The New Design of Syrup Drug Delivery Device

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Abstract. The purpose of this paper is to solve the problem of low packing efficiency and low packing accuracy of syrup. A device for separating syrup drugs and its measuring method are discussed through a new device. The measuring device includes: the first cylinder block; the second cylinder block; the drug inlet and outlet pipelines connecting the one end of the first cylinder block and the one end of the second cylinder block; the two ends are separated. A connecting pipe connecting the other end of the first cylinder block and the other end of the second cylinder block; a first piston movably mounted in the first cylinder block; a second piston movably mounted in the second cylinder block; a pressure-guiding liquid placed between the first piston and the second piston; and a flow rate of the pressure-guiding liquid flowing through the connecting pipe. Meter; the first solenoid valve used to control the connection between the drug inlet pipeline and the first cylinder block; the third solenoid valve used to control the connection between the drug inlet pipeline and the second cylinder block; the second solenoid valve used to control the connection between the drug outlet pipeline and the first cylinder block; and the fourth solenoid valve used to control the connection between the drug outlet pipeline and the second cylinder block. In addition, the mathematical model is used to synthesize the calculation, and the frequency converter is commanded to send out a new frequency, so that the pumping machine works at this new frequency. At the same time, the flowmeter will provide a new flow data.

1. Introduction

Drugs treat cough used for children have always been mainly syrup drugs¹. However, syrup is a viscous liquid with weak fluidity and strong adhesion to the tube wall². However, syrup filling machine is commonly used in pharmaceutical factories³. The spring pressure of valve should be adjusted in filling accuracy by filling measurement and operator's experience⁴. Adjusting the switching speed of the valve mainly adjusts the spring pressure of the valve. If the spring pressure increases, the switching speed of the valve will be accelerated⁵. The speed error of syrup filler is mainly determined by filling quantity, filling speed and the switching speed of upper and lower valves⁶. The switching speed of upper and lower valves is related to the viscosity of products. The higher the viscosity, the slower the switching speed of valves⁷. Therefore, in the process of loading drugs, stickiness, continuous work and accurate measurement have become the most important problems.
1.1 Materials
The components of this product are as follows in figure 1 and 2: the first cylinder block; the second cylinder block; Feeding and discharging pipes (both connected to one end of the first cylinder block and the other end of the second cylinder block respectively); the first piston piece movably installed in the first cylinder block; the second piston piece movably installed in the second cylinder block; the first cylinder block upper fitting. There is a pressure-guiding liquid injection port in the first cylinder block, and also the second cylinder block has an exhaust hole. The pressure-conducting liquid is placed between the first piston and the second piston; a flowmeter for detecting the flow rate of the pressure-conducting liquid flowing through the connecting pipeline is arranged in the connecting pipeline, a first solenoid valve for controlling the connection between the charging pipeline and the first cylinder block, a third solenoid valve for controlling the connection between the charging pipeline and the second cylinder block, and a third solenoid valve for controlling the connection between the charging pipeline and the first cylinder block. The second solenoid valve and the fourth solenoid valve which control the connection between the discharge pipeline and the second cylinder body; The first solenoid valve and the fourth solenoid valve constitute the solenoid valve group I and switch simultaneously; the second solenoid valve and the third solenoid valve constitute the solenoid valve group II and are connected simultaneously; The central processing module of flowmeter, solenoid valve group I and solenoid valve group II is used to control the opening of solenoid valve group I or solenoid valve group II after the meter starts to work. When the flow rate of pressure-conducting liquid detected by the flowmeter is lower than the preset flow rate, the solenoid valve group I or solenoid valve group II in the open state is controlled to close, and the solenoid valve group II in the closed state is controlled at the same time. The solenoid valve group I or the solenoid valve group II are opened, which makes the solenoid valve group I and the solenoid valve group II work alternately in the open and closed states. In addition, it is applied to a frequency converter connected with the motor at the output end of the syrup drug metering device; when the output frequency of the frequency converter changes, the speed of the motor of the drug pumping machine changes accordingly; the central processing module controls the output frequency of the frequency converter according to the flow rate of the pressure-conducting liquid detected by the flowmeter and the energy consumption of the motor; and is installed in the connection. The pressure sensor and temperature sensor in the pipeline will not cause excessive loss because of the pressure conducting medium inside. The syrup drug metering device also includes a timing module and a storage module connected with the central processing module, which controls the timing module to timing each commutation cycle, and obtains the syrup drug output volume in each commutation cycle according to the timing time output by the timing module and the flow rate of the pressure-conducting liquid detected by the flowmeter; the central processing module also uses the centralized processing module. The output volume of the syrup drug is stored in the storage module. However, the central processing module is connected with the input module and the display module; the timing module is also used to output the prompt signal to the central processing module when the timing time reaches the preset time; the central processing module controls the display module to display the above prompt module; the input module is used to receive the syrup drug density and the syrup drug water content parameters input by the user. According to the density of syrup drugs and the water content of syrup drugs input by the input module, and combined with the volume of syrup drugs output in each commutation cycle, the actual quality of syrup drugs output in each commutation cycle was obtained.

1.2 Conceptual design
Figs 1 and 2 are the schematic diagrams of the metering device described in the present invention. Fig. 1 shows the opening of solenoid valve group I and the closing of solenoid valve group II. The first piston and the second piston in Figure 1 are still in the initial position, and the second piston will move to the right due to the syrup drugs entered by the second cylinder block; Figure 2 shows the opening of solenoid valve group II and the closing of solenoid valve group I, and the first piston as well as the second piston in Figure 2 are still in the initial position, at the first piston will move to the right due to the syrup drugs entered by the first cylinder block. The central processing module controls the output frequency of the
frequency converter according to the flow rate of the pressure-guiding liquid detected by the flowmeter and the power consumption of the motor as follows: The central processing module first controls the output frequency of the frequency converter equal to the preset frequency, and uses the formula to obtain the drug output per unit energy; makes fi=f, and controls the output frequency of the frequency converter equal to the preset frequency fi, and uses the formula  to obtain the drug output per unit energy ηi, then makes fi+1=fi+Δf, and c At the same time, we use formula ηi+1=F/Wi+1 to get the drug output per unit energy ηi+1. Judge the size of ηi+1 and ηi if ηi+1 is larger, then the formula fi=f+Δf will executed. Simultaneous, we use formula ηi+1=F/Wi+1 to get the drug output per unit energy ηi+1, Until fi+n appears the nth time, and determine the size of fi+n-1 and fi+ni, if fi+n-1 is larger therefore terminate the cyclic controls.

In special cases, when fi changes to the highest rated frequency fmax of the motor supply, the discriminant procedure is terminated by maintaining fmax (generally fmax = 50Hz, sometimes equal to 60Hz). At this time, the input or output of the converter should be short-circuited to reduce power loss. Normally, the cyclic fi+n of the nth order is less than fmax.

Fi in the formula denotes the flow of the pressure-conducting liquid detected by the flowmeter when the output frequency of the converter equals the preset frequency fi; Wi in the formula denotes the power consumption of the motor when the output frequency of the converter equals the preset frequency fi; ηi in the formula indicates that when the frequency of the converter is fi, the power consumption of the motor is Fi for the Wi, simultaneous flowmeter and the drug output per unit energy. Fi+1 in the formula represents the flow of the pressure-conducting liquid detected by the flowmeter when the output frequency of the frequency converter equals the preset frequency fi+1, and Wi+1 in the formula represents the power consumption of the motor when the output frequency of the frequency converter equals the preset frequency fi+1. ηi+1 in the formula indicates that when the output frequency of the frequency converter is fi+1, the power consumption of the motor at this time is Wi+1 and the crude drug output of the flowmeter is Fi+1, and the drug flow per unit energy. Δf is the change of the preset frequency, which is generally artificial presupposition. The numerical range is 0.5Hz-5Hz. If ηi is large, recordn, and reverse the sign of +Δf to –Δf. Then fi+1=fi-Δf is executed. The output drug flow ηi+1 of unit energy is calculated by formula

ηi+1=F/Wi+1 until the nth ηi+n occurs.

In the case of fi=f+Δf, another parameter gamma γi+1=F/Fin must also be calculated. Compared with γi+1 and γi=F/Fi, if γi is larger maintains fi operation, if γi+1 is larger maintains fi+1 operation. After n times cycle, it was found that the maximum γi+n-1 was maintained and the cycle was terminated. The γi in the formula represents the amount of drug produced per unit time when the frequency converter equals the preset frequency of fi.

When the output frequency of the transducer equals the preset frequency, the flow rate of the pressure-guiding liquid detected by the flowmeter can be expressed as the average flow rate of the pressure-guiding liquid when the output frequency of the transducer equals the preset frequency, or the maximum flow rate of the pressure-guiding liquid when the output frequency of the transducer equals the preset frequency. In addition, the meter also includes a pressure sensor and a temperature sensor mounted on the connecting pipeline.
Fig. 1 Piston pre-motion device diagram
1.3 Measurement steps

As shown in figs. 1, 2 and 3, a measurement method for syrup drugs for children as described above includes the following steps:

Step 1: The central processing module controls the opening of the solenoid valve group I, the closing of the solenoid valve group II, the connecting of the feeding pipeline and the second cylinder block, the connecting of the drug outlet pipeline and the first cylinder block, and the entering of the medicine into the second cylinder block by the feeding pipeline, which promotes the right movement of the second piston in the second cylinder block, thereby pushing the pressure-guiding liquid out of the second cylinder block, the flowmeter simultaneously detects the flow of the pressure-guiding liquid flowing through the connecting pipeline. The pressure-guiding liquid entering the first cylinder block pushes the first piston in the first cylinder block to move left and pushes out the air in the first cylinder block.

Step 2: To determine whether the flow rate of the pressure-guiding liquid detected by the flowmeter is lower than the preset flow rate, step 3 is executed, otherwise step 2 is returned.

Step 3: The central processing module controls the opening of the solenoid valve group II, the closing of the solenoid valve group I, the feeding pipe is connected with the first cylinder block, and the delivery pipe is connected with the second cylinder block. The medicine transported by the feeding pipe enters the first cylinder block, then pushing the first piston in the first cylinder block to the right. The flowmeter simultaneously detects the flow rate of the pressure-guiding liquid flowing through the connecting pipeline. The pressure-guiding liquid entering the second cylinder block pushes the second piston in the second cylinder block to the left and pushes the medicine out of the second cylinder block. The Medicine released from the second cylinder block is flowed out through the discharge pipeline, and step 4 is executed.

Step 4: To determine whether the flow rate of the pressure-guiding liquid detected by the flowmeter is lower than the preset flow rate, if it is lower the step 5 is executed, otherwise step 4 is returned.

Step 5: The central processing module controls the opening of the solenoid valve group I, the closing of the solenoid valve group II, the feeding pipe is connected with the second cylinder block, the delivery pipe is connected with the first cylinder block. The medicine delivered by the charging pipe enters the second cylinder block, pushing the second piston in the second cylinder block to the right, and then pushing the pressure-guiding liquid out of the second cylinder block, this time the flowmeter detects the flow of the pressure-guiding liquid flowing through the connecting pipeline at the same time. The pressure-guiding liquid flowing into the first cylinder block drives the first piston in the first cylinder block to move to the left. The medicine in the first cylinder block is pushed out. The Medicine released from the first cylinder block is flowed out through the drug-discharging pipeline and returns to step 2.

Fig.2 Drawing of the device after the first piston movement
2. Results analysis
We use 200 ml syrup to separate and measure. Because this product is a viscous liquid, we can't weigh its volume specifically, but convert it into quality for experimental operation. The theoretical weight is 276.00 g/200 ml. The experimental data are shown in the table below.

| Number of experiment | Actual weight/g | error/g |
|----------------------|-----------------|---------|
| 1                    | 275.96          | -0.04   |
| 2                    | 276.04          | 0.04    |
| 3                    | 276.03          | 0.03    |
| 4                    | 276.00          | 0.00    |
| 5                    | 275.96          | -0.04   |
| 6                    | 275.98          | -0.02   |
| 7                    | 276.00          | 0.00    |
| 8                    | 276.00          | 0.00    |
| 9                    | 275.98          | -0.02   |
| 10                   | 275.98          | -0.02   |

Average value=275.993g
Standard deviation=0.026687492

3. Discussion
The time interval between the opening of solenoid valve group I and the opening of solenoid valve group II in this experiment is a commutation period, and the metering method also has the following steps: according to the duration of each commutation period, the central processing module obtains the drug output volume in each commutation period according to the pressure-guiding liquid flow detected by the flowmeter in different commutation periods; after obtaining the volume of drug output in each reversal cycle, the central processing module also obtains the actual quality of drug output in each reversal cycle according to the density of the drug input and the volume of drug output in each reversal cycle. Also, the central processing module controls the output frequency of the frequency converter connected with the motor according to the flow rate of the pressure-guiding liquid detected by the flowmeter and the consumption power of the motor in accordance with the mode described in the third part.

The timing module cannot only time each commutation cycle, but also output prompt signal to the central processing module when the timing time reaches the preset time. The preset time is optimized to be 4 hours. According to the above prompt signal, the operator completes the drug sampling and completes the drug density measurement with the drugs. Then the results were input through the input module, and the results could be considered to remain unchanged within 4 hours. According to the parameters of the drug density of the drug input, the central processing module combined with the volume of the drug output in each commutation cycle, obtained the actual quality of the drug output in each commutation cycle, and completed the conversion of the volume and quality of the drug.
In this design, pressure conduction is realized by pressure conducting liquid, which avoids the direct contact of flow monitoring equipment with drug metering method in the existing technology, overcomes the difficulties in drug metering, has a long service life and simple installation. It can be simply connected into the crude drug pipeline, which is convenient to maintain, low in operation and detection cost, less in power consumption components and energy saving, and can accurately calculate drug dosage. At the same time, it can obviously reduce the errors of drugs and improve the accuracy of measurement results. By using intermediate pressure conducting medium, double piston parts and double cylinder block, it can ingeniously apply the flow detection equipment which cannot be used for long time. By repeatedly measuring the flow rate of pressure conducting medium, it can replace the direct measurement of the flow rate of separated drugs. And the pumping unit motor is controlled according to the amount of drug discharged per unit energy, and the amount of drug discharged per unit energy is equal to the flow of pressure-conducting liquid detected by the flowmeter divided by the consumption power of the motor, which makes the flow data directly related to the electric control part of the pumping unit, realizes the maximum amount of drug discharged per unit energy, and controls the work of the pumping unit motor in order to save electricity.

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