From (2) and (3) it has

Here $\theta_1 = 2\pi nt/60$ -------- (4) It has below as well in terms of them.

$$v = \frac{2\pi Rn}{60}\sin(2\pi nt/60)$$ ------ (5)

And $$v = -\frac{\pi dn}{60}\sin\theta_1$$ ----- (6)

And $$a = \frac{\pi dn}{60t}\sin(2\pi nt/60)$$ ---- (7)

They are the formulas for time and angle θ1. Here θ1 is the angle between crank length and center, t is the time.

Discussions

Shows that under different R and L the θmax value is listed for observing their scope rule (Table 1).

Table 1: *The θmax and L & R in crank.*

No.	R, mm	L, mm	Θmax, °
1	40	160	14
2	55	160	19
3	70	160	24
4	40	140	16
5	55	140	21
6	70	140	27
7	40	130	17
8	55	130	23
9	70	130	28
10	40	120	18
11	55	120	25
12	70	120	30

With increasing R the one will increase meanwhile decreasing L the θmax becomes large. It expresses that increasing distance ratio the one will decrease which is benefit to stroke stability. The minimum is 14° and the maximum is 30° which is the scope in this study. Shows the L changes when the crank radius R=40mm, 55mm,70mm and L=120mm, 130mm & 140mm changes which is a sinusoidal curve (Figure 3). As R gets bigger and l gets bigger, the stroke gets bigger. When R=40mm, l is 0.08m, while when R=55mm l becomes 0.11m and R=70mm, l becomes 0.14m which is correspond to the theoretical one 2R precisely. (Figure 3a) shows their curves similar to Figure 3(c) under L=130mm, 140mm, 150mm & R=40mm and R=55mm. (Figure 3b) is a mix sinusoidal profile when the R changes. At 0° the sinusoidal curve becomes minimum under L-R position meanwhile it is maximum under L+R one at 180°. (Figure 3a,c) shows that with the increasing linkage length the value of l becomes small so it will incline the width decreasing in a sinusoidal to increase the work stability of the die. Shows that the relations of velocity and time & θ1 at 30r/m (Figure 4). With increasing time and angle θ1 the velocity becomes sinusoidal wave, meanwhile it is in relation to crank length R. Figure 5 shows that the relations of velocity and time & θ1 at 40r/m. With increasing the rotation the speed will increase somewhat. Figure 6 shows that the relations of velocity and time & θ1 at 50r/m. With increasing the rotation to 50r/m the speed will increase to 200m/s. They fit the same value well. Because it regulates time and angle θ1 it is an instantaneous speed within one time (Figure 5,6). Shows the acceleration under n=40r/m. This indicates that the maximum speed in the die is up to 0.8m/s^2 and the die speed increases and decreases in sinusoidal with the increase of time (Figure 7). It is in relation to the crank length R in terms of formula. The periodic time is 1.5s in 40r/m, it means that the periodic time is long. (Figure 7b) shows that the acceleration becomes sinusoidal as time increases and finally approaches zero. The size is larger than the one at 50r/m. The periodic time is 1.2s with precise value. (Figure 7c) is at 60r/m, and there is increasing in the acceleration of it. The periodic time is 1s and the acceleration is larger than the above two. The acceleration is used instantaneous time to gain.

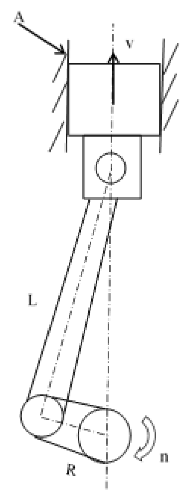


Figure 1: *the kinematic of crankshaft linkage length in the engine of vehicle.*

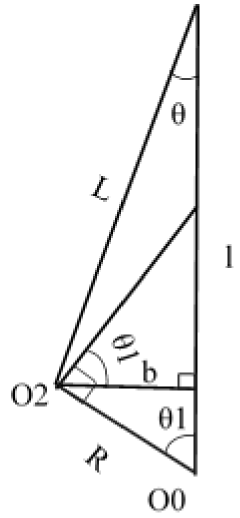
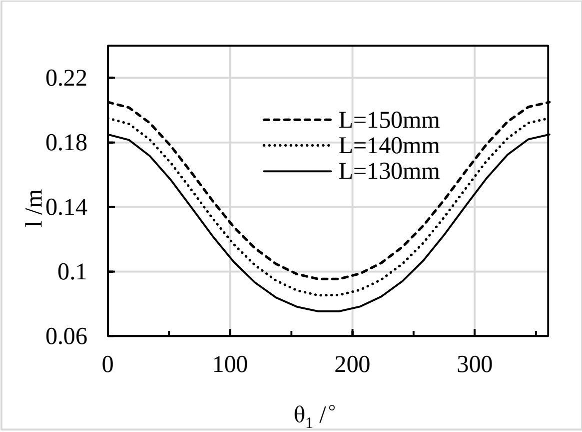
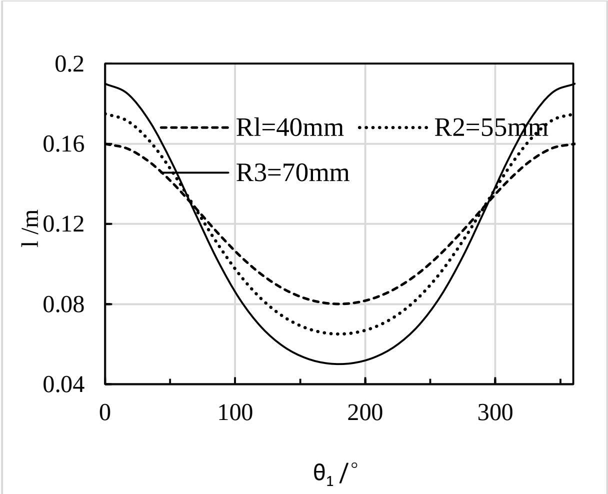


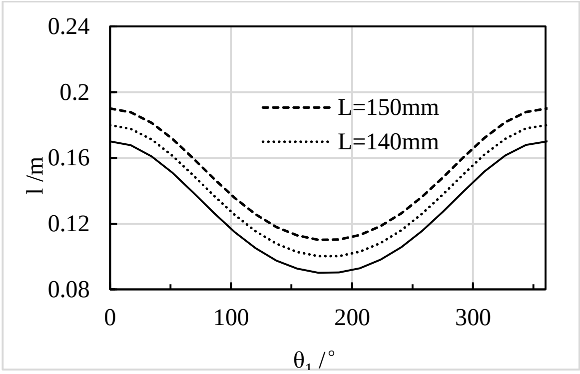
Figure 2: *The kinematic of crankshaft linkage mechanism in engine of vehicle.*



(a) L=130mm, 140mm, 150mm & R=55mm

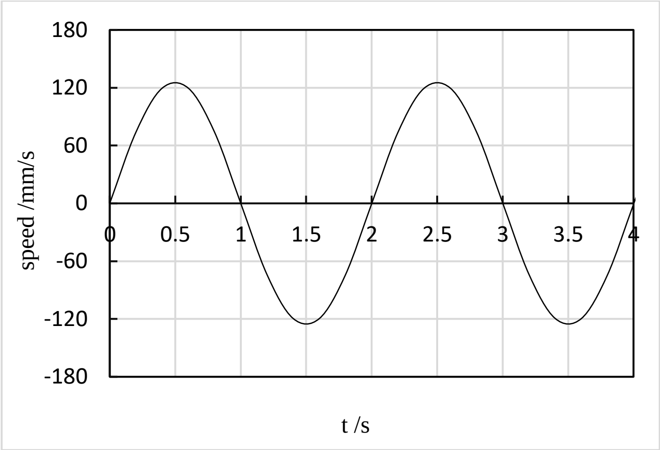


(b) R=40mm, 55mm, 70mm & L=120mm

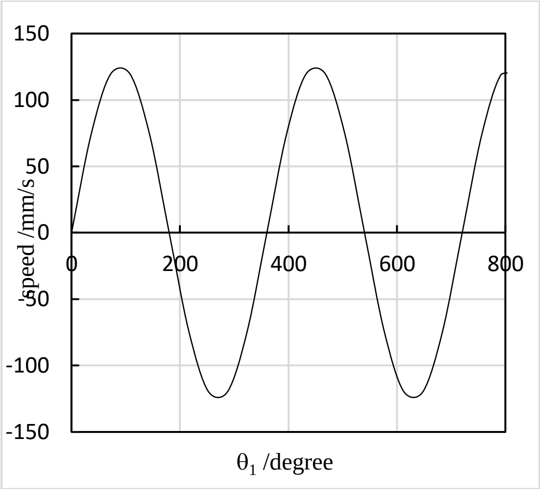


(c) L=130mm, 140mm, 150mm & R=40mm

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



(a) v-t



(b) v-θ1

Figure 5*: The relations of strokes velocity and time & θ1 with R=40mm & n=40rpm.*

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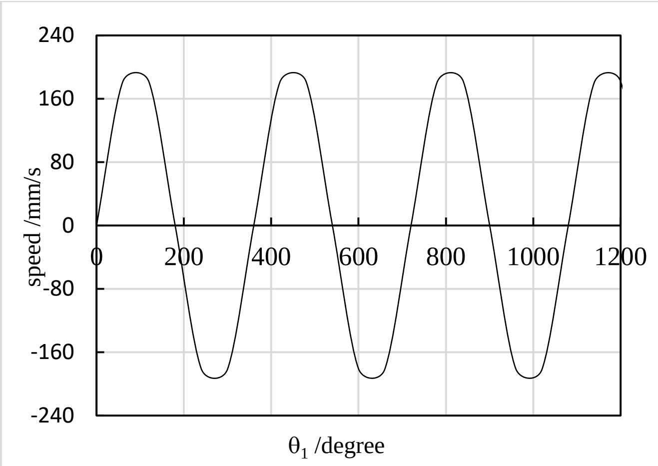
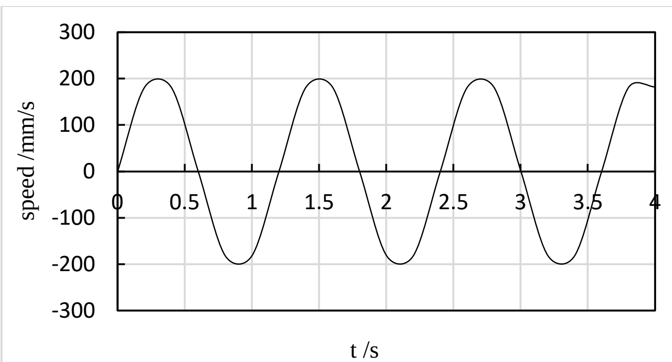
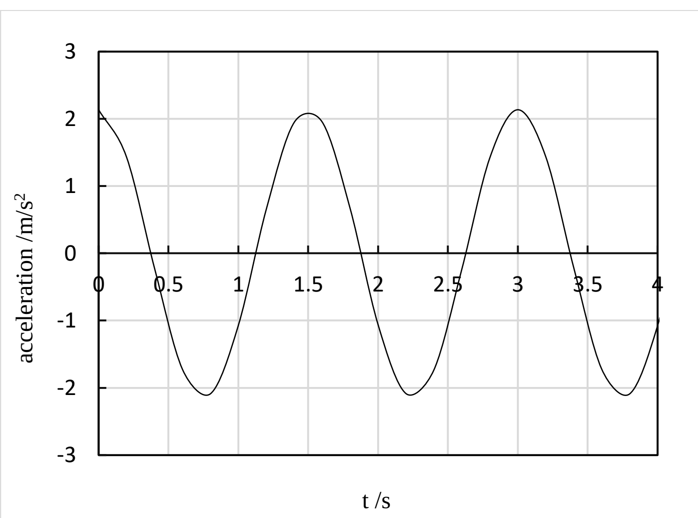


(a) v-t

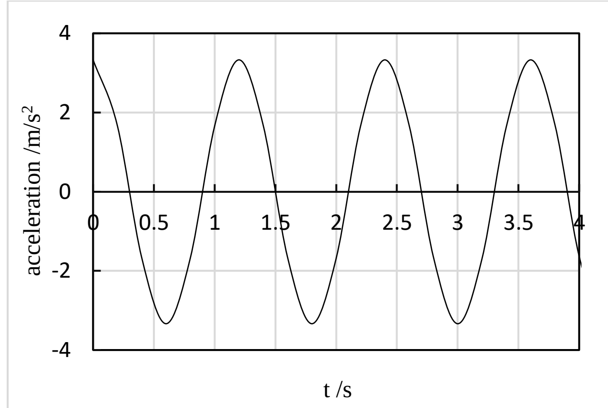


(b) v-θ1

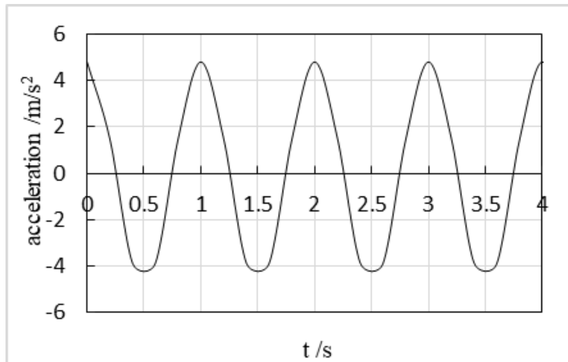
Figure 6: *the relations of strokes velocity and time & θ1 with R=40mm & n=50rpm*



(a) n=40r/m



(b) n=50r/m



(c) n=60r/m

Figure 7*: The relations of strokes acceleration and time with different rotation and R=40mm.*

Conclusions

With increasing distance ratio the maximum angle will decrease which is benefit to stroke stability. With the increase of time and the crank angle with the mold center becomes big the distance shows sinusoidal wave. When crank length is big it shows big distance. The speed and acceleration will increase when the rotation increases and periodic decreases. The speed attains 0.2m/s at n=50r/m while the acceleration attains $4m/s^2$ at n=60r/m.

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