KINEMATICS SIMULATION OF QUICK-RETURN CHARACTERISTICS OF FEED MECHANISM

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ABSTRACT
In this paper, the analytical formulas of the offset slider-crank mechanism were deduced. Data curves were presented to express the relationship between the travel speed ratio coefficient $K$, the minimum transmission angle $\gamma_{\text{min}}$, the eccentric distance $e$, the crank length $l_1$, and the connecting rod length $l_2$. The quick-return characteristics and main design parameters were discussed. Given the main design parameters, the kinematics simulation was done. Through the results of motion simulation, the feasibility of mechanism was verified.

Keywords: feed mechanism, quick-return characteristics, mathematical model, kinematics simulation.

INTRODUCTION
Using quick-return characteristics, feed mechanism can reduce auxiliary time and improve the production efficiency. The offset slider-crank mechanism is a kind of common quick-return feed mechanism. The main design parameters have: the travel speed ratio coefficient $K$, the slider stroke $H$, the eccentric distance $e$, the crank length $l_1$, and the connecting rod length $l_2$. First, we deduced the analytical formulas of the offset slider-crank mechanism. Given $K$, $H$ and any one dimension ($e$ or $l_1$ or $l_2$), we can calculate the other two dimensions.

Secondly, we discussed the relationship between the minimum transmission angle $\gamma_{\text{min}}$ and $K$. Assuming that the feed stroke is 300 mm, then $H=300\text{mm}$. Changing $e$ from 40 mm to 200 mm, changing $K$ from 1.1 to 1.5, we have calculated $\gamma_{\text{min}}$, $l_1$, $l_2$, and the crank acute angle $\theta$. Data curves were drawn to show the force transmission performance and component dimensions.

Finally, mathematical model of kinematics analysis was given, the kinematics simulation was done to verify the mechanism feasibility. The result of simulation will provide the necessary reference to evaluation motion performance and intelligent control.

RESULTS AND CONCLUSIONS
Given $H=300\text{mm}$, data curve of $\gamma_{\text{min}}-e$, $l_1-e$, $l_2-e$ with the different $K$ is shown in Fig. 1. The results showed that: (1) To meet the force transmission condition $\gamma_{\text{min}}=40^\circ$, $K$ value cannot be greater than 1.3. (2) When $K=1.25$, the optimal force transmission performance happened with $e=115\text{mm}$, because $\gamma_{\text{min}}$ was a maximum value. (3) The component dimensions were given according to different $K$ and $e$.

With a bottle pushing mechanism as an example, we let $H=300\text{mm}$, $K=1.25$, $e=115\text{mm}$. Assuming that the feed mechanism efficiency is 5 per minute, then crank angular velocity $\omega_1=\pi6 \text{ rad/s}$. The displacement curve and velocity curve were drawn in Fig. 2. Research shows that the design of the quick-return feed mechanism can meet the operation requirement.
Fig. 1 - Data curve of $\gamma_{\min}-e$, $l_1-e$, $l_2-e$ with the different $K$ (given $H=300$mm)

Fig. 2 - Kinematics simulation results

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