

Studying Job Characteristics of Times Strength Cylinder in Steel welding Nets Machine

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Abstract—This paper explores the operating characteristics of times strength cylinder which drive electrode in steel welding nets machine, we establish the dynamic characteristics' differential equations about times strength cylinder's internal cavity by application of first law of thermodynamics, and obtain the mathematics model about the cylinder's work-stroke. Meanwhile, we simulate it by the use of SIMULINK module in MATLAB. Through the SIMULINK, we draw the cylinder chambers' working pressure and the dynamic curve which is about the piston displacement, velocity changing with time variation, also we have a theoretical analysis about the dynamic change curve.

Keywords—Times strength cylinder; MATLAB; SIMULINK

I. INTRODUCTION

Welding steel nets have been used in reinforced concrete structure, especially a flat structure, such as roads, bridges and metopes, they have incomparable advantages binding compared with binding reinforced, such as shorting construction period, low labor strength ,greatly reducing the social labor productivity, reinforced decorating accurate positioning, the net surface rigidity, improving the comprehensive performance, and prefabricated steel structure component in favour of preventing the fatigue. Meanwhile, they have a very important meaning on improving construction engineering quality, reducing the cost of project and so ^[1].

Studying and employing steel welding nets machine in foreign countries began in the 1990s, comparing to our country ,they have the fast molding speed in steel welding nets, the welding electrode action frequency can be up to 250 times/min .But for the research and use of Steel welding nets machine in our country are quite late, the designed welding electrode action frequency can be only up to 60-70times/min now, it will greatly restrict the steel welding nets machine's working performance and the net slice's molding speed. At present, the research on steel welding nets machine's working performance and the net pieces' molding speed have been already caused the domestic engineering technical personnel's significant attention.

The cylinder is the welding electrode's power component, so speeding up the net pieces' molding velocity depends on the cylinder which drives the welding electrode. Because we demand a high steel welding net pieces' molding rate in the actual production .first, if requiring welding electrode action frequency fast, the cylinder must need short response time,

movement speed, better buffer performance. Second, the main welding method on steel welding nets molding is resistance welding, relying on the positive negative electrode's butt welding shaping, and resistance welding has three elements: welding time, welding current and welding stress. But the cylinder mainly influences the welding pressure and welding time. In the resistance welding, in order to ensure the size of the nuclear fusion and the strength of the solder joint, we can adjust the welding time, heat transfer relate to time. To obtain a certain intensity of solder joint, we can adopt large current and short time. And if the welding stress teenager can cause metal splash, because the electrode driving cylinder closely spaced, it will cause the damage of the cylinder and its ventilation tubes, and also reduce the strength of solder joint.

The tradition cylinder has poor stability at high speed and working fast frequency. In the frequent driver, due to the piston's huge impact, the piston's residence time is long at the cylinder block's caudal end when the cylinder movement is in the end, moreover it can't be reset, so that the cylinder has less gas volume, the short actual displacement and the insufficient riving force in the next action, which can affect electrode driving speed and the mesh piece's welding effect.

According to the above situations, this paper proposed a new type cylinder. On the basis of the single-acting cylinder, we design twin pistons times strength cylinder (hereinafter referred to as The Times strength cylinder), The Times strength cylinder undertakes a rapid exhaust by opening many holes on cylinder body, its piston returns by spring return, so that it increase the piston velocity, reduce the retention time, improve the stability of the electrode driving cylinder, and make the cylinder quickly reset and does not affect the next rapid welding.

II. THE TIMES STRENGTH CYLINDER'S STRUCTURE AND PRINCIPLE DIAGRAM FIGURE

When the times strength cylinder is working, high-pressure air goes into the no stem cavity 1 and the stem cavity 8 by the intake11,26 , the high pressure gas effect on the piston, overcoming the spring resistance to promote the piston forward movement, when the pistons moving forward ,the gas of the exhaust cavity educts by the air vent2, 3 , the intake stops venting when the piston quickly move to the designing trip, the piston return by the spring, complete a welding action.

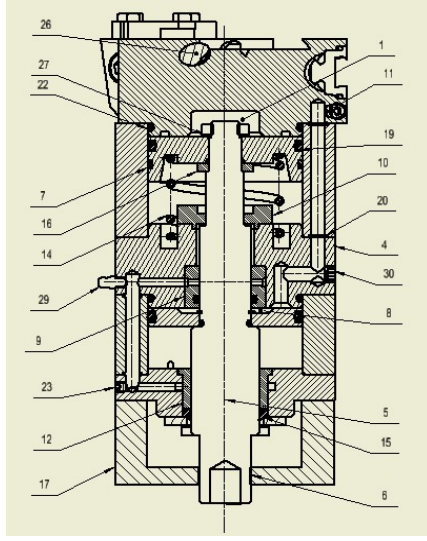


Figure 1.The Times strength Cylinder's section figure

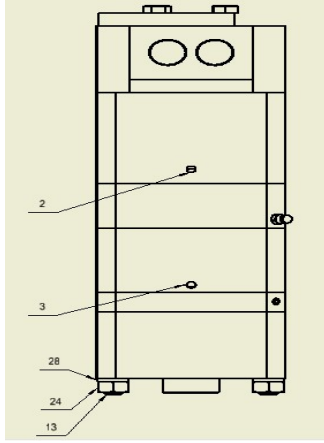


Figure 2.The Times strength Cylinder's structure figure

1—the no stem cavity (air cavity I) 2, 3—the air vent 4—the cylinder center 5—the cylinder ahead 6—the piston rod 7—the cylinder piston 8—the stem cavity (air cavity II) 9—the piston center banjo 10—the oriented banjo 11—air cavity II the intake 12—the piston rod front banjo 14—the spring 15—the piston rod front seal ring 16—the positioning banjo 17—guide bar stents 19, 20, 22—type O sealing ring 26—air cavity I the intake.

III. THE TIMES STRENGTH CYLINDER'S MATHEMATICAL MODEL IN THE ACTION

According to the gas dynamics and thermodynamics basic theory, Gas has the compressibility, gas flow state will change in energy transmission and throttling process. For simplified model, we raise the following hypothesis about the movement process of the cylinder which not influences the results^[2]:

- (1) Gas as the ideal gas, meet the equation of ideal state gas $p = \rho RT$;
- (2) Indoor gas of cylinder cavity having no heat exchange with outside;
- (3) The air pressure is constant, the temperature is for environmental temperature;

environmental temperature;

- (4) The friction is relatively small, can be neglected;

(5) Ignored the effect of gas inertia force as to the gas speed caused, gas just only roles on the piston by static pressure;

- (6) The cylinder leakage is neglected.

A. The energy equation

The Cylinder chamber's filling, deflating process is thermal process for a change quality system, according to the constant air pressure to finite volume of air thermal energy equation^[3]:

$$KRT_s dM_s = Vdp + KpdV \text{ and } Q_{m1} = dM_s / dt ,$$

Obtain air cavity I(no stem cavity)pressure equation:

$$\dot{p}_1 = \frac{KRT_s Q_{m1}}{V_1} - \frac{Kp_1}{V_1} \dot{V}_1 \quad (1)$$

$$V_1 = A_1 (x_{10} + x) \quad (2)$$

Air cavity II (Stem cavity) pressure equation:

$$\dot{p}_2 = \frac{KRT_s Q_{m1}}{V_2} - \frac{Kp_2}{V_2} \dot{V}_2 \quad (3)$$

$$V_2 = A_2 (x_{20} + x) \quad (4)$$

Type: V_1 、 V_2 for air cavity volume m^3 ; A_1 、 A_2 for the cylinder air cavity gas effective function area m^2 ; p_1 、 p_2 for the cylinder air cavity gas' absolute pressure p_a ; x for the pistons displacement m; x_{10} 、 x_{20} for more than cavity volume of the gap equivalent length m; Q_{m1} for the quality flow of air flowing through the air pipe kg/s ; R for gas constant $J/(kg \cdot K)$; K for gas adiabatic index; T_s for air temperature K. The air vent always are interlink to the atmospheric pressure, so the discharge cavity has the atmospheric pressure.

B. Quality flow equation

In the pneumatic technology, people usually make the various pneumatic components by gas passing abstract into a contract nozzle or throttling holes to calculate^[4], the flow can be used to calculate by the following formulas^[5]:

$$Q_m = \frac{A_e p_u}{\sqrt{RT_u}} \psi(\sigma) \quad (5)$$

$$\psi(\sigma) = \begin{cases} \sqrt{2\sigma(1-\sigma)} & 0.528 \leq \frac{p_d}{p_u} < 1 \\ \frac{\sqrt{2}}{2} & 0 < \frac{p_d}{p_u} < 0.528 \end{cases} \quad (6)$$

Type: p_d 、 p_u for upstream and downstream pressure of

respectively holes MPa, T_u for the upstream the temperature of the tubes system K; σ for pressure ratio; A_e for the effective cross-sectional area of the hole m^2 .

C. Motion equation

According to the Newton's second law, the times strength cylinder piston's motion equation for:

$$\left\{ \begin{array}{l} \ddot{x} = \frac{1}{M} [(p_1 A_1 + p_2 A_2) - kx - F] \\ (x=0 \cap (p_1 A_1 + p_2 A_2) > kx + F) \cup (0 < x < L) \\ \ddot{x} = \frac{1}{M} (kx - F) \\ (x=L \cap (p_1 A_1 + p_2 A_2) + F < kx) \\ \ddot{x} = 0 \\ (x=0 \cap (p_1 A_1 + p_2 A_2) \leq kx + F) \cup (x=L \cap (p_1 A_1 + p_2 A_2) + F \geq kx) \end{array} \right. \quad (7)$$

Type: M for cylinder piston and its driving parts quality kg; L for the schedule of the times strength cylinder m. F for load bearing N.

IV. THE TIMES STRENGTH CYLINDER'S DYNAMIC SIMULATION MODEL

In the simulation system of the times strength cylinder, the gas flow's sound velocity, no sound velocity's conditions choice, and the differential equations' constraint conditions have been realized by SIMULINK 2D switch^[6]. The main structure and performance parameters of the times strength cylinder are: air pressure $p_1 = 600\text{kPa}$, $p_2 = 600\text{kPa}$, $M = 1.5\text{kg}$, spring coefficient $k = 1000$,

$A_e = 3.14 \times 10^{-6} m^2$, $A_1 = 0.025434 m^2$, $A_2 = 0.011304 m^2$, $T_s = 300\text{K}$, $F = 125.4\text{N}$, $R = 287.1\text{J/(kg} \cdot \text{K)}$, $K = 1.4$ (air adiabatic index), $x_{10} = 0.01\text{m}$, $x_{20} = 0.005\text{m}$, the piston stroke $L = 0.025\text{m}$. We make the dynamic characteristics' actual structure parameters and working parameters generation into the established dynamic characteristics' differential equations. and obtain the SIMULINK simulation model as shown in figure 3.

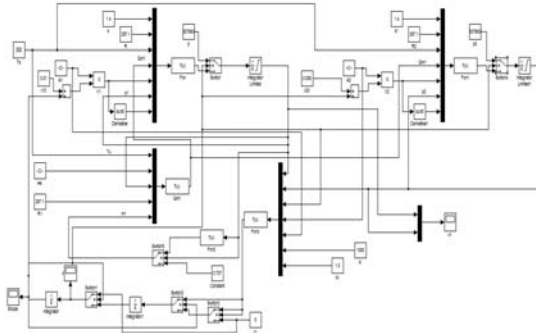


Figure 3 The times strength cylinder dynamic simulation model

V. THE TIMES STRENGTH CYLINDER MOVEMENT SIMULATION

RESULTS

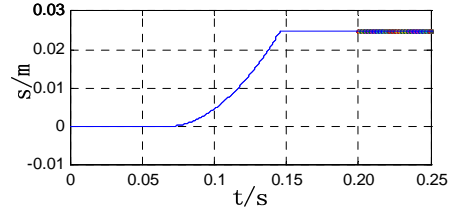


Figure 4 The piston displacement curve

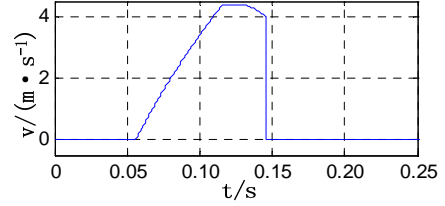


Figure 5 The piston speed curve

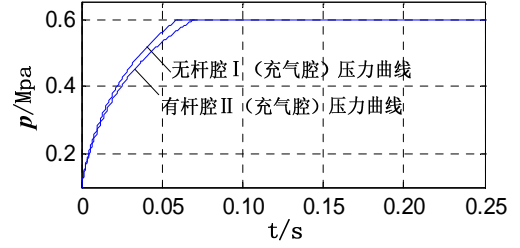


Figure 6 The times strength cylinder's air cavity I, II pressure change curve

VI. CONCLUSION

By the times strength cylinder' dynamic characteristics' digital simulation results, we can verdict that:

(1) The times strength cylinder's action frequency is in the 160-170 times/min by the piston displacement curve analysis, it was 2.5 times or so comparing to the original cylinder action frequency 60-70 times/min.

(2) For the piston speed curve analysis, the pistons can finish accelerated acceleration, constant speed, slowing down and stopping a stroke in the 150ms. So the new times strength cylinder can meet short response time, movement speed, good buffer performance.

(3) In the operation process of the new times strength cylinder, the air pressure of the pressure cavities will achieve to meet the actual demand and pressure change in 60-70ms, it also accords with theoretical requirements.

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